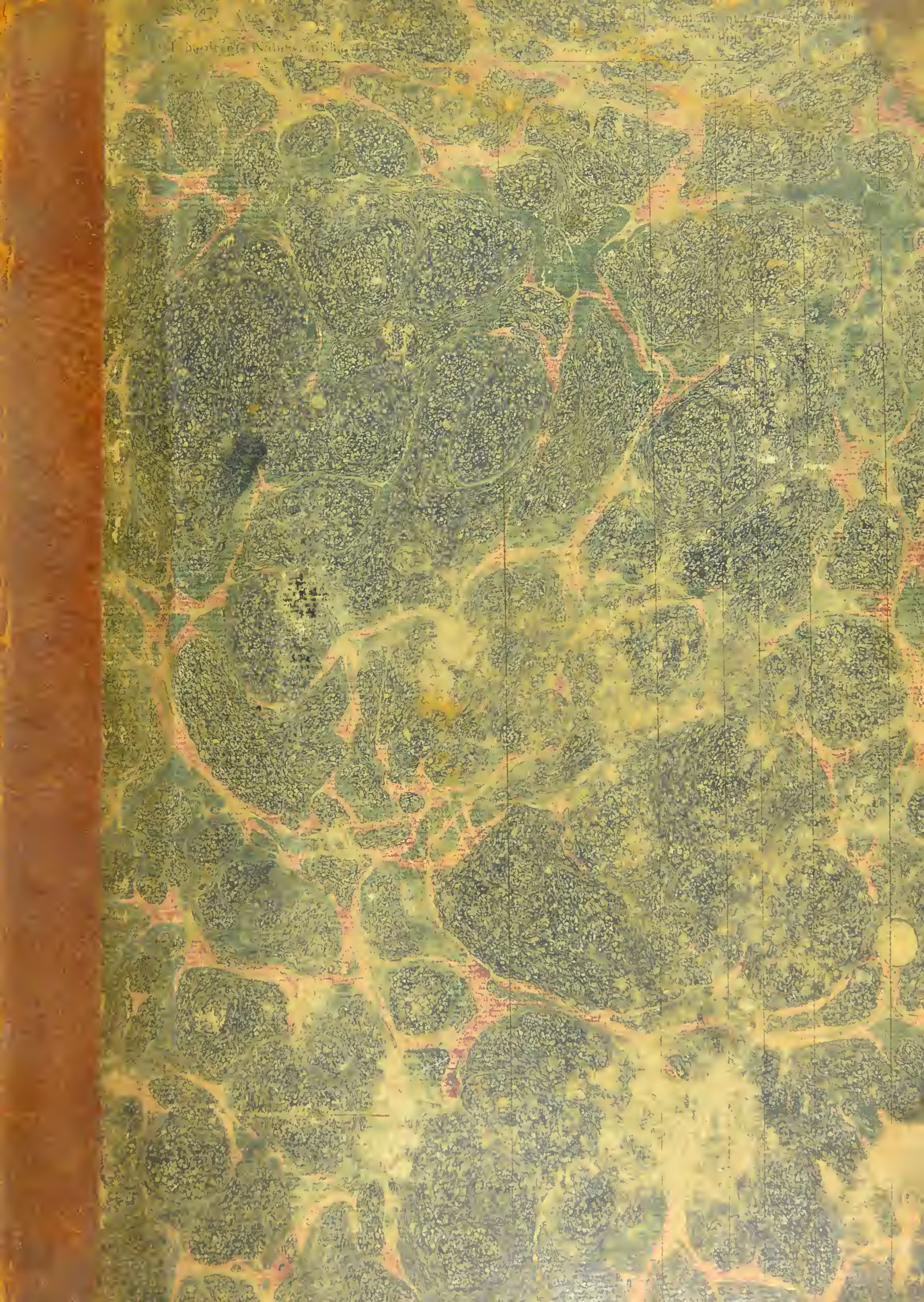

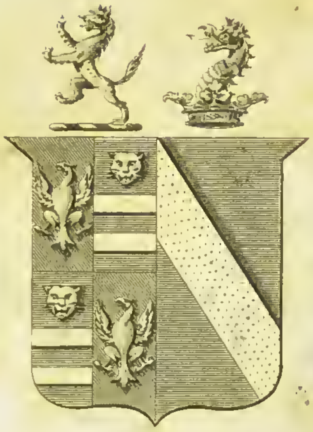

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PHILTER, or Philtre, *(Philtrum,)* in pharmacy, &c. a ſtrainer.

Philter, is alſo uſed for a drug or preparation, which it is pretended will excite love.—The word is formed from the Greek φιλεω, "I love," or φιλος, "lover." Philters are diſtinguiſhed into *true* and *ſpurious*, and were given by the Greeks and Romans to excite love. The ſpurious are ſpells or charms, ſuppoſed to have an effect beyond the ordinary laws of nature by ſome magic virtue; ſuch are thoſe ſaid to be given by old women, witches, &c.—The true philters are thoſe ſuppoſed to work their effect by ſome natural and magnetical power. There are many grave authors who believe the reality of theſe philters, and allege matter of fact in confirmation of their ſentiments: among the reſt, Van Helmont, who ſays, that upon holding a certain herb in his hand for ſome time, and taking afterwards a little dog by the foot with the ſame hand, the dog followed him wherever he went, and quite deſerted his former maſter; which he pretends to account for thus: The heat communicated to the herb, not coming alone, but animated by the emanations of the natural ſpirits, determines the herb towards the man, and identifies it to him: having then received this ferment, it attracts the ſpirit of the other object magnetically, and gives it an amorous motion.—But this is mere cant; and all philters, whatever facts may be alleged, are mere chimeras.

PHILYCA, in botany. See Phylica.

PHILYRA (fab. hiſt.), was one of the Oceanides, whom Saturn met in Thrace. The god, to eſcape from the vigilance of Rhea, changed himſelf into a horſe, to enjoy the company of Philyra, by whom he had a ſon, half a man and half a horſe, called *Chiron.* Philyra was ſo aſhamed of giving birth to ſuch a monſter, that ſhe entreated the gods to change her nature. She was accordingly metamorphoſed into a tree, called by her name among the Greeks.

PHIMOSIS, in medicine, a diſorder of the penis, in which the prepuce is ſo ſtrict or tenſe, that it cannot be drawn back over the glans. See Surgery.

PHINEHAS, or, as the Jews pronounce it, Pinchas, was the ſon of Eleazar, and grandſon of Aaron. He was the third high-prieſt of the Jews, and diſcharged this office from the year of the world 2571, till towards the year 2590. He is particularly commended in Scripture for the zeal he ſhowed in vindicating the glory of God, when the Midianites had ſent their daughters into the camp of Iſrael, to tempt the Hebrews to fornication and idolatry. For Zimri having publicly entered into the tent of a Midianitiſh woman named *Cozbi*, Phinehas aroſe up from among the people (Numb. xxv. 7, &c.), took a javelin in his hand, entered after Zimri into that infamous place, and ſtabbed both man and woman at one blow, in thoſe parts that were chiefly concerned in this criminal commerce. Upon which the plague or diſtemper ceaſed with which the Lord had already begun to puniſh the Iſraelites. This happened in the year of the world 2553.

Then the Lord ſaid to Moſes, Phinehas the ſon of Eleazar the high-prieſt hath turned away my wrath from the children of Iſrael, becauſe he has been zealous in my cauſe, and has hindered me from deſtroying them: wherefore acquaint him, that I give him my covenant of peace, and the prieſthood ſhall be given to his poſterity by a perpetual covenant, becauſe he has been zealous for his God, and has made atonement for the crime of the children of Iſrael. This promiſe that the Lord made to Phinehas, to give him the prieſthood by a perpetual covenant, interpreters obſerve, evidently included this tacit condition, that his children ſhould continue faithful and obedient; ſince we know that the prieſthood paſſed out of the family of Eleazar and Phinehas to that of Ithamar, and that it returned not to the poſterity of Eleazar till after about 150 years.

This is what we find concerning the tranſlation of the high-prieſthood from one family to the other. This dignity continued in the race of Phinehas, from Aaron down to the high-prieſt Eli, for about 335 years.

The manner and cauſes of this change are unknown. It re-entered again into the family of Eleazar under the reign of Saul, when this prince having put to death Abimelech and the other prieſts of Nob, he gave the high-prieſthood to Zadok, who was of the race of Phinehas. At the ſame time, David had Abiathar with him of the race of Eli, who performed the functions of high-prieſt. So that, after the death of Saul, David continued the prieſt-hood to Zadok and Abiathar conjointly. But towards the end of David's reign, Abiathar having eſpouſed the intereſt of Adonijah, to the prejudice of Solomon, he was in diſgrace, and Zadok only was acknowledged as high-prieſt. The prieſthood continued in his family till after the captivity of Babylon, and even to the deſtruction of the temple. But from the beginning of Zadok's prieſthood alone, and the excluſion of Abiathar, to the ruin of the temple, is 1084 years.

We read of another memorable action of Phinehas, in which he ſtill ſhowed his zeal for the Lord. This was when the Iſraelites that were beyond Jordan had raiſed upon the banks of this river a vaſt heap of earth (Joſh. xxii. 30, 31.). Thoſe on the other ſide fearing they were going to forſake the Lord, and ſet up another religion, deputed Phinehas and other chief men among them, to go and inform themſelves of the reaſon of erecting this monument. But when they had found that it was in commemoration of their union and common original, Phinehas took occaſion from thence to praiſe the Lord, ſaying, "We know that the Lord is with us, ſince you are not guilty of that prevarication we ſuſpected you were."

We do not exactly know the time of the death of Phinehas; but as he lived after the death of Joſhua, and before the firſt ſervitude under Chuſhan-riſhathaim, during the time that there were neither kings nor judges in the land, and every one did what was right in his own eyes (Judges xvii. 6. xviii. 1. xxi. 24.); his death is put about the year of the world 2590. It was under his pontificate that the ſtory of Micah happened, as alſo that of the tribe of Dan, when they made a conqueſt of Laiſh; and the enormity that was committed upon the wife of the Levite of the mountain of Ephraim (Judges xx. 28.). Phinehas's ſucceſſor in the high-prieſthood was Abiezer, or Abiſhuah.

The rabbins allow a very long life to Phinehas. There are ſome who believe he lived to the time of the high-prieſt Eli, or even to the time of Samſon. Others will have it that he was the ſame as Eli, or rather as the prophet Elias, which would ſtill prolong his life for ſeveral ages.

PHINEUS (fab. hiſt.), was a ſon of Agenor, king of Phœnicia, or, according to ſome, of Neptune. He became king of Thrace, or, according to the greater part of mythologiſts, of Bithynia. He married Cleopatra the daughter of Boreas, called by ſome *Cleobula*, by whom he had Plexippus and Pandion. After her death he married Idæa the daughter of Dardanus. Idæa, jealous of his former wife's children, accuſed them of attempts upon their father's life and crown, or, as others aſſert, of attempts upon her virtue; on which they were condemned by Phineus to be deprived of their eyes. This cruelty was ſoon after puniſhed by the gods; for Phineus ſuddenly became blind, and the Harpies were ſent by Jupiter to keep him in continual alarm, and to ſpoil the meats which were placed on his table. He was afterwards delivered from theſe dangerous monſters by his brothers-in-law Zetes and Calais, who purſued them as far as the Strophades. He likewiſe recovered his ſight by means of the Argonauts, whom he had received with great hoſpitality, and whom he inſtructed in the eaſieſt and ſpeedieſt way of arriving in Colchis. The cauſes of the blindneſs of Phineus are a matter of diſpute among the ancients; ſome ſuppoſing that this was inflicted by Boreas for his cruelty to his grandſon; while others attribute it to the anger of Neptune, becauſe he had directed the ſons of Phryxus how to eſcape from Colchis to Greece. Many, however, imagine that it proceeded from his having raſhly attempted to develope futurity; while others aſſert that Zetes and Calais put out his eyes on account of his cruelty to their nephews. The ſecond wife of Phineus is called by ſome *Dia*, *Eurytia*, *Danae*, and *Idothea*.—He was killed by Hercules.

PHLEBOTOMY, the opening of a vein with a proper ſharp-edged and pointed inſtrument, in order to let out a certain quantity of blood, either for the preſervation or recovery of a perſon's health. See SURGERY.

PHLEGM, in the animal economy, one of the four humours whereof the ancients ſuppoſed the blood to be compoſed. The chemiſts make phlegm or water an elementary body; the characters of which are fluidity, inſipidity, and volatility.

PHLEGMAGOGUES, in medicine, a term anciently made uſe of for ſuch medicines as were ſuppoſed to be endowed with the property of purging off phlegm; ſuch as hermodactyls, agaric, turbith, jalap, &c.

PHLEGMATIC, among phyſicians, an appellation given to that habit or temperament of body wherein phlegm is predominant; which gives riſe to catarrhs, coughs, &c.

PHLEGMON, denotes an external inflammation and tumour, attended with a burning heat.

PHLEGON, who was ſurnamed *Trallianus*, was born in Trallis a city of Lydia. He was the emperor Hadrian's freedman, and lived to the 18th year of Antoninus Pius; as is evident from his mentioning the conſuls of that year. He wrote ſeveral works of great erudition, of which we have nothing left but fragments. Among theſe was a Hiſtory of the Olympiads, A Treatiſe of Long lived Perſons, and another of Wonderful Things; the ſhort and broken remains of which Xylander tranſlated into Latin, and publiſhed at Baſil in 1568, with the Greek and with notes. Meurſius publiſhed a new edition of them with his notes at Leyden, in 1622. The titles of part of the reſt of Phlegon's writings are preſerved by Suidas. It is ſuppoſed that the Hiſtory of Hadrian, publiſhed under Phlegon's name, was written by Hadrian himſelf, from this paſſage of Spartianus: "Hadrian thirſted ſo much after fame (ſays he), that he gave the books of his own life, drawn up by himſelf, to his freedmen, commanding them to publiſh thoſe books under their own names; for we are told that Hadrian wrote Phlegon's books."

Phlegon's name has been more familiar among the moderns, and his fragments have had a greater degree of regard paid to them than perhaps they deſerve, merely becauſe he has been ſuppoſed to ſpeak of the darkneſs which prevailed during our Lord's paſſion. The book in which the words are contained is loſt; but Euſebius has preſerved them in his *Chronicon*. They are theſe: "In the 4th year of the 202d Olympiad, there was a greater and more remarkable eclipſe of the ſun than any that had ever happened before; for at the ſixth hour the day was ſo turned into the darkneſs of night, that the very ſtars in the firmament were viſible; and there was an earthquake in Bithynia which threw down many houſes in the city of Nicæa." Euſebius thinks that theſe words of Phlegon related to the prodigies which accompanied Chriſt's crucifixion; and many other fathers of the church have thought the ſame: but this opinion is liable to many difficulties; for no man had ever a ſtronger deſire than Phlegon to compile marvellous events, and to obſerve the ſupernatural circumſtances in them. How was it then poſſible that a man of this turn of mind ſhould not have taken notice of the moſt ſurpriſing circumſtance in the eclipſe, which it is imagined he hints at, viz. its happening on the day when the moon was at the full? But had Phlegon done this, Euſebius would not have omitted it; and Origen would not have ſaid that Phlegon had omitted this particular.

It was a matter of controverſy ſome time ago, whether Phlegon really ſpoke of the darkneſs at the time of our Lord's paſſion; and many diſſertations were written on both ſides of the queſtion. This diſpute was occaſioned by the above paſſage from Phlegon being left out in an edition of Clarke's Boyle's Lectures, publiſhed after his death, at the inſtance of Sykes, who had ſuggeſted to Clarke that an undue ſtreſs had been laid upon it. Whiſton, who informs us of this affair, expreſſes great diſpleaſure againſt Sykes, and calls "the ſuggeſtion groundleſs." Upon this, Sykes publiſhed "A Diſſertation on the Eclipſe mentioned by Phlegon: or, An Inquiry whether that Eclipſe had any relation to the darkneſs which happened at our Saviour's Paſſion," 1732, 8vo. Sykes concludes it to be moſt probable that Phlegon had in view a natural eclipſe which happened November 24, in the 1ſt year of the 202d Olympiad, and not in the 4th year of the Olympiad in which Chriſt was crucified. Many pieces were written againſt him, and to ſome of them he replied; but perhaps it is a controverſy which concerns the learned world merely, ſince the cauſe of religion is but little affected by it.

Photius blames Phlegon for expatiating too much on trifles, and for collecting too great a number of anſwers pronounced by the oracles. "His ſtyle (he tells us) is not altogether flat and mean, nor does it everywhere imitate the Attic manner of writing: but otherwiſe, the over-nice accuracy and care with which he computes the Olympiads, and relates the names of the conteſts, the tranſactions, and even oracles, is not only very tireſome to the reader, whereby a cloud is thrown over all other particulars in that book, but the diction is thereby rendered unpleaſant and ungrateful; and indeed he is every moment bringing in the anſwers pronounced by all kinds of deities."

PHLOGISTON, a term uſed by chemiſts to expreſs a principle which was ſuppoſed to enter the compoſition of various bodies.

The bodies which were thought to contain it in the largeſt quantity are the inflammable ſubſtances; and the property which theſe ſubſtances poſſeſs of being ſuſceptible of inflammation was thought to depend on this principle; and hence it was ſometimes called the *Principle of Inflammability*. Inflammation, according to this doctrine, was the ſeparation of *this principle* or *phlogiſton* from the other matter which compoſed the combuſtible body. As its ſeparation was always attended with the emiſſion of light and heat, ſome of the chemiſts concluded that it was light and heat combined with other matter in a peculiar manner, or that it was ſome highly elaſtic and very ſubtile matter, on certain modifications of which heat and light depended.

Another claſs of bodies which were ſuppoſed to contain phlogiſton are the metals; and the chemiſts ſuppoſed that the peculiar luſtre of the metals depended on this principle. Of this they thought themſelves convinced by the evidence of their ſenſes in two ways; viz. firſt, becauſe by expoſing a metal to the action of a long continued heat, it loſt its metallic luſtre, and was converted into an earthy-like ſubſtance called *calx metallicus*; and ſecondly, becauſe by mixing this calx with any inflammable ſubſtance whatever, and ſubjecting the mixture to certain operations, the inflammable matter diſappeared, and the metal was reſtored to its former ſtate and luſtre, without ſuffering much diminution in quantity, eſpecially if the proceſſes had been conducted with care and attention.

This fact relative to the metals was thought to be a full demonſtration of itſelf, independent of other proofs which were brought to ſupport the doctrine. Theſe were, that a combuſtible body, by the act of inflammation (*i. e.* by the diſſipation of its phlogiſton in the form of heat and light), was converted into a body that was no longer combuſtible, but which might have its property of combuſtibility reſtored to it again by mixing the incombuſtible remains with any kind of inflammable matter, and ſubmitting the mixture to certain proceſſes. In this way the body was reſtored to its former ſtate of inflammability.

They were alſo at ſome pains to prove that the *phlogiſton* or the *principle of inflammability* was the ſame in all inflammable bodies and in the metals. This identity of phlogiſton they thought to be evident from the fact, that the calx of a metal might be reſtored to its metallic ſtate, or that the remains after the combuſtion of a combuſtible body might be again reſtored to its original ſtate of combuſtibility by the addition of any inflammable body whatever, taken either from the animal, vegetable, or mineral kingdoms.

Theſe and ſeveral other facts were brought to prove not only the exiſtence of phlogiſton, but its effects in mixture with other ſubſtances; and the objections which were made againſt the doctrine were removed with wonderful ingenuity. The chief objection againſt it was, that if the inflammation of a combuſtible body, or the converſion of a metal into calx, depends on the diſſipation or extrication of phlogiſton; then it muſt follow, that the remains of a combuſtible body after inflammation, and the calx of the metal, muſt be leſs than the matter from which they were produced: but this is contrary to fact; for when we collect with care all the vapour into which the pureſt inflammable bodies are converted by combuſtion, theſe incombuſtible remains are much heavier than the inflammable body was from which they were produced, and the calx into which a metal is converted by long expoſure to the action of heat is heavier than the metal from which it was produced. This conſideration made ſeveral people doubt of the truth of the doctrine; but the objection was removed by ſaying, that phlogiſton was ſo ſubtile as not only to have no weight, but to poſſeſs an abſolute levity; and that when it was taken from an abſolutely heavy body, that body muſt, by loſing ſo much abſolute levity, become heavier, in the ſame manner, as the algebraiſts ſay, that a poſitive quantity is augmented by the ſubſtraction of a negative quantity. This ſophiſm ſatisfied the minds of moſt of the chemiſts, eſpecially thoſe who were algebraiſts.

The opinion that phlogiſton was heat and light ſomehow combined with other matter, was proved not only by the fact that heat and light were emitted from a combuſtible body during its combuſtion, but from the reduction of certain metallic calces to their original metallic ſtate again, at leaſt in ſome degree, by ſimple expoſure to heat and light. The white calx of ſilver for inſtance, when expoſed in cloſe ſealed glaſs veſſels to the light and heat of the ſun, reſumes a black tinge, and is in part reſtored to its metallic luſtre without any addition whatever; but then this reſtoration, like the others above mentioned, is attended with a loſs of weight.

Beſides conſtituting the principal part of inflammable bodies and metals, phlogiſton was thought to be the cauſe of colour in all vegetable and animal ſubſtances. This was concluded from the fact of plants growing white when defended from the action of the ſun's rays, and in having their green colour reſtored by expoſure to his rays again; and ſo far did the chemiſts ſuffer themſelves to be deceived, that they actually thought the green colouring matter, which they extracted from freſh plants by certain chemical proceſſes, to be an inflammable ſubſtance. A very material objection was made to this argument, viz. if plants owe their colour to phlogiſton imparted by the ſun's rays, why do the ſun's rays deſtroy vegetable colours that are expoſed to them? for we know that the ſun's rays are very effectual in diminiſhing the luſtre of cloth dyed with vegetable colours, and in bleaching or taking out various ſtains from linen and other ſubſtances. All this was removed by ſaying, that the ſun's rays poſſeſſed different powers on living and on dead vegetable matter, and that the living vegetables had the power of abſorbing phlogiſton from the ſun's rays, which dead vegetable matter had not.

Since the exiſtence of phlogiſton, as a chemical principle in the compoſition of certain bodies, is now fully proved to be falſe, we ſhall not trouble our readers with any further obſervations on it, except adding, that although the chemiſts were ſatisfied with the proofs they gave of its reality, they were never able to exhibit it in a ſeparate ſtate, or ſhow it in a pure form, unmixed with other matter.

Phlogiſton ſeems to have been admitted as a principle in the compoſition of certain bodies, and to have been ſuppoſed the cauſe of certain modifications of matter, merely with a view to explain ſome of thoſe natural phenomena which the authors of it were unable to explain on other principles. Subſequent diſcoveries in natural philoſophy and in chemiſtry have repreſented things in a very different light from that in which the old chemiſts viewed them. The old chemiſts knew nothing but chemiſtry; they ſeldom extended their views to the obſervation of objects beyond their laboratories, and it was not till philoſophers became chemiſts, and chemiſts philoſophers, that chemiſtry began to wear the garb of ſcience. The epoch in which this change began was in the time of Lord Verulam, who firſt removed the dimneſs from the chemiſt's eyes, and to him ſucceeded the Honourable Mr. Boyle. Sir Iſaac Newton, with the little aſſiſtance which his predeceſſors in this branch of ſcience afforded him, is in reality the firſt who eſtabliſhed chemiſtry on ſcientific ground. It muſt, however, be acknowledged, that although he made a great progreſs, he left much undone; and ſubſequent chemiſts, who were leſs accurate obſervers of nature, admitted principles unwarrantably. From the time of Sir Iſaac Newton till the middle of the 18th century, no real improvement was made in ſcientific chemiſtry; and the progreſs this ſcience has made ſince that period is owing to the important diſcovery of the exiſtence of heat in a ſtate of compoſition with other matter. Heat thus combined loſes its activity or becomes inſenſible, juſt in the ſame way as any other active ſubſtance loſes its apparent qualities in compoſition. Acids, for example, when combined in a certain proportion with ſubſtances for which they have ſtrong attraction, as alkalis or abſorbent earths, loſe all their obvious acid qualities, and the compound turns out mild, and totally conceals the acid which it contains. In a ſimilar manner, heat, when combined in certain proportions with other matter, loſes its ſenſible qualities, and the compound conceals the heat which it contains. Heat, in this combined ſtate, was called by its ingenious diſcoverer, Dr. Black, *latent heat*, and it was found to be very abundant in the atmoſphere, which owes its exiſtence as an elaſtic fluid to the quantity of latent heat that it contains. After this diſcovery was made, Dr. Crawford, conſidering that air was abſorbed by a burning body, concluded that the heat which appears in the combuſtion of a combuſtible body is the heat that had before exiſted in the air which was conſumed by the burning body. Mr. Lavoiſier and others, proſecuting this inquiry, found that the combuſtible body, while it is burning, unites with the baſis of the air, and that the heat which the air contained, and which was the cauſe of the air exiſting in the ſtate of air, is expelled. This abſorption of the baſis of the air by the burning body, and the reduction of this baſis to a ſolid form, accounts for the increaſe of weight which a body acquires by burning; or, in other words, gives a reaſon why the matter into which a combuſtible body is converted by combuſtion is heavier than the body from which it was produced. The ſame abſorption of air is obſervable when a metal is converted into a calx, and the additional weight of the calx is found to be preciſely equal to the weight of the air abſorbed during the calcination. On theſe principles, therefore, we now explain the phenomena in a much more ſatisfactory manner than by the ſuppoſition of phlogiſton, or a principle of inflammability.

This theory is more fully elucidated in ſeveral articles in the former part of this work; we ſhall not, therefore, in this place, repeat what the reader may find under the words Heat, Inflammation, Flame, Chemistry, Calcination *of Metals*, Oxygen, &c.

PHLOGONÆ, a claſs of compound, inflammable, and metallic foſſils, found in ſmall maſſes of determinately angular figures; comprehending the pyricubia, pyroctogonia, and pyripolygonia.

PHLOMIS, the Sage-tree, or *Jeruſalem Sage*; a genus of the gymnoſpermia order, belonging to the didynamia claſs of plants. There are 14 ſpecies, all of which have perennial roots, and of many the ſtalks alſo are perennial. The latter riſe from two to five or ſix feet high; and are adorned with yellow, blue, or purple flowers in whorls. They are all ornamental plants; and deſerve a place in gardens, as they are ſufficiently hardy to endure the ordinary winters in this climate: they require, however, a pretty warm ſituation.

There are two ſpecies of this plant, which are peculiarly adapted to the ſhrubbery, viz. the *Phlomis fructicoſa*, a native of Spain and Sicily, and the *Phlomis purpurea*. Of the firſt ſpecies there are three varieties, 1. The *broad-leaved Jeruſalem Sage-tree*, is now very common in our gardens. Its beauty is great, and its culture very eaſy. It grows to be about five feet high, and ſpreads its branches without order all around. The older branches are covered with a dirty, greeniſh, dead, falling, ill-looking bark; and this is the worſt property of this ſhrub: but the younger ſhoots are white and beautiful; they are four-cornered, woolly, and ſoft to the touch. The leaves are roundiſh and oblong, and moderately large; and theſe grow oppoſite at the joints of the ſhrub on long footſtalks. They are hoary to a degree of whiteneſs, and their footſtalks alſo are woolly, white, tough, and ſtrong. The flowers are produced in June, July, and Auguſt, at the top joints of the young ſhoots, in large whorled bunches. They are of the labiated kind, each conſiſting of two lips, the upper end of which is forked, and bends over the other. A finer yellow can hardly be conceived than the colour of which they are poſſeſſed; and, being large, they exhibit their golden flowers at a great diſtance, cauſing thereby a handſome ſhow. 2. The *narrow-leaved Jeruſalem Sage-tree*, is of lower growth than the other, ſeldom riſing higher than a yard or four feet. This ſhrub is in every reſpect like the other; only the ſhoots ſeem to have a more upright tendency of growth. The leaves alſo, which are narrower, are more inclined to a lanceolate form: they are numerous in both the ſorts, and hide the deformity of the bark on the older ſtems, which renders them leſs exceptionable on that account. In ſhort, theſe ſorts are qualified for ſhrubberies of all kinds, or to be ſet in borders of flower-gardens, where they will flower, and be exceeded even in that reſpect by very few ſhrubs. 3. *Cretan Sage-tree*, is ſtill of lower growth than either of the former, ſeldom ariſing to a yard in height. The leaves are of the ſame white hoary nature; they are very broad, and ſtand on long footſtalks. The flowers are alſo of a delightful yellow colour, very large, and grow in large whorls, which give the plant great beauty.

The ſecond ſpecies, which is *Purple Phlomis* or *Portugal Sage*, is four feet high; the ſtalks are woody, and ſend forth ſeveral angular branches, which are covered with a white bark. The leaves are ſpear-ſhaped, oblong, woolly underneath, crenated, and grow on ſhort footſtalks. The flowers are produced in whorls from the joints of the branches. They are of a deep purple colour, and have narrow involucra. They appear in June and July, but are not ſucceeded by ripe ſeeds in England. There is a variety of this ſpecies with iron-coloured flowers, and another with flowers of a bright purple.

There are ſome other ſhrubby ſorts of phlomis, of great beauty; but theſe not only often loſe their leaves and even branches, from the firſt froſt, but are frequently wholly deſtroyed, if it happens to be ſevere. They are low ſhrubs, very beautiful, and look well among perennial flowers, where they will not only claſs as to ſize with many of that ſort, but, being rather tender, may with them have ſuch extraordinary care as the owner may think proper to allow them.

The propagation of the above ſorts is, as we have already hinted, very eaſy, and is accompliſhed either by layers or cuttings. 1. If a little earth be thrown upon the branches any time in the winter, they will ſtrike root and be good plants by the autumn following, fit for any place. Thus eaſy is the culture by that method. 2. The cuttings will alſo grow, if planted any time of the year. Thoſe planted in winter ſhould be the woody ſhoots of the former ſummer: theſe may be ſet cloſe in a ſhady border; and, being watered in dry weather, will often grow. This ſhrub may be propagated by young ſlips alſo, in any of the ſummer months. Theſe ſhould be planted in a ſhady border, like ſage, and well watered. If the border is not naturally ſhady, the beds muſt be hooped, and covered with matting in hot weather. Watering muſt be conſtantly afforded them; and with this care and management many of them will grow.

PHLOX, Lychnidea, or *Baſtard Lychnis*; a genus of the monogynia order, belonging to the pentandria claſs of plants. There are ſeven ſpecies, all natives of North America. They have perennial roots, from which ariſe herbaceous ſtalks from nine inches to two feet in height, adorned with tubulated flowers of a purple colour. They are propagated by offsets, and will bear the winters in this country. They require a moiſt rich ſoil, in which they thrive better and grow taller than in any other.

PHLYCTENÆ, in medicine, ſmall eruptions on the ſkin.

PHOCA, in zoology.—See *Sea*-Bear.

PHOCÆA, the laſt town of Ionia, (Mela, Pliny;) of Æolis, (Ptolemy,) becauſe ſituated on the right or north ſide of the river Hermus, which he makes the boundary of Æolis to the ſouth. It ſtood far in the land, on a bay or arm of the ſea; had two very ſafe harbours, the one called *Lampter*, the other *Nauſtathmos*, (Livy.) It was a colony of Ionians; ſituated in the territory of Æolis, (Herodotus.) Maſſilia in Gaul was again a colony from it. *Phocæenſes*, the people, (Livy;) *Phocaicus*, the epithet, (Lucan;) applied to *Marſeilles*. It was one of the 12 cities which aſſembled in the panionium or general council of Ionia.

Some writers tell us, that while the foundations of this city were laying, there appeared near the ſhore a great ſhoal of ſea-calves; whence it was called *Phocæa*, the word *phoca* ſignifying in Greek a *ſea-calf*. Ptolemy, who makes the river Hermus the boundary between Æolia and Ionia, places Phocæa in Æolis; but all other geographers reckon it among the cities of Ionia. It ſtood on the ſea-coaſt, between Cuma to the north, and Smyrna to the ſouth, not far from the Hermus; and was, in former times, one of the moſt wealthy and powerful cities of all Aſia; but is now a poor beggarly village, though the ſee of a biſhop. The Phocæans were expert mariners, and the firſt among the Greeks that undertook long voyages; which they performed in galleys of fifty oars. As they applied themſelves to trade and navigation, they became acquainted pretty early with the coaſts and iſlands of Europe, where they are ſaid to have founded ſeveral cities, namely, Velia in Italy; Alalia, or rather Aleria, in Corſica; and Marſeilles in Gaul. Neither were they unacquainted with Spain; for Herodotus tells us, that, in the time of Cyrus the Great, the Phocæans arriving at Sarteſſus, a city in the bay of Cadiz, were treated with extraordinary kindneſs by Arganthonius king of that country; who, hearing that they were under no ſmall apprehenſion of the growing power of Cyrus, invited them to leave Ionia, and ſettle in what part of his kingdom they pleaſed. The Phocæans could not be prevailed upon to forſake their country; but accepted a large ſum of money, which that prince generouſly preſented them with, to defray the expenſe of building a ſtrong wall round their city. The wall they built on their return; but it was unable to reſiſt the mighty power of Cyrus, whoſe general, Harpagus, inveſting the city with a numerous army, ſoon reduced it to the utmoſt extremities. The Phocæans, having no hopes of any ſuccour, offered to capitulate; but the conditions offered by Harpagus ſeeming ſevere, they begged he would allow them three days to deliberate; and, in the mean time, withdraw his forces. Harpagus, though not ignorant of their deſign, complied with their requeſt. The Phocæans, taking advantage of this condeſcenſion, put their wives, children, and all their moſt valuable effects, on board ſeveral veſſels which they had ready equipped, and conveyed them ſafe to the iſland of Chios, leaving the Perſians in poſſeſſion of empty houſes. Their deſign was to purchaſe the Œneſſion iſlands, which belonged to the Chians, and ſettle there; but the Chians not caring to have them ſo near, leſt they ſhould engroſs all the trade to themſelves, as they were a ſea-faring people, they put to ſea again; and, having taken Phocæa, their native country, by ſurpriſe, put all the Perſians they found in it to the ſword. They went to Corſica; great part of them however returned very ſoon, as did the reſt alſo in a few years. They then lived in ſubjection either to the Perſians, or tyrants of their own. Among the latter we find mention made of Laodamus, who attended Darius Hyſtaſpis in his expedition againſt the Scythians; and of Dionyſius, who, joining Ariſtagoras, tyrant of Miletus, and chief author of the Ionian rebellion, retired, after the defeat of his countrymen, to Phœnicia, where he made an immenſe booty, ſeizing on all the ſhips he met with trading to that country. From Phœnicia he ſailed to Sicily, where he committed great depredations on the Carthaginians and Tuſcans; but is ſaid never to have moleſted the Greeks.

In the Roman times the city of Phocæa ſided with Antiochus the Great; whereupon it was beſieged, taken, and plundered, by the Roman general; but allowed to be governed by its own laws. In the war which Ariſtonicus, brother to Attalus king of Pergamus, raiſed againſt the Romans, they aſſiſted the former to the utmoſt of their power; a circumſtance which ſo diſpleaſed the ſenate, that they commanded the town to be demoliſhed, and the whole race of the Phocæans to be utterly rooted out. This ſevere ſentence would have been put in execution, had not the Maſſilienſes, a Phocæan colony, interpoſed, and, with much difficulty, aſſuaged the anger of the ſenate. Pompey declared Phocæa a free city, and reſtored the inhabitants to all the privileges they had ever enjoyed; whence, under the firſt emperors, it was reckoned one of the moſt flouriſhing cities of all Aſia Minor. This is all we have been able to collect from the ancients touching the particular hiſtory of Phocæa.

PHOCAS, a Roman centurion, was raiſed to the dignity of emperor by the army, and was crowned at Conſtantinople about the year 603. The emperor Mauritius, who was thus deſerted both by the army and the people, fled to Chalcedon with his five children, whom Phocas cauſed to be inhumanly murdered before his eyes, and then he murdered Mauritius himſelf, his brother, and ſeveral other perſons who were attached to that family.

Phocas, thus proclaimed and acknowledged at Conſtantinople, ſent, according to cuſtom, his own image and that of his wife Leontia to Rome, where they were received with loud acclamations, the people there being incenſed againſt Mauritius on account of the cruel exactions of the exarchs, and his other miniſters, in Italy. Gregory, ſurnamed the Great, then biſhop of Rome, cauſed the images to be lodged in the oratory of the martyr Cæſarius, and wrote letters to the new emperor, congratulating him upon his advancement to the throne, which he ſaid was effected by a particular providence, to deliver the people from the innumerable calamities and heavy oppreſſions under which they had long groaned. Had we no other character of Phocas and Leontia but that which has been conveyed to us in Gregory's letters, we ſhould rank him amongſt the beſt princes mentioned in hiſtory; but all other writers paint him in quite different colours; and his actions, tranſmitted to us by ſeveral hiſtorians, evidently ſpeak him a moſt cruel and blood-thirſty tyrant. He was of middling ſtature, ſays Cedrenus, deformed, and of a terrible aſpect: his hair was red, his eye-brows met, and one of his cheeks was marked with a ſcar, which, when he was in a paſſion, grew black and frightful: he was greatly addicted to wine and women, blood-thirſty, inexorable, bold in ſpeech, a ſtranger to compaſſion, in his principles a heretic. He endeavoured, in the beginning of his reign, to gain the affections of the people by celebrating the Circenſian games with extraordinary pomp, and diſtributing on that occaſion large ſums amongſt the people; but finding that inſtead of applauding they reviled him as a drunkard, he ordered his guards to fall upon them. Some were killed, many wounded, and great numbers were dragged to priſon; but the populace riſing, ſet them at liberty, and thenceforth conceived an irreconcileable averſion to the tyrant.

As ſoon as the death of Mauritius was known, Narſes, who then commanded the troops quartered on the frontiers of Perſia, revolted. Phocas, however, managed matters ſo as to gain him over to his intereſt, and then treacherouſly and cruelly burnt him alive. He endeavoured to ſtrengthen his cauſe by reſpectable alliances; but his cruelty was ſuch as to render him generally hated, for he ſpared neither ſex nor age, and amongſt others he murdered Conſtantina, the widow of Mauritius, and her daughters. Theſe cruelties were at length the cauſe of his downfal. He became univerſally hateful; and perſons in great authority near his perſon conſpired againſt him. This conſpiracy, however, was diſcovered, and the perſons concerned in it were all put to death. The following year, however, 610, he was overtaken by the fate he had ſo long deſerved.

Heraclius, the ſon of the governor of Africa, who bore the ſame name, taking upon him the title of emperor, and being acknowledged as ſuch by the people of Africa, ſailed from thence with a formidable fleet, and a powerful army on board, for Conſtantinople, while Nicetas marched thither by way of Alexandria and the Pentapolis. Heraclius ſteered his courſe to Abydus, where he was received with great demonſtrations of joy by ſeveral perſons of rank, who had been baniſhed by Phocas. From Abydus he ſailed to Conſtantinople, where he engaged and utterly defeated the tyrant's fleet. Phocas took refuge in the palace; but one Photinus, whoſe wife he had formerly debauched, purſuing him with a party of ſoldiers, forced the gates, dragged the cowardly emperor from the throne, and having ſtripped him of the imperial robes, and clothed him with a black veſt, carried him in chains to Heraclius, who commanded firſt his hands and feet, then his arms, and at laſt his head, to be cut off: the remaining part of his body was delivered up to the ſoldiers, who burnt it in the forum. We are told, that Heraclius having reproached him with his evil adminiſtration, he anſwered, with great calmneſs, "It is incumbent upon you to govern better." Such was the end of this cruel tyrant, after he had reigned ſeven years and ſome months.

PHOCILIDES, a Greek poet and philoſopher of Miletus, flouriſhed about 540 years before the Chriſtian era. The poetical piece now extant, attributed to him, is not of his compoſition but of another poet who lived in the reign of Adrian.

PHOCION was a diſtinguiſhed Athenian general and orator in the time of Philip II. of Macedon. His character is thus deſcribed in the Ancient Univerſal Hiſtory. "He was too modeſt to ſolicit command, nor did he promote wars that he might raiſe his authority by them; though, taken either as a ſoldier, orator, ſtateſman, or general, he was by far the moſt eminent Athenian of his time. As he was a moſt diſintereſted patriot, he could entertain no great affection for Philip: but as he perfectly well knew the diſpoſition of his countrymen, and how unlikely they were long to ſupport ſuch meaſures as were neceſſary to humble the Macedonian power, he did not expreſs himſelf vehemently, but choſe rather to cultivate the eſteem which on all occaſions Philip ſhowed for the ſtate of Athens, as a mean of preſerving her, when ſhe ſhould be reduced to that ſituation which he conceived they wanted virtue to prevent. From this character the reader will eaſily diſcern that Demoſthenes and he could not well agree. The former was always warm, his language copious, and his deſigns extenſive: and Phocion, on the other hand, was of a mild temper, delivered his opinion in very few words, and propoſed ſchemes at once neceſſary and eaſy to be effected. Yet he ſeldom or never concurred with the people, but ſpoke as poignantly againſt their vices as Demoſthenes himſelf; inſomuch that this orator once told him, 'The Athenians, Phocion, in ſome of their mad fits, will murder thee.' 'The ſame (anſwered he) may fall to thee, Demoſthenes, if ever they come to be ſober.'

He was afterwards appointed to command the army which was ſent to aſſiſt the Byzantines againſt Philip, whom he obliged to return to his own dominions. This truly great man, whom (though extremely poor) no ſum could bribe to betray his country, and who at every riſk on all occaſions gave them ſound advice, was at length accuſed by his ungrateful countrymen. This event happened in the year before Chriſt 318. He was ſent to Athens by Polyperchon, head of a faction in Macedonia, together with his friends, chained in carts, with this meſſage, "That though he was convinced they were traitors, yet he left them to be judged by the Athenians as a free people." Phocion demanded whether they intended to proceed againſt him by form of law; and ſome crying out that they would, Phocion demanded how that could be if they were not allowed a fair hearing; but perceiving, by the clamour of the people, that no ſuch thing was to be expected, he exclaimed, "As for myſelf, I confeſs the crime objected to me, and ſubmit to the judgment of the law; but conſider, O ye Athenians, what have theſe poor innocent men done that they ſhould be involved in the ſame calamity with me?" The people replied with great vociferation, "They are your accomplices, and that is enough." Then the decree was read, adjudging them all to death, viz. Phocion, Nicocles, Atheudippus, Agamon, and Pythocles; theſe were preſent; Demetrius, Phalereus, Callimedon, Charicles, and others, were condemned in their abſence. Some moved that Phocion might be tortured before he was put to death; nay, they were for bringing the rack into the aſſembly, and torturing him there. The majority, however, thought it enough if he was put to death, for which the decree was carried unanimouſly; ſome putting on garlands of flowers when they gave their votes. As he was going to execution, a perſon who was his intimate friend aſked him if he had any meſſage for his ſon? "Yes", replied Phocion; "tell him it is my laſt command that he forget how ill the Athenians treated his father."

The ſpleen of his enemies was not extinguiſhed with his life: they paſſed a decree whereby his corpſe was baniſhed the Athenian territories; they likewiſe forbad any Athenians to furniſh fire for his funeral pile. One Conopian took up the corpſe, and carried it beyond Eleuſina, where he borrowed ſome fire of a Megarian woman and burned it. A Megarian matron, who attended with her maid, raiſed on the place an honorary monument; and having gathered up the bones, carried them home, and buried them under her own hearth; praying at the ſame time thus to the Penates: "To you, O ye gods, guardians of this place, I commit the precious remains of the moſt excellent Phocion. Protect them, I beſeech you, from all inſults; and deliver them one day to be repoſited in the ſepulchre of his anceſtors, when the Athenians ſhall become wiſer." It was not long before this opportunity occurred. When the Athenians began to cool a little, and remember the many ſervices they had received from Phocion, they decreed him a ſtatue of braſs; ordered his bones to be brought back at the public expenſe; and decreed that his accuſers ſhould be put to death. Agnonides, who was principally concerned in that tragedy, ſuffered; but Epicurus and Demophilus, who were alſo accomplices in it, fled. However, Phocion's ſon met with them, and executed his revenge upon them; which was almoſt the only good action he ever performed, as he had a very ſmall ſhare of his father's abilities, and not any of his virtues. Such is the fickleneſs and injuſtice of popular governments; failings which, if we are to judge from univerſal experience, are abſolutely inſeparable from them.

PHOCIS, (Demoſthenes, Strabo, Pauſanias); a country of Greece, contained between Bœotia to the eaſt and Locris to the weſt, but extending formerly from the Sinus Corinthiacus on the ſouth to the ſea of Eubœa on the north, and, according to Dionyſius, as far as Thermopylæ; but reduced afterwards to narrower bounds. *Phocenſes*, the people; *Phocicus*, the epithet, (Juſtin.) *Bellum Phocicum*, the ſacred war which the Thebans and Philip of Macedon carried on againſt them for plundering the temple of Delphi; and by which Philip paved the way to the ſovereignty of all Greece, (Juſtin.) Its greateſt length was from north to ſouth, that is, from 38° 45′ to 39° 20′, or about 35 miles; but very narrow from eaſt to weſt, not extending to 30 miles, that is, from 23° 10′ to 23° 40′ at the wideſt, but about 23 miles towards the Corinthian bay, and much narrower ſtill towards the north. This country is generally allowed to have taken its name from Phocus the ſon of Ornytion, a native of Corinth; but having been ſoon after invaded by the Eginetæ, under the conduct of another Phocus, who was the ſon of Eacus king of Euopia, the memory of the firſt inſenſibly gave way to that of the ſecond.

In Phocis there were ſeveral celebrated mountains, ſuch as Cythæron, Helicon, and Parnassus. The laſt two we have already noticed in the order of the alphabet. Cythæron was conſecrated to the muſes as well as the other two, and was conſequently much celebrated by the poets. Both it and Helicon contend with Mount Parnaſſus for height and magnitude. There were no remarkable rivers in Phocis except Cephiſus, which runs from the foot of Parnaſſus northward and empties itſelf in the Pindus, which was near the boundary of that kingdom. It had ſeveral very conſiderable cities; ſuch as Cyrra, Criſſa, and Antecyra, which, according to Ptolemy, were on the ſea-coaſts; and Pythia, Delphi, Daulis, Elatia, Ergoſthenia, and Baulia, which were inland towns. Elatia was the largeſt and richeſt after Delphi.

Deucalion was king of that part of Phocis which lies about Parnaſſus, at the time that the Cecrops flouriſhed in Attica; but the Phocians afterwards formed themſelves into a commonwealth, to be governed by their general aſſemblies, the members of which were choſen from among themſelves, and were changed as often as occaſion required. Of the hiſtory of the Phocians but little is known till the time of the holy war, of which we have the following account in the Ancient Univerſal Hiſtory.

"The Phocians having preſumed to plough the territories of the city of Cyrra, conſecrated to the Delphic god, were ſummoned by the other Grecian ſtates before the court of the Amphictyons, where a conſiderable fine was impoſed upon them for their ſacrilege. They refuſed to pay it, on pretence that it was too large; and at the next aſſembly their dominions were adjudged confiſcated to the uſe of the temple. This ſecond ſentence exaſperated the Phocians ſtill more; who, at the inſtigation of one Philomelus, or, as he is called by Plutarch, Philomedes, ſeized upon the temple, plundered it of its treaſure, and held the ſacred depoſitum for a conſiderable time. This ſecond crime occaſioned another aſſembly of the Amphictyons, the reſult of which was a formal declaration of war againſt the Phocians. The quarrel being become more general, the ſeveral ſtates took part in it according to their inclinations or intereſt. Athens, Sparta, and ſome others of the Peloponneſians, declared for the Phocians; and the Thebans, Theſſalians, Locrians, and other neighbouring ſtates, againſt them. A war was commenced with great fury on both ſides, and ſtyled *the holy war*, which laſted ten years; during which the Phocians, having hired a number of foreign troops, made an obſtinate defence, and would in all probability have held out much longer had not Philip of Macedon given the finiſhing ſtroke to their total defeat and puniſhment. The war being ended, the grand council aſſembled again, and impoſed an annual fine of 60 talents upon the Phocians, to be paid to the temple, and continued till they had fully repaired the damage it had ſuſtained from them; and, till this reparation ſhould be made, they were excluded from dwelling in walled towns, and from having any vote in the grand aſſembly. They did not, however, continue long under this heavy ſentence: their known bravery made their aſſiſtance ſo neceſſary to the reſt, that they were glad to remit it; after which remiſſion they continued to behave with their uſual courage and reſolution, and ſoon obliterated their former guilt."

We cannot finiſh this article without mentioning more particularly Daulis, rendered famous, not ſo much for its extent or richneſs, as for the ſtature and proweſs of its inhabitants; but ſtill more for the inhuman repaſt which was ſerved up to Tereus king of Thrace by the women of this city, by whom he was ſoon after murdered for the double injury he had done to his ſiſter in-law Philomela, daughter of Pandion king of Athens. See Philomela.

PHŒBUS, one of the names given by ancient mythologiſts to the Sun, Sol, or Apollo. See Apollo.

PHŒNICIA, or more properly Phœnice, the ancient name of a country lying between the 34th and 36th degrees of north latitude; bounded by Syria on the north and eaſt, by Judæa on the ſouth, and by the Mediterranean on the weſt. Whence it borrowed its name is not abſolutely certain. Some derive it from one Phœnix; others from the Greek word *phœnix*, ſignifying a *palm* or *date*, as that tree remarkably abounded in this country. Some again ſuppoſe that Phœnice is originally a tranſlation of the Hebrew word *Edom*, from the Edomites who fled thither in the days of David. By the contraction of Canaan it was alſo called *Chna*, and anciently *Rhabbothin* and *Colpitis* *. The Jews commonly named it *Canaan*; though ſome part of it, at leaſt, they knew by the name of *Syrophœnice* †. Bochart tells us that the moſt probable etymology is *Phene Anak*, i. e. "the deſcendants of Anak." Such were the names peculiar to this ſmall country; though Phœnice was ſometimes extended to all the maritime countries of Syria and Judæa, and Canaan to the Philiſtines, and even to the Amalekites. On the contrary, theſe two names, and the reſt, were moſt generally ſwallowed up by thoſe of Paleſtine and Syria ‡.

There is ſome diſagreement among authors with reſpect to the northern limits of this country. Ptolemy makes the river Eleutherus the boundary of Phœnice to the north; but Pliny, Mela, and Stephanus, place it in the iſland of Aradus, lying north of that river. Strabo obſerves, that ſome will have the river Eleutherus to be the boundary of Seleucis, on the ſide of Phœnis and Cœleſyria. On the coaſt of Phœnice, and ſouth of the river Eleutherus, ſtood the following cities; Simyra, Orthoſia, Tripolis, Botrys, Byblus, Palæbyblus, Berytus, Sidon, Sarepta, Tyrus, Palætyrus.

Phœnice extended, according to Ptolemy, even beyond Mount Carmelus; for that geographer places in Phœnice not only Ecdippa and Ptolemais, but Sycaminum and Dœra, which ſtand ſouth of that mountain. Theſe, however, properly ſpeaking, belonged to Paleſtine. We will not take upon us to mark out the bounds of the midland Phœnice. Ptolemy reckons in it the following towns: Arca, Palæbyblus (Old Byblus), Gabala, and Cæſeria Paniæ. This province was conſiderably extended in the times of Chriſtianity; when, being conſidered as a province of Syria, it included not only Damaſcus but Palmyra alſo.

The ſoil of this country is good, and productive of many neceſſaries for food and clothing. The air is wholeſome, and the climate agreeable. It is plentifully watered by ſmall rivers; which, running down from Mount Libanus, ſometimes ſwell to an immoderate degree, either increaſed by the melting of the ſnows on that mountain, or by heavy rains. Upon theſe occaſions they overflow, to the great danger and hindrance of the traveller and damage of the country. Among theſe rivers is that of ADONIS.

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* This laſt name is a tranſlation of the firſt. *Rabbotſen* is in Hebrew a *great gulph* or *bay*. From *rabbotſen*, by changing the Hebrew *tſ* into the Greek *t*, comes *rabboten*; and, with a little variation, *rhabbothin*. Κολπος, *colpos*, is Greek alſo for a *bay* or *gulph*; whence it appears that *colpitis* or *colpites* is a tranſlation of *rabbothin*.

† Bochart ſuppoſes that the borderers, both upon the Phœnician and Syrian ſide, were called by the common name of Syrophœnicians, as partaking equally of both nations.

‡ Or rather Phœnice, Paleſtine, and Syria, were promiſcuouſly uſed for each other, and particularly the two former. Phœnice and Paleſtine, ſays Stephanus Byzantinus, were the ſame. As for Syria, we have already obſerved, that in its largeſt extent it ſometimes comprehended Phœnice and Cœleſyria. Herodotus plainly confounds theſe three names; we mean, uſes one for the other indifferently.

It is univerſally allowed that the Phœnicians were Canaanites [*] by deſcent: nothing is plainer or leſs conteſted, and therefore it were time loſt to prove it. We ſhall only add, that their blood muſt have been mixed with that of foreigners in proceſs of time, as it happens in all trading places; and that many ſtrange families muſt have ſettled among them, who could conſequently lay no claim to this remote origin, how much ſoever they may have been called Phœnicians, and reckoned of the ſame deſcent with the ancient proprietors.

The Phœnicians were governed by kings; and their territory, as ſmall a ſlip as it was, included ſeveral kingdoms; namely, thoſe of Sydon, Tyre, Aradus, Berytus, and Byblus. In this particular they imitated and adhered to the primitive government of their forefathers; who, like the other Canaanites, were under many petty princes, to whom they allowed the ſovereign dignity, reſerving to themſelves the natural rights and liberties of mankind. Of their civil laws we have no particular ſyſtem.

With regard to religion, the Phœnicians were the moſt groſs and abominable idolators. The Baal-berith, Baalzebub, Baalſamen, &c. mentioned in ſcripture, were ſome of the Phœnician gods; as were alſo the Moloch, Aſhtaroth, and Thammuz, mentioned in the ſacred writings. The word *Baal*, in itſelf an appellative, was no doubt applied to the true God, until he rejected it on account of its being ſo much profaned by the idolaters. The name was not appropriated to any particular deity among the idolatrous nations, but was common to many; however, it was generally imagined that one great God preſided over all the reſt. Among the Phœnicians this deity was named *Baal-ſamen*; whom the Hebrews would have called *Baal-ſhemin*, or the God of heaven. In all probability this was alſo the principal Carthaginian deity, though his Punic name is unknown. We have many religious rites of the Carthaginians handed down to us by the Greek and Roman writers; but they all beſtowed names of their own gods upon thoſe of the Carthaginians, which leads us to a knowledge of the correſpondence between the characters of the Phœnician and European deities. The principal deity of Carthage, according to Diodorus Siculus, was Chronus or Saturn. The ſacrifices offered up to him were children of the beſt families. Our author alſo tells us, that the Carthaginians had a brazen ſtatue or coloſſus of this god, the hands of which were extended in act to receive, and bent downwards in ſuch a manner, that the child laid thereon immediately fell down into a hollow where there was a fiery furnace. He adds alſo, that this inhuman practice ſeemed to confirm a tradition handed down to the Greeks from very early antiquity, viz. that Saturn devoured his own children.

The goddeſs Cœleſtis, or Urania, was held in the higheſt veneration by the Carthaginians. She is thought to have been the ſame with the queen of heaven mentioned in Jeremiah, the Juno Olympia of the Greeks. According to Heſychius, the ſame word applied in the Punic language both to Juno and Venus: nay, the ancient Greeks frequently confound Juno, Venus, and Diana or the moon, all together which is to be attributed to the Egyptians and Phœnicians, from whom they received their ſyſtem of religion; who ſeem in the moſt ancient times to have had but one name for them all. Beſides theſe there were ſeveral other deities of later date, who were worſhipped among the Phœnicians, particularly thoſe of Tyre, and conſequently among the Carthaginians alſo. Theſe were Jupiter, Apollo, Mars, and Bacchus. Jupiter was worſhipped under the name of *Belus* or *Baal*. To him they addreſſed their oaths; and placed him for the moſt part, as there is reaſon to believe, at the head of their treaties. The ſame name was alſo given to the other two, whence they were frequently miſtaken for one another. Apollo or the ſun went either by this name ſimply, or by others of which this made a part.

The Carthaginian ſuperſtition, however, was not confined to theſe deities alone. They worſhipped alſo the fire, air, and other elements; and had gods of rivers, meads, &c. Nay, they paid divine honours to the ſpirits of their heroes, and even to men and women themſelves while yet in life; and in this adoration Hannibal the Great had for ſome time a ſhare, notwithſtanding the infamous conduct of his countrymen towards him at laſt. In order to worſhip thoſe gods with more conveniency on all occaſions, the Carthaginians had a kind of portable temples. Theſe were only covered chariots, in which were ſome ſmall images repreſenting their favourite deities; and which were drawn by oxen. They were alſo a kind of oracle; and their reſponſes were underſtood by the motion impreſſed upon the vehicle. This was likewiſe an Egyptian or Libyan cuſtom; and Tacitus informs us that the ancient Germans had ſomething of the ſame kind. The tabernacle of Moloch is thought to have been a machine of this kind; and it is not improbable that the whole was derived from the tabernacle of the Jews in the wilderneſs.

Beſides all the deities above mentioned, we ſtill find another, named the *Dæmon* or *Genius* of Carthage, mentioned in the treaty made by Philip of Macedon and Hannibal. What this deity might be, we know not; however, it may be obſerved, that the pagan world in general believed in the exiſtence of demons, or intelligences who had a kind of middle nature between gods and men, and to whom the adminiſtration of the world was in a great meaſure committed. Hence it is no wonder that they ſhould have received religious honours; for, when once mankind were poſſeſſed with the opinion that they were the miniſters of the gods, and truſted with the diſpenſation of their favours as well as the infliction of their puniſhments, it is natural to ſuppoſe that they would be deſirous of making their addreſſes to them. See ASTARTE and POLYTHEISM.

Herodotus ſuppoſes the Phœnicians to have been circumciſed; but Joſephus aſſerts, that none of the nations included under the vague name of Paleſtine and Syria uſed that rite, the Jews excepted; ſo that if the Phœnicians had anciently that cuſtom, they came in time to neglect it, and at length wholly laid it aſide. They abſtained however from the fleſh of ſwine.

Much is ſaid of their arts, ſciences, and manufactures; but as what we find concerning them is couched in general terms only, we cannot deſcant on particulars. The Sidonians, under which denomination we comprehend the Phœnicians in general, were of a moſt happy genius. They were from the beginning addicted to philoſophical exerciſes of the mind; inſomuch that a Sidonian, by name Moſchus, taught the doctrine of atoms before the Trojan war: and Abomenus of Tyre puzzled Solomon by the ſubtilty of his queſtions. Phœnice continued to be one of the ſeats of learning, and both Tyre and Sidon produced their philoſophers of later ages; namely, Boethus and Diodatus of Sidon, Antipater of Tyre, and Appollonius of the ſame place; who gave an account of the writings and diſciples of Zeno. For their language, ſee PHILOLOGY. As to their manufactures, the glaſs of Sidon, the purple of Tyre, and the exceeding fine linen they wove, were the product of their own country, and their own invention; and for their extraordinary ſkill in working metals, in hewing timber and ſtone; in a word, for their perfect knowledge of what was ſolid, great, and ornamental in architecture—we need only put the reader in mind of the large ſhare they had in erecting and decorating the temple at Jeruſalem under their king Hiram. Their fame for taſte, deſign, and ingenious invention, was ſuch, that whatever was elegant, great, or pleaſing, whether in apparel, veſſels, or toys, was diſtinguiſhed by way of excellence with the epithet of Sidonian.

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[*] Bochart intimates that the Canaanites were aſhamed of their name, on account of the curſe denounced on their progenitor, and terrified by the wars ſo vigorouſly and ſucceſſively waged on them by the Iſraelites, purely becauſe they were Canaanites; and that therefore, to avoid the ignominy of the one and the danger of the other, they abjured their old name, and changed it for Phœnicians, Syrians, Syrophœnicians, and Aſſyrians. Heidegger conjectures alſo that they were aſhamed of their anceſtor Canaan.

The Phœnicians were likewiſe celebrated as merchants, navigators, and planters of colonies in foreign parts. As merchants, they may be ſaid to have engroſſed all the commerce of the weſtern world: as navigators, they were the boldeſt, the moſt experienced, and greateſt diſcoverers, of the ancient times: they had for many ages no rivals. In planting colonies they exerted themſelves ſo much, that, conſidering their habitation was little more than the ſlip of ground between Mount Libanus and the ſea, it is ſurpriſing how they could furniſh ſuch ſupplies of people, and not wholly depopulate their native country.

It is generally ſuppoſed that the Phœnicians were induced to deal in foreign commodities by their neighbourhood with the Syrians, who were perhaps the moſt ancient of thoſe who carried on a conſiderable and regular trade with the more eaſtern regions: and this conjecture appears probable at leaſt; for their own territory was but ſmall, and little able to afford any conſiderable exports, if we except manufactures: but that their manufactures were anyways conſiderable till they began to turn all the channels of trade into their own country, it is hard to believe. In Syria, which was a large country, they found ſtore of productions of the natural growth of that ſoil, and many choice and uſeful commodities brought from the eaſt. Thus, having a ſafe coaſt, with convenient harbours, on one ſide, and excellent materials for ſhip-building on the other; perceiving how acceptable many commodities that Syria furniſhed would be in foreign parts, and being at the ſame time, perhaps, ſhown the way by the Syrians themſelves, who may have navigated the Mediterranean—they turned all their thoughts to trade and navigation, and by an uncommon application ſoon eclipſed their maſters in that art.

It were in vain to talk of the Edomites, who fled hither in David's time; or to inquire why Herodotus ſuppoſes the Phœnicians came from the Red Sea: their origin we have already ſeen. That ſome of the Edomites fled into this country in the days of David, and that they were a trading people, is very evident: what improvements they brought with them into Phœnice, it is hard to ſay; and by the way, it is as difficult to aſcertain their numbers. In all probability they brought with them a knowledge of the Red Sea, and of the ſouth parts of Arabia, Egypt, and Ethiopia; and by their information made the Phœnicians acquainted with thoſe coaſts; by which means they were enabled to undertake voyages to thoſe parts, for Solomon, and Pharaoh Necho, king of Egypt.

Their whole thoughts were employed on ſchemes to advance their commerce. They affected no empire but that of the ſea; and ſeemed to aim at nothing but the peaceable enjoyment of their trade. This they extended to all the known parts they could reach; to the Britiſh iſles, commonly underſtood by the Caſſiterides; to Spain, and other places in the ocean, both within and without the Straits of Gibraltar; and, in general, to all the ports of the Mediterranean, the Black Sea, and the Lake Mæotis. In all theſe parts they had ſettlements and correſpondents, from which they drew what was uſeful to themſelves, or might be ſo to others; and thus they exerciſed the three great branches of trade, as it is commonly divided into importation, exportation, and tranſportation, in full latitude. Such was their ſea-trade; and for that which they carried on by land in Syria, Meſopotamia, Aſſyria, Babylonia, Perſia, Arabia, and even in India, it was of no leſs extent, and may give us an idea of what this people once were, how rich and how deſervedly their merchants are mentioned in Scripture as equal to princes. Their country was, at that time, the great warehouſe where every thing that might either adminiſter to the neceſſities or luxury of mankind was to be found; which they diſtributed as they judged would be beſt for their own intereſt. The purple of Tyre, the glaſs of Sidon, and the exceeding fine linen made in this country, together with other curious pieces of art in metals and wood, already mentioned, appear to have been the chief and almoſt only commodities of Phœnice itſelf. Indeed their territory was ſo ſmall, that it is not to be imagined they could afford to export any of their own growth; it is more likely that they rather wanted than abounded with the fruits of the earth.

Having thus ſpoken in general terms of their trade, we ſhall now touch upon their ſhipping and ſome things remarkable in their navigation. Their larger embarkations were of two ſorts; they divided them into round ſhips or gauli; and long ſhips, galleys, or triremes. When they drew up in line of battle, the gauli were diſpoſed at a ſmall diſtance from each other in the wings, or in the van and the rear: their triremes were contracted together in the centre. If, at any time, they obſerved that a ſtranger kept them company in their voyage, or followed in their track, they were ſure to get rid of him if they could, or deceive him if poſſible; in which policy they went ſo far, as to venture the loſs of their ſhips, and even their lives; ſo jealous were they of foreigners, and ſo tenaciouſly bent on keeping the whole trade to themſelves. In order to diſcourage other nations from engaging in commerce, they practiſed piracy, or pretended to be at war with ſuch as they met when they thought themſelves ſtrongeſt. This was but a natural ſtroke of policy in people who graſped at the whole commerce of the then known world. We muſt not forget here the famous fiſhery of Tyre, which ſo remarkably enriched that city in particular. See ASTRONOMY, OPHIR, and TYRE.

PHOENICOPTERUS, or FLAMINGO, in ornithology, a genus of birds belonging to the order of grallæ. The beak is naked, teethed, and bent as if it was broken; the noſtrils are linear; the feet are palmated, and four-toed. There is but one ſpecies; viz. the Bahamenſis of Cateſby, a native of Africa and America. See pl. 40.

This bird reſembles the heron in ſhape, excepting the bill, which is of a very ſingular form. It is two years old before it arrives at its perfect colour; and then it is entirely red, excepting the quill-feathers, which are black. A full-grown one is of equal weight with a wild duck; and when it ſtands erect, it is five feet high. The feet are webbed. The fleſh is delicate, and moſt reſembles that of a partridge in taſte. The tongue, above any other part, was in the higheſt eſteem with the luxurious Romans. Theſe birds make their neſts on hillocks in ſhallow water; on which they ſit with their legs extended down, like a man ſitting on a ſtool. They breed on the coaſts of Cuba and the Bahama iſlands in the Weſt Indies; and frequent ſalt-water only. By reaſon of the particular ſhape of its bill, this bird, in eating, twiſts its neck from ſide to ſide, and makes the upper mandible touch the ground. They are very ſtupid, and will not riſe at the report of a gun; nor is it any warning to thoſe who ſurvive that they ſee others killed by their ſide; ſo that, by keeping himſelf out of ſight, a fowler may kill as many as he pleaſes.

Theſe birds prefer a warm climate. In the old continent they are not often met with beyond 40 degrees north or ſouth. They are met with everywhere on the African coaſt and adjacent iſles, to the Cape of Good Hope; and ſometimes on the coaſts of Spain, Italy, and thoſe of France lying in the Mediterranean Sea; being at times found at Marſeilles, and for ſome way up the Rhone. In ſome ſeaſons they frequent Aleppo and the parts adjacent. They are ſeen alſo on the Perſian ſide of the Caſpian Sea, and thence along the weſtern coaſt as far as the Wolga; though this is at uncertain times, and chiefly in conſiderable flocks coming from the north-eaſt, moſtly in October and November; but ſo ſoon as the wind changes they totally diſappear. They breed in the Cape Verd iſles, particularly in that of Sal. They go for the moſt part together in flocks, except in breeding time. Dampier ſays, that, with two more in company, he killed 14 at once, which was effected by ſecreting themſelves; for they are ſo very ſhy, that they will by no means ſuffer any one to approach openly near enough to ſhoot them. Kolben tells us that they are very numerous at the Cape; keeping in the day on the borders of the lakes and rivers, and lodging themſelves at night in the long graſs on the hills. They are alſo common to various places in the warmer parts of America, frequenting the ſame latitudes as in other quarters of the world; being found at Peru, Chili, Cayenne, and the coaſt of Braſil, as well as the various iſlands of the Weſt Indies. Sloane found them in Jamaica; but particularly at the Bahama Iſlands and at Cuba, where they breed. When ſeen at a diſtance, they appear as a regiment of ſoldiers, being ranged along-ſide one another, on the borders of the rivers, ſearching for food; which chiefly conſiſts of ſmall fiſh or the eggs of them; and of water-inſects, which they ſearch after by plunging in the bill and part of the head, from time to time trampling with their feet to muddy the water, that their prey may be raiſed from the bottom. Whilſt they are feeding, one of them is ſaid to ſtand centinel, and the moment he ſounds the alarm the whole flock takes wing. This bird, when at reſt, ſtands on one leg, the other being drawn up cloſe to the body, with the head placed under the wing on that ſide of the body it ſtands on.

They are ſometimes caught young, and are brought up tame; but are always impatient of cold; and in this ſtate will ſeldom live a great while, gradually loſing their colour, fleſh, and appetite, and dying for want of that food which in a ſtate of nature at large they were abundantly ſupplied with.

PHOENIX, in aſtronomy. See ASTRONOMY.

PHOENIX, the *Great Palm*, or *Date-tree*; a genus of plants belonging to the order of palmæ. There is only one ſpecies, viz. the dactylifera, or common date-tree, a native of Africa and the eaſtern countries, where it grows to 50, 60, and 100 feet high. The trunk is round, upright, and ſtudded with protuberances, which are the veſtiges of the decayed leaves. From the top iſſues forth a cluſter of leaves or branches eight or nine feet long, extending all round like an umbrella, and bending a little towards the earth. The bottom part produces a number of ſtalks like thoſe of the middle, but ſeldom ſhooting ſo high as four or five feet. Theſe ſtalks, ſays Adanſon, diffuſe the tree very conſiderably; ſo that, wherever it naturally grows in foreſts, it is extremely difficult to open a paſſage through its prickly leaves. The date-tree was introduced into Jamaica ſoon after the conqueſt of the iſland by the Spaniards. There are, however, but few of them in Jamaica at this time. The fruit is ſomewhat in the ſhape of an acorn. It is compoſed of a thin, light, and gloſſy membrane, ſomewhat pellucid and yellowiſh; which contains a fine, ſoft, and pulpy fruit, which is firm, ſweet, and ſomewhat vinous to the taſte, eſculent, and wholeſome; and within this is encloſed a ſolid, tough, and hard kernel, of a pale grey colour on the outſide, and finely marbled within like the nutmeg. For medicinal uſe dates are to be choſen large, full, freſh, yellow on the ſurface, ſoft and tender, not too much wrinkled; ſuch as have a vinous taſte, and do not rattle when ſhaken. They are produced in many parts of Europe, but never ripen perfectly there. The beſt are brought from Tunis; they are alſo very fine and good in Egypt and in many parts of the eaſt. Thoſe of Spain and France look well; but are never perfectly ripe, and very ſubject to decay. They are preſerved three different ways; ſome preſſed and dry; others preſſed more moderately, and again moiſtened with their own juice; and others not preſſed at all, but moiſtened with the juice of other dates, as they are packed up, which is done in baſkets or ſkins. Thoſe preſerved in this laſt way are the beſt. Dates have always been eſteemed moderately ſtrengthening and aſtringent.

Though the date-tree grows everywhere indiſcriminately on the northern coaſts of Africa, it is not cultivated with care, except beyond Mount Atlas; becauſe the heat is not ſufficiently powerful along the coaſts to bring the fruits to proper maturity. We ſhall here extract ſome obſervations from Mr. Des Fontaines reſpecting the manner of cultivating it in Barbary, and on the different uſes to which it is applied. All that part of the Zaara which is near Mount Atlas, and the only part of this vaſt deſert which is inhabited, produces very little corn: the ſoil being ſandy, and burnt up by the ſun, is almoſt entirely unfit for the cultivation of grain, its only productions of that kind being a little barley, maize, and ſorgo. The date-tree, however, ſupplies the deficiency of corn to the inhabitants of theſe countries, and furniſhes them with almoſt the whole of their ſubſiſtence. They have flocks of ſheep; but as they are not numerous, they preſerve them for the ſake of their wool; beſides, the fleſh of theſe animals is very unwholeſome food in countries that are exceſſively warm; and theſe people, though ignorant, have probably been enabled by experience to know that it was ſalutary for them to abſtain from it. The date-trees are planted without any order, at the diſtance of 12 feet, one from the other, in the neighbourhood of rivulets and ſtreams which iſſue from the ſand. Foreſts of them may be ſeen here and there, ſome of which are ſeveral leagues in circumference. The extent of theſe plantations depends upon the quantity of water which can be procured to water them; for they require much moiſture. All theſe foreſts are intermixed with orange, almond, and pomegranate trees, and with vines which twiſt round the trunks of the date-trees; and the heat is ſtrong enough to ripen the fruit, though they are never expoſed to the ſun.

Along the rivulets and ſtreams, dykes are erected to ſtop the courſe of their waters, in order that they may be diſtributed amongſt the date-trees by means of ſmall canals. The number of canals is fixed for each individual; and in ſeveral cantons, to have a right to them, the proprietors are obliged to pay an annual ſum proportionable to the number and extent of their plantations. Care is taken to till the earth well, and to raiſe a circular border around the root of each tree, that the water may remain longer and in larger quantity. The date-trees are watered in every ſeaſon, but more particularly during the great heats of ſummer.

It is generally in winter that new plantations of this tree are formed. For this purpoſe thoſe who cultivate them take ſhoots of thoſe which produce the beſt dates, and plant them at a ſmall diſtance one from the other. At the end of three or four years theſe ſhoots, if they have been properly taken care of, begin to bear fruit; but this fruit is as yet dry, without ſweetneſs, and even without kernels; they never reach the higheſt degree of perfection of which they are ſuſceptible till they are about 15 or 20 years old.

Theſe plants are however produced from the ſeeds taken out of the fruit, provided they are freſh. They ſhould be ſown in pots filled with light rich earth, and plunged into a moderate hot-bed of tanners bark, which ſhould be kept in a moderate temperature of heat, and the earth frequently refreſhed with water. When the plants are come up to a proper ſize, they ſhould be each planted in a ſeparate ſmall pot, filled with the ſame light earth, and plunged into a hot-bed again, obſerving to refreſh them with water, as alſo to let them have air in proportion to the warmth of the ſeaſon and the bed in which they are placed. During the ſummer time they ſhould remain in the ſame hot-bed; but in the beginning of Auguſt, they ſhould have a great ſhare of air to harden them againſt the approach of winter; for if they are too much forced, they will be ſo tender as not to be preſerved through the winter without much difficulty, eſpecially if you have not the conveniency of a bark-ſtove to keep them in. The ſoil in which theſe plants ſhould be placed muſt be compoſed in the following manner, viz. half of light freſh earth taken from a paſture-ground, the other half ſea-ſand and rotten dung or tanners bark in equal proportion; theſe ſhould be carefully mixed, and laid in a heap three or four months at leaſt before it is uſed, but ſhould be often turned over to prevent the growth of weeds, and to ſweeten the earth.

The trees, however, which ſpring from ſeed never produce ſo good dates as thoſe that are raiſed from ſhoots, they being always poor and ill taſted. It is undoubtedly by force of cultivation, and after ſeveral generations, that they require a good quality.

The date-trees which have been originally ſown grow rapidly, and we have been aſſured that they bear fruit in the fourth or fifth year. Care is taken to cut the inferior branches of the date-tree in proportion as they riſe; and a piece of the root is always left of ſome inches in length, which affords the eaſy means of climbing to the ſummit. Theſe trees live a long time, according to the account of the Arabs; and in order to prove it, they ſay that when they have attained to their full growth, no change is obſerved in them for the ſpace of three generations.

The number of females which are cultivated is much ſuperior to that of the males, becauſe they are much more profitable. The ſexual organs of the date-tree grow, as is well known, upon different ſtalks, and theſe trees flower in the months of April and May, at which time the Arabs cut the male branches to impregnate the female. For this purpoſe, they make an inciſion in the trunk of each branch which they wiſh to produce fruit, and place in it a ſtalk of male flowers; without this precaution the date-tree would produce only abortive fruit. * In ſome cantons the male branches are only ſhaken over the female, The practice of impregnating the date-tree in this manner is very ancient. Pliny deſcribes it very accurately in that part of his work where he treats of the palm-tree.

There is ſcarcely any part of the date-tree which is not uſeful. The wood, though of a ſpongy texture, laſts ſuch a number of years, that the inhabitants of the country ſay it is incorruptible. They employ it for making beams and inſtruments of huſbandry; it burns ſlowly, but the coals which reſult from its combuſtion are very ſtrong, and produce a great heat.

The Arabs ſtrip the bark and fibrous parts from the young date-trees, and eat the ſubſtance, which is in the centre; it is very nouriſhing, and has a ſweet taſte: it is known by the name of the marrow of the date-tree. They eat alſo the leaves, when they are young and tender, with lemon-juice; the old ones are laid out to dry, and are employed for making mats and other works of the ſame kind, which are much uſed, and with which they carry on a conſiderable trade in the interior parts of the country. From the ſides of the ſtumps of the branches which have been left ariſe a great number of delicate filaments, of which they make ropes, and which might ſerve to fabricate cloth.

Of the freſh dates and ſugar, ſays Haſſelquiſt, the Egyptians make a conſerve, which has a very pleaſant taſte. In Egypt they uſe the leaves as fly-flaps, for driving away the numerous inſects which prove ſo troubleſome in hot countries. The hard boughs are uſed for fences and other purpoſes of huſbandry; the principal ſtem for building. The fruit, before it is ripe, is ſomewhat aſtringent; but, when thoroughly mature, is of the nature of the fig. The Senegal dates are ſhorter than thoſe of Egypt, but much thicker in the pulp, which is ſaid to have a ſugary agreeable taſte, ſuperior to that of the beſt dates of the Levant.

A white liquor, known by the name of *milk*, is drawn alſo from the date-tree. To obtain it, all the branches are cut from the ſummit of one of theſe trees, and after ſeveral inciſions have been made in it, they are covered with leaves, in order that the heat of the ſun may not dry it.

The ſap drops down into a veſſel placed to receive it, at the bottom of a circular groove made below the inciſions. The milk of the date-tree has a ſweet and agreeable taſte when it is new; it is very refreſhing, and it is even given to ſick people to drink, but it generally turns ſour at the end of 24 hours. Old trees are choſen for this operation, becauſe the cutting of the branches, and the large quantity of ſap which flows from them, greatly exhauſt them, and often cauſe them to decay.

The male flowers of the date-tree are alſo uſeful. They are eaten when ſtill tender, mixed up with a little lemon-juice. They are reckoned to be very provocative: the odour which they exhale is probably the cauſe of this property being aſcribed to them.

Theſe date-trees are very lucrative to the inhabitants of the deſert. Some of them produce 20 bunches of dates; but care is always taken to lop off a part of them, that thoſe which remain may become larger; 10 or 12 bunches only are left on the moſt vigorous trees.

It is reckoned that a good tree produces, one year with another, about the value of 10 or 12 ſhillings to the proprietor. A pretty conſiderable trade is carried on with dates in the interior part of the country, and large quantities of them are exported to France and Italy. The crop is gathered towards the end of November. When the bunches are taken from the tree, they are hung up in ſome very dry place where they may be ſheltered and ſecure from inſects.

Dates afford wholeſome nouriſhment, and have a very agreeable taſte when they are freſh. The Arabs eat them without ſeaſoning. They dry and harden them in the ſun, to reduce them to a kind of meal, which they lay up in ſtore to ſupply themſelves with food during the long journeys which they often undertake acroſs their deſerts. This ſimple food is ſufficient to nouriſh them for a long time.—The inhabitants of the Zaara procure alſo from their dates a kind of honey which is exceedingly ſweet. For this purpoſe they chooſe thoſe which have the ſofteſt pulp; and having put them into a large jar with a hole in the bottom, they ſqueeze them by placing over them a weight of eight or ten pounds. The moſt fluid part of the ſubſtance, which drops through the hole, is what they call the *honey* of the date.

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* The celebrated Linnæus, in his Diſſertation on the Sexes of Plants, ſpeaking of the date-tree, ſays, " A female date-bearing palm flowered many years at Berlin without producing any ſeeds; but the Berlin people taking care to have ſome of the bloſſoms of the male tree, which was then flowering at Leipſic, ſent to them by the poſt, they obtained fruit by theſe means; and ſome dates, the offspring of this impregnation, being planted in my garden, ſprung up, and to this day continue to grow vigorouſly. Kœmpfer formerly told us how neceſſary it was found by the oriental people, who live upon the produce of palm-trees, and are the true *Lotophagi*, to plant ſome male trees among the females, if they hoped for any fruit: hence it is the practice of thoſe who make war in that part of the world to cut down all the male palms, that a famine may afflict their proprietors; ſometimes even the inhabitants themſelves deſtroy the male trees when they dread an invaſion, that their enemies may find no ſuſtenance in the country."

Even the ſtones, though very hard, are not thrown away. They give them to their camels and ſheep as food, after they have bruiſed them or laid them to ſoften in water.

The date, as well as other trees which are cultivated, exhibits great variety in its fruit, with reſpect to ſhape, ſize, quality, and even colour. There are reckoned to be at leaſt twenty different kinds. Dates are very liable to be pierced by worms, and they ſoon corrupt in moiſt or rainy weather.

From what has been ſaid, it may eaſily be perceived that there is, perhaps, no tree whatever uſed for ſo many and ſo valuable purpoſes as the date-tree.

Phœnix, in ornithology, a bird famous in antiquity, but generally looked upon by the moderns as fabulous. The ancients ſpeak of this bird as ſingle, or the only one of its kind; they deſcribe it as of the ſize of an eagle; its head finely creſted with a beautiful plumage, its neck covered with feathers of a gold colour, and the reſt of its body purple, only the tail white, and the eyes ſparkling like ſtars: they hold, that it lives 500 or 600 years in the wilderneſs; that, when thus advanced in age, it builds itſelf a pile of ſweet wood and aromatic gums, and fires it with the wafting of its wings, and thus burns itſelf; and that from its aſhes ariſes a worm, which in time grows up to be a phœnix. Hence the Phœnicians gave the name of phœnix to the palm-tree; becauſe when burnt down to the root it riſes again fairer than ever.

In the ſixth book of the Annals of Tacitus, ſect. 28. it is obſerved that, in the year of Rome 787, the phœnix reviſited Egypt; which occaſioned among the learned much ſpeculation. This being is ſacred to the ſun. Of its longevity the accounts are various. The common perſuaſion is, as we have mentioned above, that it lives 500 years; though by ſome the date is extended to 1461. The ſeveral eras when the phœnix has been are fixed by tradition. The firſt, we are told, was in the reign of Seſoſtris; the ſecond in that of Amaſis; and, in the period when Ptolemy the third of the Macedonian race was ſeated on the throne of Egypt, another phœnix directed its flight towards Heliopolis. When to theſe circumſtances are added the brilliant appearance of the phœnix, and the tale that it makes frequent excurſions with a load on its back, and that when, by having made the experiment through a long tract of air, it gains ſufficient confidence in its own vigour, it takes up the body of its father and flies with it to the altar of the ſun to be there conſumed; it cannot but appear probable, that the learned of Egypt had enveloped under this allegory the philoſophy of comets.

Phœnix, ſon of Amyntor king of Argos, by Cleobule or Hippodamia, was preceptor to young Achilles. His father having proved faithleſs to his wife, through fondneſs for a concubine called *Clytia*, Cleobule, who was jealous of him, perſuaded her ſon Phœnix to ingratiate himſelf with his father's miſtreſs. Phœnix eaſily ſucceeded; but Amyntor diſcovering his intrigues, he drew a curſe upon him, and the ſon was ſoon after deprived of his ſight by divine vengeance. Some ſay that Amyntor himſelf put out his ſon's eyes, which ſo cruelly provoked him that he meditated the death of his father. Reaſon and piety, however, prevailed over paſſion; and, that he might not become a parricide, Phœnix fled from Argos to the court of Peleus king of Phthia. Here he was treated with tenderneſs; Peleus carried him to Chiron, who reſtored him to his eyeſight; ſoon after which he was made preceptor to Achilles, his benefactor's ſon. He was alſo preſented with the government of many cities, and made king of the Dolopes. He went with his pupil to the Trojan war; and Achilles was ever grateful for the inſtructions and precepts which he had received from him. After the death of Achilles, Phœnix, with others, was commiſſioned by the Greeks to return into Greece, to bring to the war young Pyrrhus. This commiſſion he ſucceſsfully performed; and, after the fall of Troy, he returned with Pyrrhus, and died in Thrace. He was buried, according to Strabo, near Trachinia, where a ſmall river in the neighbourhood received the name of *Phœnix*. There was another Phœnix, ſon of Agenor, by a nymph who was called *Telephaſſa*, according to Apollodorus and Moſchus, or, according to others, *Epimeduſa*, *Perimeda*, or *Agriope*. He was, like his brother Cadmus, and Cilix, ſent by his father in purſuit of his ſiſter Europa, whom Jupiter had carried away under the form of a bull; and when his inquiries proved unſucceſsful, he ſettled in a country, which, according to ſome, was from him called *Phœnicia*. From him, as ſome ſuppoſe, the Carthaginians were called *Pœni*.

PHOLAS, a genus of inſects, belonging to the order of vermes teſtacea. The ſhell is double-valved and divaricated; the cardo is turned backwards, and connected by a cartilage. There are ſix ſpecies, diſtinguiſhed by the figure of their ſhells. See pl. 40.

The word *pholas* is derived from the Greek, and ſignifies ſomething which lies hid. This name they derive from their property of making themſelves holes in the earth, ſand, wood, or ſtone, and living in them. The means of their getting there, however, are as yet entirely unknown. All that we can know with certainty is, that they muſt have penetrated theſe ſubſtances when very ſmall; becauſe the entrance of the hole in which the pholas lodges is always much leſs than the inner part of it, and indeed than the ſhell of the pholas itſelf. Hence ſome have ſuppoſed that they were hatched in holes accidentally formed in ſtones, and that they naturally grew of ſuch a ſhape as was neceſſary to fill the cavity.

The holes in which the pholades lodge are uſually twice as deep, at leaſt, as the ſhells themſelves are long; the figure of the holes is that of a truncated cone, excepting that they are terminated at the bottom by a rounded cavity, and their poſition is uſually ſomewhat oblique to the horizon. The openings of theſe holes are what betray the pholas being in the ſtone; but they are always very ſmall in proportion to the ſize of the fiſh. There ſeems to be no progreſſive motion of any animal in nature ſo ſlow as that of the pholas; it is immerſed in the hole, and has no movement except a ſmall one towards the centre of the earth; and this is only proportioned to the growth of the animal. Its work is very difficult in its motion; but it has great time to perform it in, as it only moves downward, ſinking itſelf deeper in the ſtone as it increaſes itſelf in bulk. That part by means of which it performs this is a fleſhy ſubſtance placed near the lower extremity of the ſhell; it is of the ſhape of a lozenge, and is conſiderably large in proportion to the ſize of the animal; and though it be of a ſoft ſubſtance, it is not to be wondered at that in ſo long a time it is able, by conſtant work, to burrow into a hard ſtone. The manner of their performing this may be ſeen by taking one of them out of the ſtone, and placing it upon ſome ſoft clay; for they will immediately get to work in bending and extending that part allotted to dig for them, and in a few hours they will bury themſelves in the mud in as large a hole as they had taken many years to make in the ſtone. They find little reſiſtance in ſo ſoft a ſubſtance; and the neceſſity of their hiding themſelves evidently makes them haſten their work. The animal is lodged in the lower half of the hole in the ſtone, and the upper half is filled up by a pipe of a fleſhy ſubſtance and conic figure, truncated at the end: this they uſually extend to the orifice of the hole, and place on a level with the ſurface of the ſtone; but they ſeldom extend it any farther than this. The pipe, though it appears ſingle, is in reality compoſed of two pipes, or at leaſt it is compoſed of two parts ſeparated by a membrane. The uſe of this pipe or proboſcis is the ſame with that of the proboſcis of other ſhell-fiſh, to take in ſea-water into their bodies, and afterwards to throw it out again. In the middle of their bodies they have a ſmall green veſſel, the uſe of which has not yet been diſcovered. This, when plunged in ſpirit of wine, becomes of a purple colour: but its colour on linen will not become purple in the ſun like that of the murex; and even if it would, its quantity is too ſmall to make it worth preſerving.

The pholas is remarkable for its luminous quality. That this fiſh is luminous was noticed by Pliny, who obſerves that it ſhines in the mouth of the perſon who eats it; and if it touch his hands or clothes, it makes them luminous. He alſo ſays that the light depends upon its moiſture. The light of this fiſh has furniſhed matter for various obſervations and experiments to M. Reaumur and the Bolognian academicians, eſpecially Beccarius, who took ſo much pains with the ſubject of phoſphoreal light.

M. Reaumur obſerves, that whereas other fiſhes give light when they tend to putreſcence, this is more luminous in proportion to its being freſh; that when they are dried, their light will revive if they be moiſtened either with freſh or ſalt water, but that brandy immediately extinguiſhes it. He endeavoured to make this light permanent, but none of his ſchemes ſucceeded.

The attention of the Bolognian academicians was engaged to this ſubject by M. F. Marſilius in 1724, who brought a number of theſe fiſhes, and the ſtones in which they were encloſed, to Bologna, on purpoſe for their examination.

Beccarius obſerved, that though this fiſh ceaſed to ſhine when it became putrid, yet that in its moſt putrid ſtate it would ſhine, and make the water in which it was immerſed luminous when it was agitated. Galeatius and Montius found that wine and vinegar extinguiſhed this light; that in common oil it continued ſome days, but in rectified ſpirit of wine or urine hardly a minute.

In order to obſerve in what manner this light was affected by different degrees of heat, they made uſe of a Reaumur's thermometer, and found that water rendered luminous by theſe fiſhes increaſed in light till the heat arrived to 45°, but that it then became ſuddenly extinct, and could not be revived again.

In the experiments of Beccarius, a ſolution of ſea-ſalt increaſed the light of the luminous water; a ſolution of nitre did not increaſe it quite ſo much. Sal ammoniac diminiſhed it a little, oil of tartar *per deliquium* nearly extinguiſhed it, and the acids entirely. This water poured upon freſh calcined gypſum, rock cryſtal, ceruſe, or ſugar, became more luminous. He alſo tried the effects of it when poured upon various other ſubſtances, but there was nothing very remarkable in them. Afterwards, uſing luminous milk, he found that oil of vitriol extinguiſhed the light, but that of tartar increaſed it.

This gentleman had the curioſity to try how differently coloured ſubſtances were affected by this kind of light; and having, for this purpoſe, dipped ſeveral ribbons in it, the white came out the brighteſt, next to this was the yellow, and then the green; the other colours could hardly be perceived. It was not, however, any particular colour, but only light, that was perceived in this caſe. He then dipped boards painted with the different colours, and alſo glaſs tubes filled with ſubſtances of different colours, in water rendered luminous by the fiſhes. In both theſe caſes, the red was hardly viſible, the yellow was the brighteſt, and the violet the dulleſt. But on the boards, the blue was nearly equal to the yellow, and the green more languid; whereas in the glaſſes, the blue was inferior to the green.

Of all the liquors to which he put the pholades, milk was rendered the moſt luminous. A ſingle pholas made ſeven ounces of milk ſo luminous, that the faces of perſons might be diſtinguiſhed by it, and it looked as if it was tranſparent.

Air appeared to be neceſſary to this light; for when Beccarius put the luminous milk into glaſs tubes, no agitation would make it ſhine unleſs bubbles of air were mixed with it. Alſo Montius and Galeatius found, that, in an exhauſted receiver, the pholas loſt its light, but the water was ſometimes made more luminous; which they aſcribed to the riſing of bubbles of air through it.

Beccarius, as well as Reaumur, had many ſchemes to render the light of theſe pholades permanent. For this purpoſe he kneaded the juice into a kind of paſte with flour, and found that it would give light when it was immerſed in warm water; but it anſwered beſt to preſerve the fiſh in honey. In any other method of preſervation, the property of becoming luminous would not continue longer than ſix months, but in honey it had laſted above a year; and then it would, when plunged in warm water, give as much light as ever it had done. See Barbut's *Genera Verminum*, p. 14. &c.

PHOLEYS, or Foulies, are a people of Africa, of very peculiar manners. Some authors tell us, that the kingdom of Pholey, from whence they derive their name, is divided from that of Jaloff by a lake called in the language of the Mundingoes *Cayor*; and that it ſtretches from eaſt to weſt about 180 miles; but that, though it extends a great way ſouth, its limits in that direction are not exactly aſcertained.

Mr. Moore, however, gives a very different account, and ſays, that the Pholeys live in clans, build towns, and are in every kingdom and country on each ſide the river; yet are not ſubject to any of the kings of the country, though they live in their territories; for if they are uſed ill in one nation, they break up their towns, and remove to another. They have chiefs of their own, who rule with ſuch moderation, that every act of government ſeems rather an act of the people than of one man. This form of government is eaſily adminiſtered, becauſe the people are of a good and quiet diſpoſition, and ſo well inſtructed in what is juſt and right, that a man who does ill expoſes himſelf to univerſal contempt.

The natives of all theſe countries, not being avaricious of land, deſire no more than they can uſe; and as they do not plough with horſes or other cattle, they can uſe but very little; and hence the kings willingly allow the Pholeys to live in their dominions, and cultivate the earth.

The Pholeys have in general a tawny complexion, though many of them are of as deep a black as the Mundingoes; and it is ſuppoſed that their alliances with the Moors have given them the mixed colour between the true olive and the black. They are rather of a low ſtature, but have a genteel and eaſy ſhape, with an air peculiarly delicate and agreeable.

Though they are ſtrangers in the country, they are the greateſt planters in it. They are extremely induſtrious and frugal, and raiſe much more corn and cotton than they conſume, which they ſell at reaſonable rates; and are ſo remarkable for their hoſpitality, that the natives eſteem it a bleſſing to have a Pholey town in their neighbourhood; and their behaviour has gained them ſuch reputation, that it is eſteemed infamous for any one to treat them in an unhoſpitable manner. Their humanity extends to all, but they are doubly kind to people of their race; and if they know of any one of their body being made a ſlave, they will readily redeem him. As they have plenty of food, they never ſuffer any of their own people to want; but ſupport the old, the blind, and the lame, equally with the others.

Theſe people are ſeldom angry; and Mr. Moore obſerves that he never heard them abuſe each other; yet this mildneſs is far from proceeding from want of courage, they being as brave as any people of Africa, and very expert in the uſe of their arms, which are javelins, cutlaſſes, bows and arrows, and upon occaſion guns. They uſually ſettle near ſome Mundingo town, there being ſcarce any of note up the river that has not a Pholey town near it. Moſt of them ſpeak Arabic, which is taught in their ſchools, and they are able to read the Koran in that language, though they have a vulgar tongue called *Pholey*. They are ſtrict Mahometans, and ſcarce any of them will drink brandy, or any thing ſtronger than ſugar and water.

They are ſo ſkilful in the management of cattle, that the Mundingoes leave theirs to their care. The whole herd belonging to a town feed all day in the ſavannas, and after the crop is off, in the rice-grounds. They have a place without each town for their cattle, ſurrounded by a circular hedge, and within this encloſure they raiſe a ſtage about eight feet high, and eight or ten feet wide, covered with a thatched roof; all the ſides are open, and they aſcend to it by a ladder. Round this ſtage they fix a number of ſtakes, and when the cattle are brought up at night, each beaſt is tied to a ſeparate ſtake with a ſtrong rope made of the bark of trees. The cows are then milked, and four or five men ſtay upon the ſtage all night with their arms to guard them from the lions, tygers, and other wild beaſts. Their houſes are built in a very regular manner, they being round ſtructures, placed in rows at a diſtance from each other to avoid fire, and each of them has a thatched roof ſomewhat reſembling a high-crowned hat.

They are alſo great huntſmen, and not only kill lions, tygers, and other wild beaſts, but frequently go 20 or 30 in a company to hunt elephants; whoſe teeth they ſell, and whoſe fleſh they ſmoke-dry and eat, keeping it for ſeveral months together. As the elephants here generally go in droves of 100 or 200, they do great miſchief by pulling up the trees by the roots, and trampling down the corn; to prevent which, when the natives have any ſuſpicion of their coming, they make fires round their corn to keep them out.

They are almoſt the only people who make butter, and ſell cattle at ſome diſtance up the river. They are very particular in their dreſs, and never wear any other clothes but long robes of white cotton, which they make themſelves. They are always very clean, eſpecially the women, who keep their houſes exceedingly neat. They are, however, in ſome particulars very ſuperſtitious; for if they chance to know that any perſon who buys milk of them boils it, they will from thenceforth on no conſideration ſell that perſon any more, from their imagining that boiling the milk makes the cows dry.

PHOLIS, in natural hiſtory, is the name of a genus of foſſils of the claſs of gypſums or plaſter-ſtones. Its diſtinguiſhing characters are, that the bodies of it are tolerably hard, compoſed of particles ſomewhat broad, and of a bright cryſtalline luſtre. The name is derived from φολις, a *ſcale* or *ſmall flake*, becauſe they are compoſed of particles of that form.

The ſpecies of this genus are very valuable, and perhaps the moſt ſo of all the gypſums, becauſe they burn to the beſt and fineſt plaſter, but ſo far as is yet known, there are but two of them: the fine plaſter ſtone of Montmartre in France, called by us *plaſter of Paris ſtone* and *parget*; and the other, the coarſer and ſomewhat reddiſh kind, common in many parts of England, and call'd *ball plaſter*. See Plaster *of Paris*.

Pholis, in ichthyology, is the name of a ſmall anguilliform fiſh. The back is brown, the belly is white, the whole back and ſides are ſpotted, and the ſkin is ſoft, free of ſcales, but with a tough mucilaginous matter like the eel. This ſpecies moſt of all approaches to the *alauda*; and though uſually larger, yet Mr. Ray doubts whether it really differs from it in any thing eſſential; the diſtinction is its colour, which though a very obvious is certainly a very precarious one.

PHONICS, the doctrine or ſcience of ſounds, otherwiſe called Acoustics. See that article.

PHORMIUM, Flax-plant, (*Phormium tenax*, Forſt.) is a name which we may give to a plant that ſerves the inhabitants of New Zealand inſtead of hemp and flax. Of this plant there are two ſorts; the leaves of both reſemble thoſe of flags, but the flowers are ſmaller, and their cluſters more numerous; in one kind they are yellow, and in the other a deep red. Of the leaves of theſe plants, with very little preparation, they make all their common apparel, and alſo their ſtrings, lines, and cordage, for every purpoſe; which are ſo much ſtronger than any thing we can make with hemp, that they will not bear a compariſon. From the ſame plant, by another preparation, they draw long ſlender fibres, which ſhine like ſilk, and are as white as ſnow: of theſe, which are very ſtrong, they make their fineſt cloths; and of the leaves, without any other preparation than ſplitting them into proper breadths, and tying the ſtrips together, they make their fiſhing-nets, ſome of which are of an enormous ſize.

The ſeeds of this valuable plant have been brought over into England; but, upon trial, appeared to have loſt their vegetating power.

The filamentous parts of different vegetables have been employed in different countries for the ſame mechanic uſes as hemp and flax among us. Putrefaction, and in ſome degree alkaline lixivia, deſtroy the pulpy or fleſhy matter, and leave the tough filaments entire. By curiouſly putrefying the leaf of a plant in water, we obtain the fine flexible fibres which conſtituted the baſis of the ribs and minute veins, and which form as it were a ſkeleton of the leaf. In Madagaſcar, different kinds of cloth are prepared from the filaments of the bark of certain trees boiled in ſtrong ley; and ſome of theſe cloths are very fine, and approach to the ſoftneſs of ſilk, but in durability come ſhort of cotton: others are coarſer and ſtronger, and laſt thrice as long as cotton; and of theſe filaments they make ſails and cordage to their veſſels. The ſtalks of nettles are ſometimes uſed for like purpoſes, even in France; and Sir Hans Sloane relates, in one of his letters to Mr. Ray, that he has been informed by ſeveral, that muſlin and callico, and moſt of the Indian linens, are made of nettles. A ſtrong kind of cloth is ſaid to be prepared in ſome of the provinces of Sweden of hop-ſtalks; and in the Tranſactions of the Swediſh Academy for 1750, we have an account of an experiment relating to this ſubject: A quantity of the ſtalks was gathered in autumn, which was equal in bulk to a quantity of flax ſufficient to yield a pound after preparation. The ſtalks were put into water, and kept covered with it during the winter. In March they were taken out, dried in a ſtove, and dreſſed as flax. The prepared filaments weighed nearly a pound, and proved fine, ſoft, and white; they were ſpun and wove into ſix ells of fine ſtrong cloth. Unleſs the ſtalks are fully rotted, which will take much longer time than flax, the woody part will not ſeparate, and the cloth will prove neither white nor fine.

PHOSPHAT, is a mineral found in Eſtremadura. It is of a whitiſh colour, and of great ſolidity, though not ſufficiently hard to ſtrike fire with ſteel. If triturated in an iron mortar in the dark, or even if two pieces of it be rubbed together, it becomes luminous; but when it has once loſt this property, it does not, like ſome natural phoſphori, receive it again by being expoſed to the rays of the ſun. If reduced to a very fine powder, and laid on coals, it does not decrepitate, but burns with a beautiful green light; though, if the coals be very hot, and the powder coarſe, decrepitation will take place.

According to the analyſis made by theſe chemiſts, 100 grains of the calcareous phoſphat is reſolvable into the following elements:

Carbonic acid	1	grain.
Muriatic acid	½	
Iron	1	
Quartzous earth	2	
Pure calcareous earth	59	
Phoſphoric acid	34	
Fluoric acid	2½	
	100	grains.

We have the following account of an analyſis of a native phoſphat of lime (earth of bones) by Mr. Haſſenfratz in the *Annals of Chemiſtry*. "The phoſphat of lime of Eſtremadura, found by Mr. Prouſt, determined me to examine on the coals a phoſphoreſcent powder which I collected at Kobala-Polyana near Sigeth, in the county of Marmaroſch, during the metallurgic tour I made through Hungary by command of government. Though this powder gives abſolutely the ſame appearance when treated on the coals as the fluat of lime *(ſpath-fluor)*, yet no fluoric acid is diſengaged from it when heated with ſulphuric acid. It diſſolves in nitric acid (dephlogiſticated nitrous acid); and ſulphuric (vitriolic) acid precipitates from this ſolution a conſiderable quantity of ſulfat of lime (gypſum): the liquor filtered, and concentrated by evaporation, gives a new precipitate ſimilar to the former. The liquor again filtered, and evaporated to dryneſs, left a ſlight reſiduum. This reſiduum, after having been expoſed to a fire ſufficiently ſtrong to make the veſſel containing it red-hot, and diſengage the nitric and ſulphuric acids which might have remained united with it, was ſoluble in diſtilled water, which it acidified. This acid did not precipitate barytic muriat; it cauſed a white precipitate from the ſolutions of ſulfat of iron (green vitriol), and nitrat of mercury (mercurial nitre), and formed a thick and copious one in lime-water: hence it is evident that this acid was the phoſphoric, and the powder was phoſphat of lime."

The phoſphat of ſoda is obtained by combining the phoſphoric acid with the mineral alkali. It has, we are told, been given with ſucceſs as a purge; and M. Pelletier thinks it may be applied to the ſoldering of metals inſtead of borax: and indeed it reſembles this ſubſtance ſo much in many of its properties, that it has been ſuppoſed that phoſphoric acid is one of the conſtituent principles of borax. See Chemistry.

PHOSPHORUS, a name given to certain ſubſtances which ſhine in the dark without emitting heat. By this circumſtance they are diſtinguiſhed from the *pyrophori*, which, though they take fire on being expoſed to the air, are yet entirely deſtitute of light before this expoſure.

Phoſphori are divided into ſeveral kinds, known by the names of *Bolognian phoſphorus*, *Mr. Canton's phoſphorus*, *Baldwin's phoſphorus*, *phoſphorus of urine*, &c. of which the laſt is by far the moſt remarkable both with reſpect to the quantity of light which it emits, and its property of taking fire and burning very fiercely upon being ſlightly heated or rubbed. See Chemistry.

Beſides theſe, however, it has been found that almoſt all terreſtrial bodies, upon being expoſed to the light, will appear luminous for a little time in the dark, metals only excepted. This points out a general diviſion of the phoſphori into two claſſes; namely, ſuch as require to be expoſed to the light either of the ſun or of ſome artificial fire, before they become luminous; and ſuch as do not. Of the former kind are the Bolognian phoſphorus, Mr. Canton's phoſphorus, the phoſphori from earths, &c. Of the latter kind are rotten wood, the ſkins of fiſhes, and the phoſphorus of urine. To theſe we may add ſome other ſubſtances which become luminous in another way; *viz.* the maſs which remains after the diſtillation of volatile ſal ammoniac with chalk, loaf-ſugar, and the phoſphorus of urine diſſolved in ſpirit of wine. The firſt, which is a compoſition of the marine acid of the ſal ammoniac with the chalk, after being fuſed in a crucible, becomes luminous when ſtruck with any hard body; white ſugar is luminous when grated or ſcraped in the dark; and the ſolution of phoſphorus in ſpirit of wine is luminous only when dropped into water; and even then the light is only perceived where the drops fall into the liquid. One part of phoſphorus communicates this property to 600,000 parts of ſpirit of wine.

There is a remarkable difference between the light of rotten wood, fiſhes, and that of phoſphorus of urine, even when it is not in an ignited ſtate; for this laſt does not ceaſe to be luminous even when included within an exhauſted receiver; the contrary of which happens to rotten wood and fiſhes. If air is ſtrongly blown upon this phoſphorus from a pair of bellows, it will extinguiſh its light for ſome time, which is not the caſe with the other kinds. When kept in water, and placed in a warm air, the phoſphorus of urine dicharges ſuch large and bright flaſhes into the air above it, as are apt to ſurpriſe and even frighten thoſe who are unacquainted with it. Theſe coruſcations are contracted in their paſſage through the water, but expand as ſoon as they get above it; however, the experiment can only be tried to advantage in warm weather, and in a cylindrical glaſs not above three quarters filled with water.

The phenomena exhibited by the earthy phoſphori are very curious; both on account of the ſingular circumſtances in which they exhibit their light, and the varieties obſerved in the light itſelf. All theſe, as has been already mentioned, emit no light till they have been firſt expoſed to the light of the ſun, or ſome other luminous body. After that, they are luminous in the dark for a conſiderable time; but by degrees their light dies away, and they emit no more till after another expoſure to the ſun. But if this happens to be too long continued, they are then irrecoverably ſpoiled. The ſame thing will happen from being too much heated without any expoſure to light. Indeed, if a phoſphorus, which has juſt ceaſed to be luminous, be heated, it will again emit light without any expoſure to the ſun; but by this its phoſphoric quality is weakened, and will at laſt be deſtroyed. Indeed theſe phoſphori are ſo tender, and impatient either of light or heat, that the beſt method of rendering them luminous occaſionally is by diſcharging an electric bottle near them. The light of the flaſh immediately kindles the phoſphorus, and it continues luminous for a conſiderable time, after which it may again be revived by another flaſh, and ſo on. However, with all the care that can be taken, theſe phoſphori are very far from being perpetual; nor has any method been yet fallen upon to render them ſo.

The ſingularities in the light of the phoſphori above mentioned are, that they emit light of many different and moſt beautiful colours. This difference of colours ſeems to be natural to them; for ſome will at firſt emit a green, others a red others a violet, &c. at their formation. However, the beſt kinds agree in this ſtrange property, that if they are expoſed to a red light, they emit a red light in the dark; and the ſame of other colours. But this muſt not be underſtood without limitation; nor is the phoſphoreal light at any time ſo bright as the luminous body, whatever it was, by which it was kindled. Neither are we to imagine, that any particular phoſphorus has a particular kind of light appropriated to it; for the ſame phoſphorus which at one time emits a purple light, will at another perhaps emit a green, or a light of ſome other colour.

The explanation of the principal phenomena of phoſphori is deducible from what has been ſhown concerning the nature of fire, compared with what is mentioned under the article QUICKLIME. When calcareous earths are deprived of their fixed air, a proportionable quantity of active fire is abſorbed by them; that is, the etherial fluid which pervades all bodies has a violent tendency to expand itſelf, or to act all around every particle of the calcined earth, as from a centre. Of conſequence, if this tendency was not counteracted by ſome other power, theſe ſubſtances would emit a perpetual flame. This power, however, is found in our atmoſphere; which has already been ſhown either to be the poſitive principle of cold, or to contain it. Hence the latent fire in theſe ſubſtances is checked, and cannot act, excepting within the very ſubſtance itſelf. But if any other body comes in contact with the calcined earth, in which the principle of cold is leſs vigorous than in the atmoſphere, the active fire in the quicklime immediately ſhows itſelf, and the body either becomes hot, or is conſumed as if by fire. Hence it will follow, that if a very inflammable body is touched by quicklime, it ought to be ſet on fire. But of this we have no inſtance, becauſe it is impoſſible for the quicklime to part with any of its fire, unleſs it receives ſomething in exchange. This indeed it might receive from the atmoſphere; which could ſupply it either with more fire, if it was in a ſtate of ignition; or with fixed air, if any ſubſtance was at hand to receive the fire. But the atmoſphere refuſes to part with the fire which it contains, becauſe the effort of the fire in the quicklime is not ſufficiently ſtrong to overcome the oppoſition it meets with in other bodies; and, on the other hand, the effort of the fire in the quicklime is ſufficient to keep the earth from attracting fixed air out of the atmoſphere. But when water, for inſtance, is poured on the quicklime, the dry earth abſorbs it very greedily, and parts with a proportionable quantity of its latent fire, which the water alſo abſorbs much more readily than the atmoſphere. Hence the mixture becomes ſo exceedingly hot as ſometimes to fire combuſtible bodies. Now, if inſtead of water, we ſuppoſe the lime to be mixed with oil, this alſo will abſorb the fire, but not with ſuch force as the water; neither is the heat by any means ſo conſiderable; becauſe oil is capable of detaining a vaſt quantity of heat in a latent ſtate, the only conſequence of which is an increaſe of its fluidity, without any very perceptible change of temperature. At the ſame time, however, we muſt remember, that if the oil is in very ſmall quantity, and intimately combined with the quicklime in that peculiar ſtate which was formerly called *phlogiſton*, it is eaſy to conceive, that it may be ſo much ſaturated with fire, as to be unable to contain any more without being ignited. In this caſe, if more fire is forced into the compound, a quantity of the phlogiſtic matter which it contains will be decompounded; and of conſequence, the fire which it has imbibed will be thrown out, as in the common ignition of vapour; and in proportion to the degree of heat thus communicated, will the degree of ignition and the continuance of it be. If the quantity of heat is very great, the phlogiſton will be diſſipated all at once; but if otherwiſe, the ignition will continue for a much greater length of time, as is the caſe with a common fire.

To apply this to the accenſion of phoſphori, we muſt conſider that theſe ſubſtances are all formed by calcining calcareous ſubſtances, and combining them with ſome portion of phlogiſtic matter. Baldwin's phoſphorus is made by diſſolving chalk in the nitrous acid, afterwards evaporating the ſolution, and driving off moſt of the acid. The conſequence of this is, that the earth is left in an exceedingly cauſtic ſtate, as the acid expels the fixed air more completely than could be done almoſt by any calcination whatever; at the ſame time that any phlogiſtic matter which might have been contained in the mixture is moſt accurately diffuſed through it, and combined with it. The Bolognian phoſphorus is compoſed of a gypſeous earth, which contains a quantity of vitriolic acid; and as no mineral is to be found perfectly free from phlogiſtic matter, the vitriolic acid unites with it during the calcination into an exceedingly inflammable ſulphur; for the greater the quantity of acid there is in proportion to the phlogiſton, the more inflammable is the compound. Thus the Bolognian, as well as Baldwin's phoſphorus, is a compound of quicklime and inflammable matter; and the caſe is ſtill more plain with regard to Mr. Canton's, where the quicklime is mixed with ſulphur, and both calcined together.—Neither are the phoſphori made by calcining oyſter-ſhells without addition to be accounted any way different from thoſe already mentioned; ſince the ſhells always contain ſome portion of inflammable matter, which, being reduced to a coal by the action of the fire, furniſhes a quantity of phlogiſton, and imparts it to the whole of the calcareous matter.

Having thus ſeen that the phoſphori of which we now ſpeak are all compoſed of pure calcareous earth and phlogiſton, we are next to conſider, that the phlogiſton muſt be in ſuch a ſtate as it is when ſaturated with fire, and ready to inflame. It is not indeed in the ſtate of vapour, becauſe this would require a quantity of fire detached from any other ſubſtance, and interpoſed between the particles of the vapour in order to keep them at a diſtance, or to give it claſticity. But the fire which ought to do this is confined by the calcareous earth, which alſo detains the phlogiſton itſelf. As long therefore as the balance is thus preſerved, the phoſphorus cannot ſhine; but as ſoon as a freſh quantity of light is diſcharged upon it, then more light or fire (for they are the very ſame in this caſe) enters the quicklime than it can contain. The conſequence of this is, that the quantity which cannot be retained by the earth, exerts its force upon the phlogiſton; which having already as much as it can hold, not only the ſuperfluous quantity is diſcharged, but alſo part of that which the phlogiſton had abſorbed before. The burning indeed is very ſlow and weak, becauſe the phlogiſton is obſtinately retained by the earth, which both impedes the ignition, and prevents the diſſipation of the phlogiſton in vapour. However, as ſoon as the lime has by its action impeded the farther extrication of the phlogiſton, the balance is reſtored, the fire goes out, and the phoſphorus ceaſes to be luminous. Heat will kindle it again; but thus a larger quantity of phlogiſtic matter is diſſipated, and the phoſphorus is ſoon deſtroyed. Light does the ſame, but in a much more moderate degree; and therefore the phoſphorus may be frequently rekindled by means of light, and will continue its ſplendor for a long time. But if the light is too long continued, or too violent, it will produce the ſame conſequence whether it is attended with perceptible heat or not.

With regard to the phoſphorus of urine, the caſe is the ſame; only, inſtead of the calcareous earth, we have here an acid joined with phlogiſton. The latter is in exceeding ſmall quantity, and of conſequence ſo loaded with fire that the leaſt additional heat, rubbing, or alteration in the weather, forces more fire upon it than it can bear, and therefore part of it is continually flaſhing off in thoſe corruſcations formerly mentioned. The reaſon why this phoſphorus flaſhes like lightning, and the others give only a ſteady light like coals, is, that the compound is very volatile. It requires indeed a violent fire to diſtil it at firſt; but in the diſtillation ſo much fire is imbibed, that it ſeems ever afterwards ready to evaporate ſpontaneouſly; and therefore phoſphorus, when once made, is eaſily re-diſtilled in cloſe veſſels.

It now remains only to ſhow the reaſon why the phoſphorus of urine and ſome others will ſhine under water, or in an exhauſted receiver, while rotten wood, &c. will not. This ſeems to ariſe from the quantity of fire which they have *internally*, and which requires no ſupply from the external air, as in the caſe of common fire: and hence the phoſphorus of urine ſhines more briſkly *in vacuo* than in the air; becauſe the preſſure of the atmoſphere is then taken off, and the evaporation of the phlogiſtic matter promoted. The light of fiſhes and rotten wood ſeems to be of an electric nature; and therefore ceaſes when the air is exhauſted, as on this fluid all the phenomena of electricity are found to depend.

With regard to the various colours of phoſphoric light, ſome have imagined that the earthy ſubſtance was capable of imbibing a certain quantity of light, and emitting it afterwards in the very ſame ſtate, and having the ſame colour which it had before. But this is now known to be a miſtake, and the light of the phoſphori is found to be owing to a true accenſion, though weak, as in other burning bodies. Hence it is very probable that the colour of the light depends upon the degree of accenſion; for we ſee that even in common fires the colour depends in a great meaſure on the ſtrength of the flame. Thus the flame of a candle, where it is not well kindled at bottom, always appears blue. The flame of a ſmall quantity of ſulphur, or of ſpirit of wine, is blue; but if a large quantity of either of theſe ſubſtances be ſet on fire, the flame will in many places appear white. A ſtrong flame mixed with much ſmoke appears red; a weak one in ſimilar circumſtances appears brown, &c.—Hence if the phoſphoric is weakly kindled it will emit a brown, violet, blue, or green flame; if ſtrongly, a red or white one.

It has already been mentioned, that almoſt all terreſtrial bodies have a phoſphoric quality: however this, in moſt of them, is extremely weak, and continues only for a very ſhort time. Signor Beccaria, who diſcovered this property, in order to find out what ſubſtances were phoſphoric and what were not, had a machine contrived like a dark lantern, in which he included himſelf, in order to perceive with the greater facility any ſmall quantity of light which might be emitted by the ſubſtances which he deſigned to examine. In the ſide of the machine was a cylinder capable of being turned about without admitting any light. Upon this were paſted the ſubſtances he deſigned to examine, and by turning the cylinder he immediately brought them from the light of the ſun into intenſe darkneſs; in which ſituation there were but few ſubſtances which did not afford a ſufficient quantity of light to render themſelves viſible. This phenomenon, however, is evidently ſimilar to an optical illuſion, by which we are made to ſee what is not preſent before us; for if we look very intenſely upon any thing for ſome time, ſuffering no more light to enter our eyes than what is reflected from that object, we will imagine that we ſtill ſee it, though we remove into the dark, or ſhut our eyes. The reaſon of this is, that the nervous fluid being once put in motion after a certain manner, continues that motion for a ſhort ſpace of time after the moving cauſe is removed. In like manner, as the light is partly reflected from bodies, and partly penetrates them, when any body is expoſed to the light, and then is ſuddenly brought into a dark place, the etherial fluid within its ſubſtance being once put into motion does not ceaſe to move immediately, but for a time produces that vibration which we call *light*: for the ſubſtance of light is preſent in the moſt intenſe darkneſs as well as in ſunſhine. Hence almoſt all ſubſtances are capable of emitting light in the dark, after being expoſed to a vigorous ſunſhine; though the reaſon of their doing ſo may be very different from that by which the phoſphori become luminous.

Many entertaining experiments may be made with the various kinds of phoſphori, eſpecially with that of urine. This laſt, however, is ſometimes dangerous on account of the violence with which it burns. If diſſolved in oil of cloves, it loſes this property, but continues to be as luminous as before; ſo that this mixture, called *liquid phoſphorus*, may be uſed with ſafety. As on ſome occaſions it may be wiſhed to have it in powder, it is proper to obſerve that this may be done with ſafety by pouring ſome hot water upon the phoſphorus in a glaſs mortar. The compound melts, and while in a ſoft ſtate is eaſily reducible to powder of any degree of fineneſs.

Mr. Margraff endeavoured to combine phoſphorus with metals by diſtillation; but zinc and copper were the only two metals that ſhowed any ſigns of combination. (See Chemistry.) The great analogy, however, that has been obſerved between the properties of phoſphorus and thoſe of ſulphur and arſenic, induced M. Pelletier long ago to ſuſpect, that phoſphorus would really combine with metals, and that the eſſential point was to retain the phoſphorus in contact with the metal in a ſtate of fuſion. This happy idea led him to a method from which he has obtained all the ſucceſs that could be deſired. Of this we have already remarked elſewhere, but ſhall nevertheleſs continue the ſubject from the firſt volume of *Annals of Chemiſtry*.

"Each of the combinations which are now to be deſcribed, M. Pelletier has termed *phoſphorated metal*.

"M. Pelletier mixed half an ounce of gold of parting, in powder, with an ounce of phoſphoric glaſs and about a dram of powdered charcoal; he put this mixture into a crucible, covering it with a ſmall quantity of charcoal powder; and then applied a degree of heat ſufficient to melt the gold. During the operation, a conſiderable quantity of vapours of phoſphorus was diſengaged, but all the phoſphorus which was produced was not diſſipated; a ſmall quantity united with the gold, which was whiter than in its natural ſtate, broke under the hammer, and had alſo a cryſtallized appearance.

"Twenty-four grains of this phoſphoret of gold, placed on a cupel in a heated muffle, loſt only one grain, and the button of gold that remained had the peculiar colour of that metal.

"A mixture, conſiſting of an ounce of platina, an ounce of phoſphoric glaſs, and a dram of powdered charcoal, being put into a crucible, and covered with a little charcoal powder, M. Pelletier gave it a degree of heat nearly equal to what would have fuſed gold: this he continued for an hour. Having broken the crucible, he found underneath a blackiſh glaſs a ſmall button of a ſilver white, weighing more than an ounce. On the inferior part of the button were well defined cryſtals of the ſame ſubſtance, the figure of which was a perfect cube. The ſame experiment, frequently repeated, conſtantly afforded the ſame reſult.

"The phoſphoret of platina is very brittle, pretty hard, and ſtrikes fire with ſteel: it is not acted upon by the magnet, and when it is expoſed naked to a fire capable of fuſing it, the phoſphorus is diſengaged, and burns on its ſurface. Expoſed to the fire in a cupelling furnace on porcelain teſts, the phoſphoret of platina leaves a black glaſs, which ſurrounds the metallic ſubſtance. The colour of the glaſs is owing to iron contained in the platina; and if it continue expoſed to the ſame heat in freſh teſts, the portions of glaſs that form latterly have not ſo deep a colour, are more or leſs greeniſh, have ſometimes a blueiſh tinge; and become at laſt of a tranſparent white. This obſervation led M. Pelletier to imagine, that phoſphorus was well adapted for ſeparating iron from platina, and that it was one of the beſt means of ſeparating it entirely from that metal. But the glaſs which reſults from the combuſtion of the phoſphorus and its combination with the *oxyd* calx of iron, forms a cruſt which obſtructs the combuſtion of the phoſphorus that ſtill remains combined with the platina. To overcome this obſtacle, M. Pelletier thought of expoſing the phoſphoret of platina to the fire, in cupels made of calcined bones, which, as they eaſily abſorb the glaſs of lead, ought alſo to have the property of abſorbing the phoſphoric glaſs. He repeated the operation, therefore, ſeveral times ſucceſſively, changing the cupel. A button of platina, which had been thus operated on four times, he preſented to the academy: in this ſtate it was capable of being reduced into plates, but was brittle when heated.

"Since the reading of his memoir, M. Pelletier has purſued his proceſs, and has advanced ſo far as to be able totally to free the platina from the phoſphorus, ſo that it may be worked when heated: thus he has procured us a method of purifying this metal more advantageous, probably, than any hitherto attempted. The phoſphoret of platina detonates ſtrongly when it is thrown on nitre in fuſion. A mixture of phoſphoret of platina, and oxygenated muriat of potaſh *(dephlogiſticated digeſtive ſal)*, thrown into a red-hot crucible, produces a briſk detonation, and the platina remains pure in the crucible.

"Half an ounce of ſilver, treated with an ounce of phoſphoric glaſs, and two drams of charcoal, acquired an increaſe of weight of one dram. The phoſphoret formed was white: it appeared granulated, and as it were cryſtallized: it broke under the hammer, but was capable of being cut with a knife. Placed in a cupel in a heated muffle, the phoſphorus was diſengaged, and the ſilver remained quite pure.

"In preparing phoſphorus in the large way, M. Pelletier obſerved, that the phoſphoric acid attacked in ſome degree the copper baſons, which are in other reſpects very convenient for this operation; and in the retorts which he made uſe of for the diſtillation. he found phoſphoret of copper, ſometimes in ſmall diſtinct grains, at others in large maſſes, according as the degree of heat which finiſhed the operation was more or leſs intenſe. This phoſphoret he exhibited to the academy, and thence it was mentioned in the chemical nomenclature. The phoſphoret of copper is alſo obtainable by a proceſs ſimilar to that which we have deſcribed for obtaining that of gold, ſilver, and platina. The proportions which M. Pelletier employed were, an ounce of ſhreds of copper, an ounce of phoſphoric glaſs, and a dram of powdered charcoal. This phoſphoret appears whitiſh, is ſometimes variegated with the different colours of the rainbow, changes on expoſure to the air like pyrites, loſes its luſtre, and aſſumes a blackiſh hue.

"Margraff had formed phoſphoret of copper by diſtilling the oxyd of copper, called *crocus veneris*, with phoſphorus; and M. Pelletier alſo obtained it by the ſame proceſs: but he did not obſerve the property attributed to it by Margraff, of running when applied to a candle. Having placed the phoſphoret in a cupel in a heated muffle, it was fuſed, the phoſphorus inflamed on its ſurface; a blackiſh ſubſtance reſembling ſcoriæ remained in the cupel, which was penetrated with a glaſs that gave it a blue colour.

"The phoſphoret of iron produced by the fuſion of an ounce of phoſphoric glaſs, and an ounce of ſhreds of iron, mixed with half a dram of powdered charcoal, was very brittle, and broke white, with a ſtriated and granulated appearance: in one cavity it was cryſtallized in rhomboidal priſms. It is the ſame ſubſtance which Bergman conceived to be a peculiar metal.

"This phoſphoret, placed in a cupel in a heated muffle, ſoon entered into a ſtate of fuſion; in the cupel remained a brittle ſubſtance, which is an oxyd of iron, and the cupel was penetrated with a matter ſimilar to that which M. Pelletier had obſerved on treating in the ſame manner phoſphoret of platina, obtained from platina not purified.

"The phoſphoret of lead, obtained by the proceſs already deſcribed, appears little different from common lead. It is malleable, and eaſily cut with a knife, but it loſes its luſtre ſooner than lead, and when melted on charcoal by the blow-pipe, the phoſphorus burns, leaving the lead behind.

"The phoſphoret of tin, which M. Pelletier obtained by his proceſs, was divided into ſeveral grains, becauſe he had not given a ſufficient degree of fire to unite them. Theſe grains did not appear different from the metal itſelf; but being melted with the blow-pipe, the phoſphorus burnt on the ſurface of the metal, as in the ſimilar experiment with lead.

"In fuſing tin or lead with the charcoal powder and phoſphoric glaſs, care muſt be taken not to urge the fire, as the phoſphorus eaſily flies off from either of thoſe metals.

"From the experiments of M. Pelletier it appears, that phoſphorus may be combined with gold, platina, ſilver, copper, iron, tin, and lead; and that it deprives the five former metals of their ductility. M. Pelletier propoſes to make further experiments, to aſcertain whether it be poſſible or not to combine a greater quantity of phoſphorus with the two latter, and whether they will retain their malleability in that caſe. In another memoir he will examine the action of phoſphorus on ſemimetals: he propoſes alſo to aſcertain the order of its affinity with the metals and ſemimetals.

"It is much to be wiſhed that M. Pelletier may carry to perfection a work which will enrich chemiſtry with a ſpecies of combination hitherto almoſt entirely unknown, and which he has diſcovered means of effecting by a proceſs equally ſimple and ingenious."

In the 10th volume of the ſame Annals we find an account of the action of lime, and of ſome metallic oxyds on phoſphorus, by Dr. Raymond.

M. Gengembre diſcovered, that by boiling phoſphorus in a ſolution of pot-aſh, a peculiar kind of gas was produced, which had the ſingular property of taking fire on coming into contact with the atmoſphere, and to which the French chemiſts have given the appellation of *phoſphorized hydrogen gas*. Dr. Raymond thought of varying the proceſs, in order to diſcover whether this gas might not be produced in ſome other way. He took two ounces of lime flaked in the air, a dram of phoſphorus cut ſmall, with half an ounce of water, which he mixed up into a ſoft paſte, and put into a ſtone retort; to this retort a tube was fitted, the internal diameter of which, he ſays, ought not to exceed a line and a half, communicating with a receiver full of water. As ſoon as the retort was well heated, the phoſphorized hydrogen gas was generated ſo abundantly, that, from the quantity of ingredients here mentioned, no leſs than three quarts of it were obtained. The reſiduum was found to have all the characters of the native phoſphat of lime. Hence the doctor ſuppoſes, that the water was decompoſed during the proceſs, and that its oxygen ſerved to acidify the phoſphorus; which, in this ſtate, was combined with the lime, and formed the phoſphat; while its hydrogen, aſſuming a gaſeous ſtate, carried with it a part of the phoſphorus, to which the property of taking fire by contact with the air muſt be aſcribed. The gas ſoon loſes this property, and the phoſphorus is condenſed on the ſides of the receiver: great caution, however, is neceſſary; for though a part of the gas may ſeem to have depoſited its phoſphorus, and to be reduced to pure hydrogen, yet another part, in the ſame receiver, may retain enough to cauſe a formidable exploſion, when in contact with air.

The facility with which water was thus decompoſed led the author to ſuſpect that a ſimilar effect might be produced by the ſame mixture in the mean temperature of the atmoſphere. Accordingly he found that in ten days time a ſmall quantity of hydrogen gas was generated in the vials, in which the ingredients were placed: this, however, was not phoſphorized, the heat not being ſufficient to volatilize the phoſphorus.

Animated by this ſucceſs, Dr. Raymond reſolved to try what could be effected by metallic oxyds. He made two mixtures like the former: but inſtead of lime he ſubſtituted in the one the white oxyd of zinc, and in the other the black oxyd of iron. After long diſtillation with great heat, he obtained from both phoſphoriſed hydrogen gas: but it was produced in much leſs time, and in greater quantity, from the oxyd of zinc than from that of iron; which he aſcribed to the cloſe affinity of the former to the phoſphoric acid.

In the 12th volume of the ſame valuable work, we have an account of a proceſs for making Kunkel's phoſphorus from urine, which is ſhorter and more economical than that by which Meſſrs. Scheele and Ghan extract it from the bones of animals, by M. Giobert. This method is founded on the property of the metallic ſalts to ſeparate the phoſphoric acid from urine, which Margraff, we believe, firſt diſcovered: but M. Giobert has greatly improved on the proceſs directed by the German chemiſt, as he avoids the tedious and diſguſting operations of evaporating the urine, and expoſing it to putrefaction. He tells us, that it is indifferent whether the urine be that of healthy or diſeaſed perſons; and that of horſes is nearly as good for this purpoſe as that which is human. He gradually pours into it a ſolution of lead in the nitric acid, till the precipitation ceaſes which this had occaſioned; the whole is then diluted with a conſiderable quantity of water, and afterwards filtrated through a linen cloth. The precipitate, which is phoſphat of lead, muſt be made up into a paſte with powder of charcoal, and well dried in an iron or copper pan: it muſt afterwards be diſtilled; when it will yield, firſt, an ammoniacal, and then an empyreumatic, oil; theſe oils proceed from the urine, from which it is difficult to purify the phoſphat. As ſoon as the oil ceaſes to come over, a clean receiver muſt be applied, and the fire be greatly increaſed. The phoſphorus generally appears in about half an hour; and, within eight hours, twelve or fourteen ounces of it may thus be obtained. If the proceſs be conducted with care, M. Giobert thinks that a hundred parts of phoſphat of lead will yield between fourteen and eighteen of phoſphorus.

If on the phoſphat of lead thus precipitated from urine, a ſolution of ſulphat of ammoniac be poured, and this, after digeſting during twelve hours, be filtrated and evaporated, phoſphat of ammoniac will be obtained; and if ſulphat of ſoda be uſed, the reſult will be phoſphat of ſoda.

Acid of Phosphorus. This acid is called alſo the *microcoſmic* acid[*]. See Chemistry. It has been diſcovered by Mr. Scheele, that an acid capable of making phoſphorus is producible from calcined bones or hartſhorn and the vitriolic acid. The proceſs for procuring this acid recommended by that gentleman was to diſſolve the bones in nitrous acid; afterwards to precipitate the earth by means of the vitriolic acid; to filter and evaporate the liquor to dryneſs; and, after driving off the nitrous acid, the phoſphoric acid remains. This proceſs, however, is expenſive on account of the waſte of nitrous acid; and is likewiſe very inconvenient, becauſe a great deal of the earthy matter continues diſſolved even after the vitriolic acid is poured in; and therefore the phoſphoric acid is never to be obtained pure; for which reaſon the following proceſs is preferable.

Take of calcined bones or hartſhorn, one pound; oil of vitriol, 14 ounces. Let the bones be reduced to fine powder; then pour on the acid undiluted, and rub both together till they are as accurately mixed as poſſible. Having let them remain for ſome hours in this ſituation, pour on as much water, ſtirring and diſſolving the lumps, into which the maſs will now be concreted, till it is all equally diſtributed through the liquid, and has the conſiſtence of thick gruel. Let it remain 24 hours, and then pour it into a canvaſs cloth in order to let the liquid drain from it. This is a very tedious operation, as freſh water muſt continually be pouring on till all the ſaline matter is waſhed off. When this is done, pour into the liquid a quantity of cauſtic volatile alkali, which will occaſion a copious precipitation; for the earth of bones is much leſs ſtrongly attracted by acids than even the cauſtic volatile alkali. The liquid being now filtered a ſecond time, which will be done with ſufficient eaſe, and afterwards evaporated, there remains a maſs compoſed of phoſphoric acid and vitriolic ſal ammoniae. By increaſing the fire, the latter is diſſipated in vapour; and if the proceſs has been ſucceſsful, four ounces or more of pure phoſphoric acid will remain.

With regard to the properties of this acid, it is not yet aſcertained whether they are exactly the ſame with the microcoſmic acid or not. Indeed, as far as yet appears, they ſeem to be different; and there are very ſtrong reaſons for ſuppoſing that the phoſphoric acid thus produced is no other than the vitriolic altered by its combination with the earth of bones. See the article Bones.

PHOTINIANS, in eccleſiaſtical hiſtory, were a ſect of heretics in the fourth century, who denied the divinity of our Lord. They derive their name from *Photinus* their founder, who was biſhop of Sirmium, and a diſciple of Marcellus. Photinus publiſhed in the year 343 his notions reſpecting the Deity, which were repugnant both to the orthodox and Arian ſyſtems. He aſſerted, that Jeſus Chriſt was born of the Holy Ghoſt and the Virgin Mary; that a certain divine emanation, which he called the *Word*, deſcended upon Him; and that becauſe of the union of the divine word with his human nature, He was called the Son of God, and even God himſelf; and that the Holy Ghoſt was not a perſon, but merely a celeſtial virtue proceeding from the Deity. Both parties condemned the biſhop in the councils of Antioch and Milan, held in the years 345 and 347. He was condemned alſo by the council at Sirmium in 351, and was afterwards degraded from the epiſcopal dignity, and at laſt died in exile in the year 372 or 375. His opinions were afterwards revived by Socinus.

PHOTIUS, patriarch of Conſtantinople, was one of the fineſt geniuſes of his time, and his merit raiſed him to the patriarchate; for Bardas having driven Ignatius from the ſee, Photius was conſecrated by Aſbeſtos in 859. He condemned Ignatius in a ſynod, whereupon the pope excommunicated him; and he, to balance the account, anathematiſed the pope. Baſilius of Macedon, the emperor whom Photius had reproved for the murder of Michael the late emperor, expelled him, and reſtored Ignatius; but afterwards re-eſtabliſhed Photius, upon Ignatius's death, in 878. At laſt, being wrongfully accuſed of a conſpiracy againſt the perſon of Leo the philoſopher, ſon and ſucceſſor to Baſilius, he was expelled by him in 886, and is ſuppoſed to have died ſoon after. He wrote a *Bibliotheca*, which contains an examen of 280 authors: we have alſo 253 epiſtles of his; the *Nomacanon* under 14 titles; an abridgement of the acts of ſeveral councils, &c. This great man was born in Conſtantinople, and was deſcended from a very illuſtrious and noble family. His natural abilities were very great, and he cultivated them with the greateſt aſſiduity. There was no branch of literature, whether ſacred or profane, and ſcarcely any art or ſcience, in which he was not deeply verſed. Indeed he appears to have been by far the greateſt man of the age in which he lived; and was ſo intimately concerned in the chief tranſactions of it, that eccleſiaſtical writers have on that account called it *Seculum Photianum*. He was firſt raiſed to the chief dignities of the empire, being made principal ſecretary of ſtate, captain of the guards, and a ſenator. In all theſe ſtations he acquitted himſelf with a diſtinction ſuitable to his great abilities; for he was a refined ſtateſman, as well as a profound ſcholar. His riſe to the patriarchate was very quick; for when he was choſen to that office he was only a layman: but that he might be as it were gradually raiſed to that dignity, he was made monk the firſt day, reader the next, and the following days, ſub-deacon, deacon, and prieſt. So that in the ſpace of ſix days he attained to the higheſt office in the church. On the whole, however, his ardent love of glory, and unbounded ambition, made him commit exceſſes which rendered him a ſcourge to thoſe about him.

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[*] The principal alterations made by the author of the preſent memoir conſiſt in his putting each ſtick of phoſphorus into a glaſs pipe, the lower part of which is ſhaped like a funnel, terminating in a very ſmall opening; and in covering the apparatus with a tubulated receiver, which he can open at pleaſure. By theſe means he can diſſolve a greater quantity of phoſphorus without danger of an exploſion. His method of converting the phoſphorus into the phoſphoric acid, by the nitric or the oxygenated muriatic acid, is the ſame with that diſcovered by M. Lavoiſier, which is deſcribed in his Elements of Chemiſtry.

Fabricius calls this *Bibliotheca* or library, *non liber, ſed inſignis theſaurus*, "not a book, but an illuſtrious treaſure," in which are contained many curious things relating to authors, and many fragments of works which are no where elſe to be found. It was brought to light by Andreas Schottus, and communicated by him to David Hoeſchelius, who cauſed it to be printed in 1601. Schottus, conſidering the great utility of this work, tranſlated it into Latin, and printed his tranſlation alone in 1606. The Greek text, together with the tranſlation, were afterwards printed at Geneva in 1611. The laſt edition of this work, the largeſt, and the faireſt, was printed at Rouen in 1653, folio.

PHRAATES, or Phrahates. There were four kings of this name in Parthia. See Parthia.

PHRASE, in grammar, an elegant turn or manner of ſpeech, peculiarly belonging to this or that occaſion, this or that art, or this or that language. Thus we ſay, an Italian *phraſe*, an eaſtern *phraſe*, a poetical *phraſe*, a rhetorical *phraſe*.

Phrase is ſometimes alſo uſed for a ſhort ſentence, or ſmall ſet or circuit of words conſtructed together. In this ſenſe, Father Buffier divides phraſes into complete and incomplete. 1. Phraſes are *complete* where there is a noun and a verb, each in its proper function: *i. e.* where the noun expreſſes a ſubject, and the verb the thing affirmed of it. 2. *Incomplete* phraſes are thoſe where the noun and the verb together only do the office of a noun; conſiſting of ſeveral words without affirming any thing, and which might be expreſſed in a ſingle word. Thus, *that which is true*, is an incomplete phraſe, which might be expreſſed in one word, *truth*; as, *that which is true ſatisfies the mind*, i. e. *truth ſatisfies the mind*.

PHRASEOLOGY, a collection of the phraſes or elegant expreſſions in any language. See Phrase.

PHREATIS, or Phreattium, in Grecian antiquity, was a court belonging to the civil government of Athens, ſituated upon the ſea ſhore, in the Piræus. The name is derived from ἀπὸ τȣ φρέατος, becauſe it ſtood in a *pit*; or, as others ſuppoſe, from the hero *Phreatus*. This court heard ſuch cauſes as concerned perſons who had fled out of their own country for murder, or thoſe that fled for involuntary murder, and who had afterwards committed a deliberate and wilful murder. The firſt who was tried in this place was Teucer, on a groundleſs ſuſpicion that he had been acceſſary to the death of Ajax. The accuſed was not allowed to come to land, or ſo much as to caſt anchor, but pleaded his cauſe in his bark; and if found guilty, was committed to the mercy of the winds and waves, or, as ſome ſay, ſuffered there condign puniſhment; if innocent, he was only cleared of the ſecond *fact*, and, according to cuſtom, underwent a twelvemonth's baniſhment for the former. See Potter's *Gr. Antiq.* vol i. p. 111.

PHRENETIC, a term uſed to denote thoſe who, without being abſolutely mad, are ſubject to ſuch ſtrong ſallies of imagination as in ſome meaſure pervert their judgment, and cauſe them to act in a way different from the more rational part of mankind.

PHRENITIS, the ſame with Phrensy; an inflammation of the meninges of the brain, attended with an acute fever and delirium. See Medicine; alſo an account of a ſtrange degree of phrenſy which attacked Charles the VI. of France.

PHRYGANEA is a genus of inſects, of which Barbut gives the following characters. "The mouth is without teeth, but furniſhed with four palpi: the ſtemmata are three in number: the antennæ are filiform, and longer than the thorax. The wings are incumbent; the under ones are folded."

The ſame author informs us, that the genus is divided into two ſections: the firſt of which is characterized by having two truncated ſetæ at the extremity of the abdomen, reſembling the beard of an ear of corn; while the ſecond has the abdomen ſimple, or without appendices. The tarſi of the feet of the firſt family conſiſt of three articulations; thoſe of the ſecond are compoſed of five. The wings of this ſection decline from the inner margin towards the ſides, ſo as to reſemble the ridge of a houſe, and are curved, or turn upwards at their extremity. "This inſect (ſays Mr. Barbut), before it becomes an inhabitant of the air, has lived under water, lodged in a kind of tube or ſheath, the inward texture of which is ſilk; outwardly covered with ſand, ſtraws, bits of wood, ſhells, &c. When the hexapod worm is about to change to a chryſalis, he ſtops up the opening of his tube with threads of a looſe texture, through which the water makes its way, but prevents the approach of voracious inſects. The chryſalis is covered with a thin gauze, through which the new form of the inſect is eaſily diſcerned. The phryganea, on the point of changing its element, riſes to the ſurface of the water, leaves its tube, riſes into the air, and enjoys the ſweets of the country, flutters upon flowers and trees, but is ſoon called away to the water-ſide to depoſit its eggs; whence proceed its poſterity. Theſe aquatic larvæ are often found in ſtagnating waters, where they wrap themſelves up in the water-lentil, cut out into regular ſquares, and fitted one to another. Trouts are very greedy of theſe larvæ; which is the reaſon, that in ſome countries, after ſtripping them of their coats, they make uſe of them for fiſhing baits."

There are a variety of different ſpecies of the phryganea; but except the phryganea bicauda and ſtriata, they do not materially differ from one another, except in ſize and colour. The bicauda is of a deep dark-brown colour; having a ſingle yellow longitudinal band running acroſs the head and thorax. The legs are of a brown colour, as are the antennæ; which are alſo long and filiform. Two brown threads, almoſt as long as the antennæ, terminate the abdomen. The wings, which are about a third longer than the body, are veined with brown fibres, are narrow at the top, broad below, and are as it were ſtuck upon the body; which they infold, croſſing one over the other. This inſect, which is met with on the banks of rivers and ſtanding waters, carries its eggs in a cluſter at its abdomen, like ſome ſpiders.

The ſtriata is a large ſpecies, of a dun colour, except the eyes, which are black, and has a conſiderable reſemblance to the phalena in the carriage of its wings. The antennæ are as long as the body, and are borne ſtraight forward. The wings are a third larger than the body, having veins of a colour rather deeper than the reſt. The feet are large, long, and ſomewhat finny. Mr. Yeats tells us, that the perlæ of Geoffroy, and phryganeæ of Linnæus, do not differ generically. It appears, however, from Yeats's experiments, that the phryganeæ remain longer in the chryſalis than the perlæ.

The leſſer phryganeæ very much reſemble the tineæ; but upon examining them with a glaſs, the former will be found to be covered with ſmall hairs inſtead of the ſcales which adorn the wings of the latter.

PHRYGIA, a country in Aſia. From whence it derived its name is not certain: ſome ſay it was from the river Phryx (now Sarabat), which divides Phrygia from Caria, and empties itſelf into the Hermus; others from Phrygia, the daughter of Aſopus and Europa. The Greek writers tell us, that the country took its name from the inhabitants and theſe from the town of Brygium in Macedonia, from whence they firſt paſſed into Aſia, and gave the name of *Phrygia* or *Brygia* to the country where they ſettled. Bochart is of opinion that this tract was called Phrygia from the Greek verb φρυγειν "to burn or parch;" which, according to him, is a tranſlation of its Hebrew name, derived from a verb of the ſame ſignification.

No leſs various are the opinions of authors as to the exact boundaries of this country; an uncertainty which gave riſe to an obſervation made by Strabo, viz. that the Phrygians and Myſians had diſtinct boundaries; but that it was ſcarce poſſible to aſcertain them. The ſame writer adds, that the Trojans, Myſians, and Lydians, are, by the poets, all blended under the common name of Phrygians, which Claudian extends to the Piſidians, Bithynians and Ionians. Phrygia Proper, according to Ptolemy, whom we chooſe to follow, was bounded on the north by Pontus and Bithynia; on the weſt by Myſia, Troas, the Ægean Sea, Lydia, Mæonia, and Caria; on the ſouth by Lycia; on the eaſt by Pamphylia and Galatia. It lies between the 37th and 41ſt degrees of north latitude, extending in longitude from 56 to 62 degrees. The inhabitants of this country, mentioned by Ptolemy, are the Lycaones and Antheniſenii, towards Lycia; and Moccadelis or Moccadine, the Cydeſes or Cydiſſes towards Bithynia; and between theſe the Peltini or Speltini, the Moxiani, Phylacenſes, and Hierapolitæ. To theſe we may add the Berecyntes mentioned by Strabo.

Phrygia is commonly divided into the Greater and Leſſer Phrygia, called alſo Troas. But this diviſion did not take place till Troas was ſubdued by the Phrygians; and hence it is more conſidered by ſome Roman writers as a part of Phrygia, than Bithynia, Capadocia, or any other of the adjacent provinces. In after-ages, the Greater Phrygia was divided into two diſtricts or governments; one called Phrygia Pacatiana, from Pacatianus, who, under Conſtantine, bore the great office of the præfectus prætorio of the Eaſt; the other Phrygia Salutaris, from ſome miraculous cures ſuppoſed to have been performed there by the archangel Michael.

This country, and indeed all Aſia Minor, as lying in the 5th and 6th northern climates, was in ancient times greatly celebrated for its fertility. It abounded in all ſorts of grain; being, for the moſt part, a plain country covered with a deep rich ſoil, and plentifully watered by ſmall rivers. It was in ſome parts productive of bitumen and other combuſtible ſubſtances. It was well ſtocked with cattle, having large plains and paſture grounds. The air was anciently deemed moſt pure and wholeſome, though it is now in ſome parts thought extremely groſs, great part of the country lying uncultivated.

In Phrygia Major were anciently ſeveral cities of great celebrity; ſuch as APAMEA LAODICEA, HIERAPOLIS, Gordium, &c. There were alſo ſome famous rivers; ſuch as Marſyas, Mæander, &c. The Mæander is now called *Madre* or *Mindre*, and was much celebrated by the ancients for its windings and turnings; from whence all ſuch windings and turnings have been denominated *meanders*.

The Phrygians accounted themſelves the moſt ancient people in the world. Their origin, however, is extremely dark and uncertain. Joſephus and St. Jerome ſay, they were deſcended from Togarmah, one of Gomer's ſons; and that they were known to the Hebrews under the name of Tigraminanes. The Heathen authors derive them from the Brygians, a people of Macedonia. But this is but mere conjecture; and it is a conjecture totally unſupported, except by the ſimilarity of names. Bochart thinks that the Phrygians were the offſpring of Gomer the eldeſt ſon of Japhet; the word Phrygia being the Greek tranſlation of his name. Joſephus makes Gomer the father of the Galatians; but he, by the Galatians, muſt neceſſarily mean the Phrygians inhabiting that part of Phrygia which the Galatians had made themſelves maſters of; the deſcendants of Gomer being placed by Ezekiel northward of Judæa, near Togarmah (which Bochart takes to be Cappadocia), long before the Gauls paſſed over into Aſia. We are willing to let Gomer enjoy the fine country which Bochart is pleaſed to give him, and allow him the honour of being the progenitor of the Phrygians, ſince we know no other perſon on whom it can be conferred with any degree of probability.

The ancient Phrygians are deſcribed as ſuperſtitious, voluptuous, and effeminate, without any prudence or forecaſt, and of ſuch a ſervile temper, that nothing but ſtripes and ill uſage could make them comply with their duty; which gave riſe to ſeveral trite and well known proverbs *. They are ſaid to have been the firſt inventors of divination by the ſinging, flying, and feeding of birds. Their muſic commonly called the *Phrygian mood*, is alleged by ſome as an argument of their effeminacy.

Their government was certainly monarchical; for all Phrygia was, during the reigns of ſome kings, ſubject to one prince. Ninnacus, Midas, Manis, Gordius, and his deſcendants, were undoubtedly ſovereigns of all Phrygia. But ſome time before the Trojan war, we find this country divided into ſeveral petty kingdoms, and read of divers princes reigning at the ſame time. Apollodorus mentions a king of Phrygia contemporary with Ilus king of Troy. Cedrenus and others ſpeak of one Teuthrans, king of a ſmall country in Phrygia, whoſe territories were ravaged by Ajax, himſelf ſlain in ſingle combat, his royal ſeat laid in aſhes, and his daughter, by name Tecmeſſa, carried away captive by the conqueror. Homer makes mention of Phoreys and Aſcanius, both princes and leaders of the Phrygian auxiliaries that came to the relief of Troy. Tantalus was king of Sipylus only, and its diſtrict; a prince no leſs famous for his great wealth, than infamous for his covetouſneſs and other deteſtable vices. That Phrygia was ſubdued either by Ninus, as Diodorus Siculus informs us, or by the Amazons, as we read in Suidas, is not ſufficiently warranted. Moſt authors that ſpeak of Gordius tell us, that the Phrygians having ſent to conſult an oracle in order to know how they might put an end to the inteſtine broils which rent their country into many factions and parties, received for anſwer, that the moſt effectual means to deliver themſelves and their country from the calamities they groaned under, was to commit the government to a king. This advice they followed accordingly, and placed Gordius on the throne.

As to their commerce, all we can ſay is, that Apamea was the chief emporium of all Aſia Minor. Thither reſorted merchants and traders from all parts of Greece, Italy, and the neighbouring iſlands. Beſides, we know from Syncellus, that the Phrygians were for ſome time maſters of the ſea; and none but trading nations ever prevailed on that element. The country produced many choice and uſeful commodities, which afforded conſiderable exports. They had a ſafe coaſt, convenient harbours, and whatever may incline us to think that they carried on a conſiderable trade. But as moſt of the Phrygian records are loſt, we will not dwell on conjectures ſo difficult to be aſcertained.

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* "Phryges ſero ſapiunt, Phryx verberatus melior, Phryx non minus quam Spyntharus, &c." which proverbs intimate their ſervile temper; and ſhow that they were more fit to bewail misfortunes in an unmanly manner, than to prevent them by proper meaſures. Their muſic, too, was ſuited to their effeminate temper. The Doric mood was a kind of grave and ſolid muſic; the Lydian a doleful and lamentable harmony; but the Phrygian chiefly calculated to effeminate and enervate the mind. But this character is contradicted by others.

We have no ſet form of their laws; and as to their learning, ſince we are told that for ſome time they enjoyed the ſovereignty of the ſea, we may at leaſt allow them a competent ſkill in geography, geometry, and aſtronomy; and add to theſe, from what we have ſaid above, a more than ordinary knowledge of muſic.

Some have been of opinion that the Phrygian language bore a great reſemblance to the Greek; but the contrary is manifeſt from the few Phrygian words which have been tranſmitted to us, and carefully collected by Bochart and Rudbechius. To theſe we may add the authority of Strabo, who, after attempting to derive the name of a Phrygian city from the Greek, concludes, that it is a difficult matter to diſcover any ſimilitude between the barbarous words of the Phrygian language and the Greek. The Phrygian tongue, after the experiment made by Pſammetichus king of Egypt, was looked upon by the Egyptians as the moſt ancient language of the world. But other nations, particularly the Scythians, refuſed to ſubmit to their opinion, as founded on an argument of no real weight. "As the two children (ſay they) had never heard the voice of any human creature, the word *bec*, or *bekkos*, the firſt they uttered, was only an imitation of the goats that had ſuckled them, and happened to be a Phrygian word ſignifying *bread* *.

We have aleady ſaid that the Phrygians were ſuperſtitious; their idols were conſequently very numerous. The chief of theſe was Cybele, who went by a variety of names. (See CYBELE). They alſo worſhipped Bacchus under the name of *Sabazios*; and his prieſts they called *Saboi*.

The hiſtory of their kings is dark and uncertain, and the dates of their ſeveral reigns and actions cannot now be fixed; we ſhall refer ſuch of our readers, therefore, as wiſh to know what is certain reſpecting them, to the Ancient Univerſal Hiſtory, already quoted more than once in the preſent article. See alſo GORDIUS, MIDAS, &c. For Phrygia Minor, ſee TROY.

PHRYGIAN STONE, in natural hiſtory, is the name of a ſtone deſcribed by the ancients, and uſed by them in dying; perhaps from ſome vitriolic or alluminous ſalt contained in it, which ſerved to enliven or fix the colours uſed by the dyers. It was light and ſpongy, reſembling a pumice; and the whiteſt and lighteſt were reckoned the beſt. Pliny gives an account of the method of preparing it for the purpoſe of dying, which was by moiſtening it with urine, and then heating it red-hot, and ſuffering it to cool. This calcination was repeated three times, and the ſtone was then fit for uſe. Dioſcorides recommends it in medicine after burning; he ſays it was drying and aſtringent,

PHRYGIANS, a Chriſtian ſect. See CATAPHRYGIANS and MONTANIST.

PHRYNE, was a famous proſtitute, who flouriſhed at Athens about 328 years before the Chriſtian era. She was miſtreſs of Praxiteles, who drew her picture, which was one of his beſt pieces, and was placed in the temple of Apollo at Delphi. We are told that Apelles painted his Venus Anadyomene after he had ſeen Phryne on the ſea-ſhore naked, and with diſhevelled hair. Phryne became ſo very rich by the liberality of her lovers, that ſhe offered to rebuild Thebes at her own expenſe, which Alexander had deſtroyed, provided this inſcription was placed on the walls: *Alexander diruit, ſed meretrix Phryne refecit*; which was refuſed. See *Plin.* 34. c. 8. There was another of the ſame name who was accuſed of impiety. When ſhe found that ſhe was going to be condemned, ſhe unveiled her boſom, which ſo influenced her judges, that ſhe was immediately acquitted.

PHRYNICUS, a general of Samos, who endeavoured to betray his country, &c.—A flatterer at Athens.—A tragic poet of Athens, diſciple to Theſpis. He was the firſt who introduced a female character on the ſtage.

PHRYNIS was a muſician of Mitylene. He was the firſt who obtained a muſical prize at the Panathenæa at Athens. He added two ſtrings to the lyre, which had always been uſed with ſeven by all his predeceſſors. He flouriſhed about 438 years before the Chriſtian era. We are told that he was originally a cook at the houſe of Hiero king of Sicily.—There was another of the ſame name, a writer in the reign of Commodus, who made a collection, in 36 books, of phraſes and ſentences from the beſt Greek authors, &c.

PHRYXUS (fab. hiſt.), was a ſon of Athamas king of Thebes, by Nephele. When his mother was repudiated, he was perſecuted with the moſt inveterate fury by his ſtep-mother Ino, becauſe he was to ſit on the throne of Athamas, in preference to the children of a ſecond wife. His mother apprized him of Ino's intentions upon his life; or, according to others, his preceptor; and the better to make his eſcape, he ſecured part of his father's treaſures, and privately left Bœotia with his ſiſter Helle, to go to their friend and relation Æetes king of Colchis. They embarked on board a ſhip, or, as we are informed by the fabulous account of the poets and mythologiſts, they mounted on the back of a ram, whoſe fleece was of gold, and proceeded on their journey through the air. The height to which they were carried made Helle giddy, and ſhe fell into the ſea. Phryxus gave his ſiſter a decent burial on the ſea-ſhore, and after he had called the place *Helleſpont* from her name, he continued his flight, and arrived ſafe in the kingdom of Æetes, where he offered the ram on the altars of Mars. The king received him with great tenderneſs, and gave him Chalciope his daughter in marriage. She had by him Phrontis Melas, Argos Cylindrus, whom ſome call *Cytorus*. He was afterwards murdered by his father-in-law, who envied him the poſſeſſion of the golden fleece; and Chalciope, to prevent her children from ſharing their father's fate, ſent them privately from Colchis to Bœotia, as nothing was to be dreaded there from the jealouſy or reſentment of Ino, who was then dead. The fable of the flight of Phryxus to Colchis on a ram has been explained by ſome, who obſerve, that the ſhip on which he embarked was either called by that name, or carried on her prow a figure of that animal. The fleece of gold is accounted for, by obſervying that Phryxus carried away immenſe treaſures from Thebes. Phryxus was placed among the conſtellations of heaven after death. The ram which carried him to Aſia is ſaid to have been the fruit of Neptune's amour with Theophane the daughter of Altis. This ram the gods had given to Athamas in order to reward his piety and religious life; and Nephele procured it for her children, juſt as they were going to be ſacrificed to the jealouſy of Ino. Phryxus's murder was ſome time after amply revenged by the Greeks; it having occaſioned the famous expedition atchieved under Jaſon and many of the princes of Greece, which had for its object the recovery of the golden fleece, and the puniſhment of the king of Colchis for his cruelty to the ſon of Athamas.

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* Goropius Beccanus makes uſe of the ſame argument, to prove that the High Dutch is the original or mother tongue of the world, becauſe the word *beker* in that language ſignifies "a baker."

PHTHIRIASIS, the LOUSY EVIL, from φθειρ, "a louſe." It is a louſy diſtemper; children are frequently its ſubjects, and adults are ſometimes troubled with it. The increaſe of lice, when in a warm moiſt ſituation, is very great; but a cold and dry one ſoon deſtroys them. On the human body four kinds of lice are diſtinguiſhed: 1. The *pediculi*, ſo called becauſe they are more troubleſome with their feet than by their bite. Theſe are in the heads of children, eſpecially if ſore or ſcabby; and often in thoſe of adults, if they are ſlothful and naſty. 2. Crab-lice, ſee CRAB-*Lice*. 3. Body-lice; theſe infeſt the body, and breed in the clothes of the naſty and ſlothful. 4. A ſort which breed under the cuticle, and are found in the hands and feet: they are of a round form, and ſo minute as often to eſcape the ſight: by creeping under the ſcarf-ſkin they cauſe an intolerable itching; and when the ſkin burſts where they lodge, cluſters of them are found there. See ACARUS.

Cleanlineſs conduces much to the deſtruction of lice. When they are in the head, comb it every day; and, after each combing, ſprinkle the pulv. ſem. ſtaph. agr. or coccul. Ind. among the hairs every night, and confine it with a tight cap.

Codrochius, in his treatiſe on lice, ſays, that the powdered coc. Ind. exceeds all other means; and that it may be mixed in the pulp of apple, or in lard, and applied every night to the hair. Some writers aſſert, that if the pulv. cort. rad. ſaſſafr. is ſprinkled on the head, and confined with a handkerchief, it deſtroys the lice in one night. The body-lice are deſtroyed by any bitter, ſour, ſalt, or mercurial medicine, if applied to the ſkin. The black ſoap, and the flowers called *cardamine* or *lady's-ſmock*, are ſaid to be ſpecifics in all caſes of lice on the human body.

PHTHISIS, a ſpecies of conſumption, occaſioned by an ulcer in the lungs. See MEDICINE. Dr. Beddoes has ſuggeſted a new theory of phthiſis, founded on the prevailing pneumatic doctrine in chemiſtry. Thinking that much cannot be gained by adhering to eſtabliſhed principles and modes of practice, and being unawed by any pretenſions to ſucceſs from experience, he enters into the province of ſpeculation. He fixes on the effect of pregnancy in ſuſpending the progreſs of phthiſis, as a fact which, by its mode of operation, might ſuggeſt a method of diminiſhing the havock occaſioned by this diſtemper. We ſhall give his explanation of this intereſting fact:

"The fœtus has its blood oxygenated by the blood of the mother through the placenta. During pregnancy there ſeems to be no proviſion for the reception of an unuſual quantity of oxygene. On the contrary, in conſequence of the impeded action of the diaphragm, leſs and leſs ſhould be continually taken in by the lungs. If, therefore, a ſomewhat diminiſhed proportion of oxygene be the effect of pregnancy, may not this be the way in which it arreſts the progreſs of phthiſis? and if ſo, is there not an exceſs of oxygen in the ſyſtem of conſumptive perſons? and may we not, by purſuing this idea, diſcover a cure for this fatal diſorder?"

Dr. Beddoes thinks, that this ſuppoſition is countenanced by the deficiency of oxygene in the blood of pregnant women, of aſthmatic patients, and of thoſe who labour under ſea-ſcurvy; and by the ſuperabundance of it in the blood of phthiſical perſons, indicated by its colour, as well as by the aggravation of the ſymptoms of conſumption by breathing oxygene air, and by the relief from inſpiring atmoſpheric air mixed with carbonic acid air; and, laſtly, from the ſmall proportion of deaths among ſea-faring people. Suppoſing acids to act by decompoſition, their alleged effects in producing conſumption are conſiſtent with the author's doctrine, as well as the emaciation preceding and accompanying phthiſis. From theſe facts, Dr. Beddoes concludes, that "1. The phthiſical inflammation may ſo alter the ſtructure of the lungs, as to cauſe them to tranſmit a more than ordinary portion of oxygene to the blood; or, 2. Some unknown cauſe having enabled them to tranſmit, or the blood itſelf to attract, more oxygene, an inflammation of the lungs might enſue."

From theſe principles the doctor thinks himſelf juſtified in propoſing, in a diſeaſe which is incurable by preſent modes of practice, to diminiſh the ſupply of oxygene by the two channels through which it is introduced; namely, through the lungs, by lowering the atmoſpheric air with azotic or hydrogene air; and through the ſtomach, by giving ſuch nouriſhment as contains a ſmall portion of oxygene.

Such is Dr. Beddoes's theory of conſumption; on which the following remark has been made by a critic, who poſſeſſes an equal degree of candour and judgment. Vide Monthly Rev. for Nov. 1793. It is aſſumed by Dr. Beddoes, that the blood of pregnant women has a diminiſhed proportion of oxygene: but pregnant women have the ſame circumſcribed ſpot of florid red in their countenances which is apparent in hectics. If, then, the preſence of this colour be ſufficient to prove an exceſs of oxygene in the one caſe, it muſt have the ſame weight in the other. Another queſtion is, whether leſs oxygene be really taken in by the lungs during pregnancy? For although the diaphragm be impeded in the freedom of its action, the frequency of breathing is proportionally increaſed. A third circumſtance which demands attention is, in what degree the fœtus has its blood oxygenated by the blood of the mother through the placenta. It appears highly probable, that the fœtal blood receives a very trifling ſupply of oxygene from the blood of the mother; that the fœtal heart contains only a ſmall portion of blood, which has been conveyed to the placenta; and that the blood in the heart and arteries of the fœtus is not florid. For many ingenious arguments on this ſubject, we may refer to Mr. Coleman's Diſſertation on ſuſpended Reſpiration. Leaving theſe things to Dr. Beddoes's conſideration, we will preſent our readers with his concluding remarks on this ſubject:

"The more you reflect, the more you will be convinced, that nothing would ſo much contribute to reſcue the art of medicine from its preſent helpleſs condition, as the diſcovery of the means of regulating the conſtitution of the atmoſphere. It would be no leſs deſirable to have a convenient method of reducing the oxygene to 18 or 20 in 100, than of increaſing it in any proportion. The influence of the air we breathe is as wide as the diffuſion of the blood. The minuteſt portions of the organs of motion, ſenſe, and thought, muſt be affected by any conſiderable change in this fluid. Whether it be that the brain muſt be waſhed by ſtreams of arterial blood, or that the action of every organ is a ſtimulus to the ſyſtem in general, and conſequently to every other organ in particular; it is certain, that when the acceſs of oxygene is cut off from the lungs, the functions of the brain ceaſe: perhaps there may be a mixture of azotic and oxygene airs, more favourable to the intellectual faculties than that which is found in the atmoſphere; and hence chemiſtry be enabled to exalt the powers of future poets and philoſophers. That diſeaſes of excitement on the one hand, and debility on the other, might be cured almoſt ſolely by a proper air, one can hardly doubt, as well as ſeveral diſorders at preſent highly dangerous or deſperate, which one cannot, upon the faith of any obvious phenomena, refer to either head. The materia medica might, therefore, undergo a ſtill greater reduction than it has lately undergone, in conſequence of the purification of medicine from its groſſer abſurdities; and hence the treatment of diſeaſes be at once rendered infinitely more pleaſant and more efficacious."

Our author, in a ſubſequent publication, gives an account of his treating with ſucceſs ſeveral caſes of phthiſis according to the principles of this theory. After diſtinguiſhing conſumptions into two kinds, the florid and the pituitous or catarrhal, he obſerves, "that the ſyſtem may be as variouſly affected by means of the lungs as of the ſtomach: that it is impoſſible to doubt that we are nouriſhed by the lungs as truly as by the ſtomach: and that what we take in at the former entrance, becomes, like our food, a part of the ſubſtance of our ſolids as well as of our fluids. By the lungs we can alſo introduce effectual alteratives of the blood, and by conſequence of all the parts nouriſhed by the blood."

He then acquaints us more particularly with the apparatus requiſite for the practice propoſed. 1ſt, It ſhould be able to furniſh azotic, hydrogene, carbonic, and oxygene airs: our author having, as he ſays, "no intention to confine himſelf to one incurable diſorder. 2dly, The reſervoirs ſhould be large, that the patients may be ſupplied with any quantity that their ſymptoms may require: and, 3dly, It is neceſſary to be able to mix theſe airs with one another, as well as with atmoſpheric air, in any proportion." Theſe objects, we are told, have been completely attained by a conſtruction not very unlike to that employed in the gazometers of M. Lavoiſier and Dr. Van Marum.

PHUL, or Pul, king of Aſſyria, is by ſome hiſtorians ſaid to be Ninus under another name, and the firſt founder of that monarchy: A renowned warrior. He invaded Iſrael in the reign of Manahem, who became tributary to him, and paid him 1000 talents of ſilver for a peace. Flouriſhed 771 B. C.

PHUT, or Phuth, the third ſon of Ham. (Gen. x. 6.) Calmet is of opinion, that Phut peopled either the canton of Phtemphu Phtemphuti, or Phtembuti, ſet down in Pliny and Ptolemy, whoſe capital was Thara in Lower Egypt, inclining towards Lybia; or the canton called Phtenotes, of which Buthus was the capital. The prophets often ſpeak of Phut. In the time of Jeremiah, Phut was under the obedience of Necho, king of Egypt. Nahum (iii. 9.) reckons up his people in the number of thoſe who ought to have come to the aſſiſtance of No-ammon or Dioſpolis.

PHYLACTERY, in the general, was a name given by the ancients to all kinds of charms, ſpells, or characters, which they wore about them, as amulets, to preſerve them from dangers or diſeaſes.

Phylactery particularly denoted a ſlip of parchment, wherein was written ſome text of Holy Scripture, particularly of the decalogue, which the more devout people among the Jews wore on the forehead, the breaſt, or the neck, as a mark of their religion. The primitive Chriſtians alſo gave the name *phylacteries* to the caſes wherein they incloſed the relicks of their dead. *Phylacteries* are often mentioned in the New Teſtament, and appear to have been very common among the Phariſees in our Lord's time.

PHYLICA, bastard alaternus; a genus of the monogynia order, belonging to the pentandria claſs of plants. There are ſix ſpecies, of which three are kept in the gardens of this country; but, by reaſon of their being natives of warm climates, they require to be kept in pots, and houſed in winter. They are all ſhrubby plants, riſing from three to five or ſix feet high, and adorned with beautiful cluſters of white flowers. They are propagated by cuttings.

PHYLLANTHUS, sea-side laurel; a genus of the triandria order, belonging to the monœcia claſs of plants. There are ſix ſpecies, all of them natives of warm climates; and riſe from 12 or 14 feet to the height of middling trees. They are tender, and cannot be propagated in this country without artificial heat.

PHYLLIS (fab. hiſt.), was a daughter of Sithon, or, according to others, of Lycurgus, king of Thrace, who received Demophoon the ſon of Theſeus: who, at his return from the Trojan war, had ſtopped on her coaſts. She became enamoured of him, and did not find him inſenſible to her paſſion. After ſome months of mutual tenderneſs and affection, Demophoon ſet ſail for Athens, where his domeſtic affairs recalled him. He promiſed faithfully to return as ſoon as a month was expired; but either his diſlike for Phyllis, or the irreparable ſituation of his affairs, obliged him to violate his engagement: and the queen, grown deſperate on account of his abſence, hanged herſelf, or, according to others, threw herſelf down a precipice into the ſea and periſhed. Her friends raiſed a tomb over her body, where there grew up certain trees, whoſe leaves, at a particular ſeaſon of the year, ſuddenly became wet as if ſhedding tears for the death of Phyllis. According to an old tradition mentioned by Servius, Virgil's commentator, Phyllis was changed by the gods into an almond-tree, which is called *phylla* by the Greeks. Some days after this metamorphoſis, Demophoon reviſited Thrace; and when he heard of the fate of Phyllis, he ran and claſped the tree, which, though at that time ſtripped of its leaves, ſuddenly ſhot forth, and bloſſomed as if ſtill ſenſible of tenderneſs and love. The abſence of Demophoon from the houſe of Phyllis has given riſe to a beautiful epiſtle of Ovid, ſuppoſed to have been written by the Thracian queen about the fourth month after her lover's departure.—A country-woman introduced in Virgil's eclogues.—The nurſe of the emperor Domitian.—A country of Thrace near Mount Pangæus.

PHYSALIS, the winter-cherry; a genus of the monogynia order, belonging to the pentandria claſs of plants. There are 16 ſpecies; of which the moſt remarkable is the alkekengi, or common winter-cherry. This grows naturally in Spain and Italy. The roots are perennial, and creep in the ground to a great diſtance if they are not confined. Theſe, in the ſpring, ſhoot up many ſtalks, which riſe to the height of a foot or more, garniſhed with leaves of various ſorts; ſome of which are angular and obtuſe, ſome oblong and ſharp pointed, with long foot-ſtalks. The flowers are produced from the wings, ſtanding upon ſlender foot-ſtalks; are of a white colour, and have but one petal. They are ſucceeded by round berries about the ſize of ſmall cherries, incloſed in an inflated bladder, which turns red in autumn, when the top opens and diſcloſes the red berry, which is ſoft, pulpy, and filled with flat kidney-ſhaped ſeeds. Soon after the fruit is ripe, the ſtalks decay to the root. The plant is eaſily propagated, either by ſeeds or parting the roots.

PHYSALUS. See Scolopendra.

PHYSETER, or Spermaceti-fish, in zoology, a genus belonging to the order of cete. There are four ſpecies; the moſt remarkable are,

1. The *microps*, or black-headed cachalot, with a long fin on the back, and the upper jaw conſiderably longer than the under one. A fiſh of this kind was caſt aſhore on Cramond iſle, near Edinburgh, December 22, 1769; its length was 54 feet; the greateſt circumference, which was juſt beyond the eyes, 30: the upper jaw was five feet longer than the lower, whoſe length was ten feet. The head was of a moſt enormous ſize, very thick, and above one-third the ſize of the fiſh: the end of the upper jaw was quite blunt, and near nine feet high: the ſpout-hole was placed near the end of it. The teeth were placed in the lower jaw, 23 on each ſide, all pointing outwards; in the upper jaw, oppoſite to them, were an equal number of cavities, in which the ends of the teeth lodged when the mouth was cloſed. One of the teeth meaſured eight inches long, the greateſt circumference the ſame. It is hollow within-ſide for the depth of three inches, and the mouth of the cavity very wide; it is thickeſt at the bottom, and grows very ſmall at the

point, bending very much; but in ſome the flexure is more than in others. Theſe, as well as the teeth of all other whales we have obſerved, are very hard, and cut like ivory. The eyes are very ſmall, and remote from the noſe. The pectoral fins were placed near the corners of the mouth, and were only three feet long: it had no other fin, only a large protuberance on the middle of the back. The tail was a little forked, and 14 feet from tip to tip. The penis ſeven feet and a half long. Linnæus informs us, that this ſpecies purſues and terrifies the porpoiſes to ſuch a degree as often to drive them on ſhore.

2. The *catodon*, or round-headed cachalot, with a fiſtula in the ſnout, and having no back fin. Of this ſpecies, 102 of different ſizes were caſt aſhore at one time on one of the Orkney Iſles, the largeſt 24 feet in length. The head is round, the opening of the mouth ſmall. Sibbald ſays it has no ſpout-hole, but only noſtrils: But Mr. Pennant is of opinion, that the former being placed at the extremity of the noſe, has been miſtaken by him for the latter. Some teeth of this ſpecies are an inch and three quarters long, and in the largeſt part of the thickneſs of one's thumb. The top is quite flat, and marked with concentric lines; the bottom is more ſlender than the top, and pierced with a ſmall orifice; inſtead of a back fin, there [illegible]

For the method of extracting the ſpermaceti from the brain of theſe creatures, ſee the article SPERMACETI.

PHYSIC, or PHYSICK, the art of healing: properly called MEDICINE. The word is formed from the Greek φυσις, "nature;" in regard medicine conſiſts principally in the obſervation of nature. See PHYSICS and MEDICINE.

PHYSICAL, ſomething belonging to, or really exiſting in, nature. In this ſenſe we ſay a phyſical point, in oppoſition to a mathematical one, which only exiſts in the imagination; a phyſical ſubſtance or body, in oppoſition to ſpirit, or metaphyſical ſubſtance, &c.

PHYSICIAN, a perſon who profeſſes medicine, or the art of healing diſeaſes. See MEDICINE.

PHYSICIANS, *College of, in London and Edinburgh.* See COLLEGE *of Phyſicians.*

PHYSICO-MATHEMATICS, includes thoſe branches of phyſic which, uniting obſervation and experiment to mathematical calculation, undertake to explain the phenomena of nature.

PHYSICS,

TAKEN in their moſt enlarged ſenſe, comprehend the whole ſtudy of nature; and NATURAL PHILOSOPHY is a term of the ſame extent: but ordinary language, and eſpecially in this country, employs both of theſe terms in a much narrower ſenſe, which it is proper in this place to determine with ſome preciſion.

Under the article PHILOSOPHY, we gave a particular account of that view of nature in which the objects of our attention are conſidered as connected by cauſation; and we were at ſome pains to point out the manner in which this ſtudy may be ſucceſsfully cultivated. By a judicious employment of the means pointed out in that article, we diſcover that the objects of our contemplation compoſe an UNIVERSE, which conſiſts, not of a number of independent exiſtences ſolitary and detached from each other, but of a number of ſubſtances connected by a variety of relations and dependencies, ſo as to form a whole which may with great propriety be called the SYSTEM OF NATURE.

This aſſembling of the individual objects which compoſe the univerſe into one ſyſtem is by no means the work of a haſty and warm fancy, but is the reſult of ſober contemplation. The natural hiſtorian attempts in vain to deſcribe objects, by only informing us of their ſhape, colour, and other ſenſible qualities. He finds himſelf obliged, in deſcribing a piece of marble, for inſtance, to tell us that it takes a fine poliſh; that it ſtrikes fire with ſteel; that it burns to quicklime; that it diſſolves in aquafortis, and is precipitated by alkalis; that with vitriolic acid it makes gypſum, &c. &c. &c. and thus it appears that even the *deſcription* of any thing, with the view of aſcertaining its ſpecific nature, and with the ſole purpoſe of diſcrimination, cannot be accompliſhed without taking notice of its various relations to other things. But what do we mean by the *nature* of any thing? We are ignorant of its eſſence, or what makes it that thing and no other thing. We muſt content ourſelves with the diſcovery of its *qualities* or *properties*: and it is the aſſemblage of theſe which we call its *nature.* But this is very inaccurate. Theſe do not conſtitute its eſſence, but are the conſequences of it. Yet this is all we ſhall ever know of its nature. Now the term *property* is nothing but a name expreſſing ſome relation which the ſubſtance under conſideration has to other things. This is true of all ſuch terms. Gravity, elaſticity, ſenſibility, gratitude, and the like, expreſs nothing but certain *matters of fact*, which may be obſerved reſpecting the object of our contemplation in different circumſtances of ſituation with regard to other things. Our diſtinct notions of individuals, therefore, imply their relations to other things.

The ſlighteſt obſervation of the univerſe ſhows an evident connection between all its parts in their various properties. All things on this earth are connected with each other by the laws of motion and of mind. We are connected with the whole of the ſolar ſyſtem by gravitation. If we extend our obſervations to the fixed ſtars, the connection ſeems to fail; but even here it may be obſerved. Their inconceivable diſtance, it is true, renders it impoſſible for us to obtain any *extenſive* information as to their nature. But theſe bodies are connected with the ſolar ſyſtem by the ſameneſs of the light which they emit with that emitted by our ſun or any ſhining body. It moves with the ſame velocity, it conſiſts (in moſt of them at leaſt) of the ſame colours, and it is reflected, refracted, and inflected, according to the ſame laws.

In this unbounded ſcene of contemplation, our attention will be directed to the different claſſes of objects nearly in proportion to the intereſt we take in them. There is nothing in which we are ſo much intereſted as our fellow-men; and one of the firſt ſteps that we make in our knowledge of nature, is an acquaintance with them. We learn their *diſtinctive* nature by attending to their *characteriſtic* appearance; that is, by obſerving their actions. We obſerve them continually producing, like ourſelves, certain changes in the ſituation or condition of ſurrounding objects; and theſe changes are evidently directed to certain ends *which reſpect themſelves.* Obſerving this ſubſerviency of the effects which they produce to their own accommodation, we conſider this adjuſtment of means to ends as the effect of an INTENTION, as we experience it to be in our own caſe, where we are conſcious of this intention, and of theſe its effects. We therefore interpret thoſe actions of other men, where we obſerve this adjuſtment of means to ends, as marks or ſigns of intention in them ſimilar to our own. And thus a quality, or power, or faculty, is *ſuppoſed* in them *by means of its ſign*, although the quality itſelf is not *immediately* cognizable by our ſenſes. And as this intention in ourſelves is accompanied by perception of external objects, knowledge of their properties, deſire of good, averſion from evil, volition, and exertion, without all of which we could not or would not perform [illegible] actions which we daily perform, we *ſuppoſe* the ſame perception, knowledge, deſire, averſion, volition, and exertion in them.

Thus, by the conſtitution of our mind, we conſider the employment of means, by which ends terminating in the agent are gained, as the natural ſigns of deſign or intention. ART, therefore, or the employment of means, is the natural ſign of intention; and wherever we obſerve this adjuſtment of means to ends we infer the agency of deſign.

A ſmall acquaintance with the objects around us, obliges us to extend this inference to a great number of beings beſides our fellow men, namely, to the whole animal creation: for in all we obſerve the ſame ſubſerviency to the ends of the agent, in the changes which we find them continually producing in the objects around them. Theſe changes are all adjuſted to their own well-being. In all ſuch caſes, therefore, we are forced, by the conſtitution of our own minds, to infer the exiſtence of deſign or intention in theſe beings alſo.

But in numberleſs changes produced by external objects on each other, we obſerve no ſuch fitneſs in the effects, no ſuch ſubſerviency to the well-being of the agent. In ſuch caſes, therefore, we make no ſuch inference of thought or deſign.

Thus, then, there is preſented to our obſervation an important diſtinction, by which we arrange all external objects into two claſſes. The firſt reſembles ourſelves, in giving external marks of that thought or intention of which we are conſcious; and we *ſuppoſe* in them the other properties which we diſcover in ourſelves, but cannot *immediately* obſerve in them, viz. thought, perception, memory, foreſight, and all that collection of faculties which we feel in ourſelves, and which conſtitute the animal. Objects of the other claſs exhibit no ſuch appearances, and we make no ſuch inference. And thus we divide the whole of external nature into the claſſes of THINKING and UNTHINKING beings.

Our firſt judgments about theſe claſſes will be very inaccurate; and we ſhall naturally aſcribe the differences, which we do not very well underſtand, to the differences in organical ſtructure, which we clearly obſerve. But when we have knocked down or perhaps ſmothered an animal, we find that it no longer gives the former marks of thought and intention, and that it now reſembles the claſs of unthinking beings: And yet it ſtill retains all that fitneſs of organical ſtructure which it had before; it ſeems only to want the intention and the will. This obliges us to conclude that the diſtinction does not ariſe from a difference in organical ſtructure, but from a diſtinct ſubſtance common to all thinking beings, but ſeparable from their organical frame. To this ſubſtance we aſcribe thought, intention, contrivance, and all that collection of faculties which we feel in ourſelves. To this ſubſtance in ourſelves we refer all ſenſations, pleaſures, pains, remembrances, deſires, purpoſes; and to this aggregate, however imperfectly underſtood, we give the name MIND. Our organical frame, which ſeems to be only the inſtrument of information and operation to the mind, we call *our* body.

As the animating principle is not, like our body, the immediate object of the ſenſes, we naturally conceive it to be a ſubſtance eſſentially different from thoſe which are the objects of our ſenſes. The rudeſt people have ſhown a diſpoſition to form this concluſion. Obſerving that animal life was connected with breathing, it was natural to imagine that breathing was living, and that breath was life. It is a remarkable fact that, in moſt languages, the term for expreſſing *breath* is at leaſt one of the terms for expreſſing the ſoul; רוח, *πνευμα*, *ſpiritus*, in the Hebrew, Greek, and Latin expreſs both; *gheiſt* or *ghoſt*, in the Teutonic, comes from *gheiſen*, to "breathe or ſigh;" *dūcha* or dūah, "the ſoul," in Sclavonic, comes from *duichat*, "to breathe;" ſo in the Gaelic does *anal* come from *anam*; and the ſame rela[illegible] words in the Malay and other eaſtern languages. We believe that moſt perſons can recollect ſome traces of this notion in their early conceptions of things; and many who do not conſider themſelves as uncultivated, believe that the ſoul quits the body *along with the laſt breath.* Among the Tartar nations hanging is conſidered with particular horror, on account of the ungraceful and filthy exit which the ſoul is obliged to make from the body.

But the obſervation of the ſame appearances of thought and intention in fiſhes and other animals which do not breathe, would ſoon ſhow that this was but a rude conception. Very little refinement indeed is neceſſary to convince us that air or breath cannot be the ſubſtance which thinks, wiſhes, and deſigns; and that the properties of this ſubſtance, whatever it is, muſt be totally different from, and incompatible with, any thing that we know of the immediate objects of our ſenſes.

Hence we are led to conclude that there are two kinds of ſubſtances in nature: One, which is the principle of ſenſation; and therefore *cannot* be the object of our ſenſes, any more than light can be the object of the microſcope. This ſubſtance alone can feel, think, deſire, and propoſe, and is the object of *reflection alone.* The objects of our ſenſes compoſe the other claſs, and therefore can have none of the other properties which are not cognoſcible by the ſenſes. Theſe have all the properties which our ſenſes can diſcover; and we can have no evidence of their having any other, nor indeed any conception of their having them. This claſs is not confined to the unorganized maſſes of matter; for we ſee that the bodies of animals loſe after death that organical form, and are aſſimilated to all the reſt of unthinking beings. It has ariſen from ſuch views as this, that while all nations have agreed to call this claſs of objects by the name BODY, which originally expreſſes our organical frame, ſome nations, further advanced in cultivation or refinement, have contrived an abſtract term to expreſs this general ſubſtance of which all inanimate beings are compoſed. Such a term we have in the words *materies*, ὑλη.

Matter, then, is that ſubſtance which is immediately cognoſcible by our ſenſes. Whatever, therefore, is not thus immediately cognoſcible by our ſenſes is not material, and is expreſſed by a negative term, and called *immaterial*: hence it is that mind is ſaid to be immaterial. It is of importance to keep in mind this diſtinction, merely grammatical. Little more is neceſſary for detecting the ſophiſms of Helvetius, Mirabeau, and other ſages of the Gallic ſchool, who have been anxious to remove the ties of moral and religious obligation by lowering our conceptions of our intellectual nature. It will alſo ſerve to ſhow how haſtily *they* have formed their opinions who have aſcribed to the immediate agency of mind all thoſe relations which are obſerved in the actions of bodies on each other at a diſtance. The connecting principles of ſuch relations *e diſtante* (if there are any ſuch), are not the immediate objects of our ſenſes: they are therefore immaterial. But it does not follow that they are minds. There may be many immaterial ſubſtances which are not minds. We know nothing of any object whatever but by the obſervation of certain appearances, which ſuggeſt to our minds the exiſtence and agency of its qualities or powers. Such phenomena are the natural ſigns of theſe qualities, and it is to thoſe ſigns that we muſt always have recourſe when we wiſh to conceive without ambiguity concerning them. What is the characteriſtic phenomenon of mind, or what is the *diſtinguiſhing* quality which brings it into view? It is INTENTION: and it may be aſſerted with the utmoſt confidence, that we have no other mark by which mind is immediately ſuggeſted to us, or that would ever have made us ſuppoſe that there exiſted another mind beſides our own. The *phenomenon* by which this quality is ſuggeſted to us is *art*, or the employment of means to gain ends; and the mark of art is the ſuppoſed conduciveneſs of theſe ends to the well-being of the agent. Where this train is not obſerved, deſign or intention is never thought of; and therefore where intention is not perceived in any immaterial ſubſtance, if any ſuch has ever been obſerved, it is an abuſe of language to call it mind. We do not think that even perception and intelligence entitle us to give the name mind to the ſubſtance in which they are inherent, becauſe it is from marks of intention alone that we infer the exiſtence of mind; and although theſe muſt be accompanied with perception and intelligence, it does not follow that the ſubſtance which can perceive and underſtand muſt alſo deſire and propoſe. However difficult we may find it to ſeparate them, they are evidently ſeparable in imagination. And let not this aſſertion be too haſtily objected to; for the ſeparation *has been made* by perſons moſt eminent for their knowledge and diſcernment. When Leibnitz aſcribed to his MONADES, or what we call the ultimate ATOMS of matter, a perception of their ſituation in the univerſe, and a motion preciſely ſuited to this perception, he was the furtheſt in the world from ſuppoſing them animated or endowed with minds. It is true indeed that others, who think and call themſelves philoſophers, are much more liberal in their application of this term. A modern author of great metaphyſical eminence ſays, "I call that *mind* which moves, and that *body* which is moved." This claſs of philoſophers aſſert that no motion whatever is begun except by the agency of an animating principle, which (after Ariſtotle) they call *Nature*, and which has in theſe days been exalted to the rank of a god. All this jargon (for it is nothing elſe) has ariſen from the puzzle in which naturaliſts think themſelves involved in attempting to explain the production of motion in a body at a diſtance from that body which is conceived as the cauſe of this motion. After having been reluctantly obliged, by the reaſonings of Newton, to abandon their methods of explaining ſuch phenomena by the impulſes of an intervening fluid, nothing ſeemed left but the aſſertion that theſe motions were produced by minds, as in the caſe of our own exertions. Theſe explanations (if they deſerve the name) cannot be objected to in any other way than as an abuſe of language, and as the introduction of an unmeaning jargon. We have, and can have, no notion of mind different from thoſe of our own minds; and we diſcover the exiſtence of other minds as we diſcover the exiſtence of bodies, by means of phenomena which are characteriſtic of minds, that is, which reſemble thoſe phenomena that follow the exertion of our own mental faculties, that is, by the employment of means to attain ſelfiſh ends; and where ſuch appearances are not obſerved, no exiſtence of a mind is inferred. When we ſee a man fall from the top of a houſe, and daſh out his brains on the pavement, we never aſcribe this motion to his mind. Although the fitneſs of many of the celeſtial motions for moſt important purpoſes makes us ſuppoſe deſign and contrivance ſomewhere, and therefore a *Supreme Mind*, we no more think of inferring a mind in the earth from the fitneſs of its motions for purpoſes moſt beneficial to its inhabitants, than of inferring a mind in a bit of bread from its fitneſs for nouriſhing our bodies. It is not from the mere motions of animals that their minds are inferred, but from the conduciveneſs of theſe motions to the well-being of the animal.

The term mind therefore, in the *ordinary language* of all men, is applied to what deſires and wills at the ſame time that it perceives and underſtands. If we call that mind which *produces motion*, we muſt derive our notions of its qualities or attributes from obſerving their effects. We muſt therefore diſcover the general laws by which they act, that is, the general laws obſerved in thoſe motions which we conſider as their effects. Now theſe are the general laws of motion; and in none of theſe can we find the leaſt coincidence with what we are accuſtomed to call the laws of mind. Nay, it has been the total want of [illegible] which has [illegible] in all ages and countries have made between mind and matter. This diſtinction is found in all languages; and it is an unpardonable liberty which men take with languages when they uſe a *term of diſtinction*, a *ſpecific term*, to expreſs things of a different ſpecies. What theſe authors have been pleaſed to call *mind*, the whole world beſides have called by another name, FORCE; which, though borrowed from our own exertions, is yet ſufficiently diſtinctive, and never leads us to confound things that are different, except in the language of ſome modern philoſophers, who apply it to the laws of the agency of mind; and, when ſpeaking of the force of motives, &c. commit the ſame miſtakes which the followers of Ariſtotle commit in the uſe of the term mind. *Force*, in the language of theſe philoſophers, means what connects the operations of mind; as mind, in the language of Lord Monboddo, is that which connects the operations of body.

Thoſe are not leſs to blame who conſider this *Nature* of Ariſtotle, this principle of motion, as an exiſtence or ſubſtance different both from matter and from the minds of intelligent creatures. Ariſtotle calls it in ſome places ὡσπερ ψυχη. He might with equal propriety, and equal conſiſtency with his other doctrines, have called mind ὡσπερ τελος, or an ὡσπερ δυναμις. Beſides, we have no evidence for the ſeparability of this ὡσπερ ψυχη from body, as we have for the inſeparability of ſuch minds as our own, the genuine ψυχαι. Nay, his whole doctrines, when maturely conſidered, aſſume their abſolute inſeparability.

This doctrine of elemental minds, therefore, as the immediate cauſes of the phenomena of the material world, is an abuſe of language. It is a jargon; and it is a frivolous abuſe, for it offers no explanation whatever. The phenomena are totally unlike the phenomena of ordinary minds, and therefore receive no explanation from them; and ſince our knowledge of theſe *quaſi* minds muſt be entirely derived from the phenomena, it will be preciſely the ſame, although we expreſs it in common language. We ſhall not indeed raiſe the wonder of our hearers, as thoſe do who fill the world with minds which they never ſuſpected to exiſt; but we ſhall not bewilder their imagination, confound their ideas, and miſlead their judgments.

We flatter ourſelves that our readers will not think theſe obſervations unſeaſonable or miſplaced. Of all miſtakes that the naturaliſt can fall into, there is none more fatal to his progreſs in knowledge than the confounding things which are eſſentially different; and of all the diſtinctions which can be made among the objections of our contemplation, there is none of equal philoſophical importance with this between mind and matter: And when we conſider the conſequences which naturally follow from this confuſion of ideas, and particularly thoſe which follow from ſinking the mental faculties of man to a level with the operations of mechanics or chemiſtry, conſequences which the experience of the preſent eventful day ſhows to be deſtructive of all that is noble or deſirable in human nature, and of all that is comfortable in this life, and which blaſt every hope of future excellence—we cannot be too anxious to have this capital diſtinction put in the plaineſt point of view, and expreſſed in the moſt familiar characters, "ſo that he who runneth may read." When we ſee the phrenzy which the reaſoning pride of man has raiſed in our neighbourhood, and hear the dictates of philoſophy inceſſantly appealed to in defence of whatever our hearts ſhudder at as ſhocking and abominable; and when we ſee a man [*] of great reputation as a naturaliſt, and of profeſſed humanity, and political moderation, congratulating his countrymen on the rapid improvement and almoſt perfection of philoſophy; and after giving a ſhort ſketch of the conſtitution of the viſible uni- [illegible] that particular combination and mode of cryſtallization which conſtitutes God *(horreſco referens !)*—is it not full time for us to ſtop ſhort, and to aſk our own hearts "whither are you wandering?"—But ſound philoſophy, reaſoning from effects to their cauſes, will here liſten to the words of our ſacred oracle: "By their fruits ye ſhall know them. Do men gather grapes of thorns, or figs of thiſtles?" The abſurd conſequences of the ſceptical philoſophy of Berkeley and Hume have been thought, by men of undoubted diſcernment, ſufficient reaſons for rejecting it without examination. The no leſs abſurd and ſhocking conſequences of the mechanical philoſophy now in vogue ſhould give us the ſame abhorrence; and ſhould make us abandon its blood-ſtained road, and return to the delightful paths of nature, to ſurvey the works of God, and feaſt our eyes with the diſplays of mind, which offer themſelves on every hand in deſigns of the moſt extenſive influence and the moſt beautiful contrivance. Following the guidance of heavenly wiſdom, we ſhall indeed find, that "all her ways are ways of pleaſantneſs, and all her paths are peace."

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[*] M. de la Metherie, editor of the *Journal de Phyſique*. See his prefaces to the volumes for 1792 and 1793, January and July.

Such is the ſcene of our obſervation, the ſubject of philoſophical ſtudy. Its extent is almoſt unbounded, reaching from an atom to God himſelf. It is abſolutely neceſſary for the ſucceſsful cultivation of this immenſe field of knowledge that it be committed to the care of different cultivators, and that its various portions be treated in different ways: and, accordingly, the various taſtes of men have given this curioſity different directions; and the ſtudy, like all other taſks, has been promoted by this diviſion of labour.

Some philoſophers have attended only to the appearances of fitneſs which are exhibited in every quarter of the univerſe; and by arranging theſe into different claſſes, and interpreting them as indications of thought and intention, have acquired the knowledge of many claſſes of ſentient and intelligent beings, actuated by propenſities, and directed by reaſon.

While the contemplation of theſe appearances indicates thought and deſign in any individual of one of theſe claſſes, and brings its propenſities and purpoſes of action, and the ends gained by theſe actions, into view, the contemplation of theſe propenſities, purpoſes, and ends, occaſions an inference of a much more general kind. All theſe intelligent beings give indications of knowledge and of power; but their knowledge bears, in general, no proportion to their power of producing changes in nature, and of attaining important ends; and their power is neither always, nor in the moſt important caſes, the conſequence of their knowledge. Where the effect of their actions is moſt eminently conducive to their important intereſts, the power of attaining theſe valuable ends is generally independent on any attention to the fitneſs of the means, and the exertion is frequently made without even thinking of the important end. The well-being of the individual is ſecured againſt any danger from its ignorance, indolence, or inattention, by an inſtinctive propenſity, which leads it to the performance of the neceſſary action, which is thus made immediately and ultimately deſirable, without any regard to its ultimate and important end. Thus, in our own nature, the ſupport of animal life, and the improvement of the means of ſubſiſtence by a knowledge of the objects which ſurround us, are not intruſted to our apprehenſions of the importance of theſe ends, but are committed to the ſurer guides of hunger and curioſity.

The ſame obſervers diſcover a connection between the individuals of a claſs, different from that which ariſes from the mere reſemblance of their external appearance, or even of their propenſities and purſuits: the very circumſtances which produced the claſſification. They obſerve, that theſe propenſities are ſuch, that while each individual ſeeks only its own enjoyment, theſe enjoyments are in general ſuch as contribute to the ſupport of the ſpecies and the enjoyment of other individuals. Thus, in the claſſes of animals, and in human nature, the continuance of the race, and the enjoyment of the whole, are not intruſted to the apprehenſion we entertain of the importance of theſe ends, but are produced by the operation of ſexual love and the love of ſociety.

The ſame obſervers find that even the *different* claſſes of ſentient beings are connected together; and while the whole of each claſs aim only at their own enjoyment, they contribute, in ſome way or other, to the well-being of the other claſſes. Even man, the ſelfiſh lord of this ſublunary world, is not the unconnected inhabitant of it. He cannot, in every inſtance, reap all the fruits of his ſituation, without contributing to the enjoyment of thouſands of the brute creation. Nay, it may be proved to the ſatisfaction of every intelligent man, that while one race of animals, in conſequence of its peculiar propenſities, ſubſiſts by the deſtruction of another, the ſum-total of animal life and enjoyment is prodigiouſly increaſed. See a very judicious diſſertation on this curious and puzzling ſubject, entitled *A Philoſophical Survey of the Animal Creation*; where it appears that the increaſe of animal life and enjoyment which is produced by this means, beyond what could poſſibly obtain without it, is beyond all conception. See likewiſe the laſt edition of *King's Origin of Evil*, by Dr. Law late biſhop of Carliſle.

Thus the whole aſſemblage ſeems connected, and jointly employed in increaſing the ſum-total of poſſible happineſs. This fitneſs of the various propenſities of ſentient and intelligent beings, this ſubſerviency to a general purpoſe, ſtrikes theſe obſervers as a mark of intention, evidently diſtinct from, and independent of, all the particular intentions, and ſuperior to them all; and thus it irreſiſtibly leads them to infer the exiſtence of a SUPREME MIND, directing the whole of this INTELLECTUAL SYSTEM, while the individuals of which it conſiſts appear the unconſcious inſtruments in the hand of a great Artiſt, with which he executes his grand and beneficent purpoſes.

But the obſervation goes yet further. The bodies of the inanimate creation are not only connected with each other by a mutual dependence of properties, and the relation of cauſation, but they are alſo connected with the ſentient beings by a ſubſerviency to their purpoſes of enjoyment. The philoſopher obſerves that this connection is admirably kept up by the conſtancy of natural operations, and the expectations of intelligent beings. Had either of theſe circumſtances been wanting, had either the operations of nature been without rule, or had ſentient beings no perception or expectation or their uniformity; the ſubſerviency would be totally at an end. This adjuſtment, this fitneſs, of which the effect is the enjoyment of the ſentient inhabitants of the univerſe, appear to be the effect of an intention of which this enjoyment is the final cauſe. This conſtancy therefore in the operations of nature, both in the intellectual and material world, and the concomitant expectation of ſentient beings, appear the effects of *laws* impoſed on the different parts of the univerſe by the Supreme Mind, who has formed both theſe claſſes of beings ſo admirably ſuited to each other.

To ſuch obſervers the world appears a WORK OF ART, a ſyſtem of means employed for gaining certain propoſed ends, and it carries the thoughts forward to an ARTIST; and we infer a degree of ſkill, power, and good intention in this Artiſt, proportioned to the ingenuity, extent, and happy effect which *we are able to diſcern* in his works. Such a contemplation of nature, therefore, terminates in NATURAL THEOLOGY, or the diſcovery of the exiſtence and attributes of GOD.

Our notions of this *Supreme Mind* are formed from the indications of deſign which we obſerve, and which we interpret in the ſame way as in the actions of men. Theſe notions, therefore, will differ from our notions of other minds only in the *degrees* which we *are able* to obſerve, and which we aſſign to theſe faculties; for the phenomenon or the effect is not only the mark, but alſo the meaſure, of its ſuppoſed cauſe. Theſe degrees muſt be aſcertained by our own capacity of appreciating the extent, the multiplicity, and the variety of the contrivance. Accordingly, the attributes of the Supreme Mind, in the theological creed of a rude Indian, are much more limited than in that of an European philoſopher. In proportion as our underſtandings are enlarged, and as our acquaintance with the operations of nature around us is extended, we ſhall perceive higher degrees of power, of ſkill, and of kind intention: and ſince we find that the ſcene of obſervation is unbounded, we cannot affix any boundaries to theſe attributes in our own imagination, and we are ready to ſuppoſe that they are infinite or unbounded *in their own nature*. When our attentive ſurvey of *this* univerſe, and a careful compariſon of all its parts, as far as we can underſtand or appreciate them, have made us conclude that it is *one* deſign, the work of *one Artiſt*; we are under the neceſſity of inferring, that, with reſpect to *this univerſe*, his power, wiſdom, and benevolence, are indeed infinite.

When men have been led to draw this concluſion from the appearances of fitneſs which are obſerved every where around them, they conſider that conſtancy which they obſerve in natural operations, whether in the material or the intellectual ſyſtem, and that expectation of, and confidence in, this conſtancy, which renders the univerſe a ſource of enjoyment to its ſentient inhabitants, as the conſequences of laws impoſed by the Almighty Artiſt on his works, in the ſame manner as they would conſider the conſtancy in the conduct of any people as the conſequences of laws promulgated and enforced by the ſupreme magiſtrate.

There can be no doubt of this view of nature being extremely captivating, and likely to engage the curioſity of ſpeculative men; and it is not ſurpriſing that the phenomena of mind have been keenly ſtudied in all ages. This part of the ſtudy of nature, like all others, was firſt cultivated in ſubſerviency to the wants of ſocial life; and the general laws of moral ſentiment were the firſt phenomena which were conſidered with attention. This gradually ripened into a regular ſyſtem of moral duty, accompanied by its congenial ſtudy, the inveſtigation or determination of the *ſummum bonum*, or the conſtituents of human felicity; and theſe two branches of intellectual ſcience were always kept in a ſtate of aſſociation by the philoſophers of antiquity. Juriſprudence, the ſcience of government, legiſlation, and police, were alſo firſt cultivated as arts, or at leaſt in immediate ſubſerviency to the demands of cultivated ſociety; and all theſe ſo nearly related parts of the ſtudy of human nature, had made a very conſiderable progreſs, in the form of maxims or precepts, for directing the conduct, before ſpeculative men, out of mere curioſity, treated them as ſubjects of philoſophical ſtudy. Our moral ſentiments, always involving a feeling of obligation, are expreſſed in a language much different from the uſual language of pure philoſophy, ſpeaking of things which *ought to be* rather than of things which *are*; and this diſtinction of language was increaſed by the very aim of the writers, which was generally to influence the conduct as well as the opinions of their ſcholars. It was reſerved for modern times to bring this ſtudy into the pure form of philoſophy, by a careful attention to the phenomena of moral ſentiment, and claſſing theſe according to their generality, and aſcertaining their reſpective ranks by an appeal to experiment, that is, to the general conduct of mankind: and thus it happens that in the modern treatiſes on ethics, juriſprudence, &c. there is leſs frequent reference made to the *officia* or duties, or to the conſtituents of the *ſummum bonum*, than among the ancients, and a more accurate deſcription of the human mind, and diſcrimination of its various moral feelings.

It was hardly poſſible to proceed far in theſe diſquiſitions without attending to the powers of the underſtanding. Differences of opinion were ſupported by reaſonings, or attempts to reaſoning. Both ſides could not be in the right, and there muſt be ſome court of appeals. Rules of argumentation behoved to be acquieſced in by both parties; and it could hardly eſcape the notice of ſome curious minds, that there were rules of truth and falſehood as well as of right and wrong. Thus the human *underſtanding* became an object of ſtudy, firſt in ſubſerviency to the demands of the moraliſts, but afterwards for its own ſake; and it gradually grew up into the ſcience of logic. Still further refinement produced the ſcience of metaphyſics, or the philoſophy of univerſals. But all theſe were *in fact* poſterior to the doctrines of morals; and diſquiſitions on beauty, the principles of taſte, the precepts of rhetoric and criticiſm, were the laſt additions to the ſtudy of the phenomena of mind. And now, ſince the world ſeems to have acquieſced in the mode of inveſtigation of general laws by experiment and obſervation, and to agree that this is all the knowledge that we can acquire of any ſubject whatever, it is to be expected that this branch of philoſophical diſcuſſion will attain the ſame degree of improvement (eſtimated by the coincidence of the doctrines with fact and experience) that has been attained by ſome others.

The occupations, however, of ordinary life have oftener directed our efforts towards material objects, and engaged our attention on their properties and relations; and as all ſciences have ariſen from arts, and were originally implied in the maxims and precepts of thoſe arts, till ſeparated from them by the curious ſpeculatiſt, the knowledge of the material ſyſtem of nature was poſſeſſed in detached ſcraps by the practitioners in the various arts of life long before the *natural philoſopher* thought of collecting them into a body of ſcientific doctrines. But there have not been wanting in all ages men of curioſity who have been ſtruck by the uniformity of the operations of nature in the material world, and were eager to diſcover their cauſes.

Accordingly, while the moraliſts and metaphyſicians turned their whole attention to the phenomena of mind, and have produced the ſciences of pneumatology, logic, ethics, juriſprudence, and natural theology, theſe obſervers of nature have found ſufficient employment in conſidering the phenomena of the material world.

The bodies of which it conſiſts are evidently connected by means of thoſe properties by which we obſerve that they produce changes in each other's ſituation. This aſſemblage of objects may therefore be juſtly called a ſyſtem. We may call it the MATERIAL SYSTEM. It is frequently termed NATURE; and the terms NATURAL APPEARANCES, NATURAL CAUSES, NATURAL LAWS, have been generally reſtricted to thoſe which take place in the material ſyſtem. This reſtriction, however, is improper, becauſe there is no difference in the manner in which we form our notions of thoſe laws, and reaſon from them, both with reſpect to mind and body. Or if there is to be any reſtriction, and if any part of the ſtudy of the univerſe is to be excluded in the application of theſe terms, it is that part only which conſiders moral obligation, and rather treats of what *ought to be* than of what *is*. As has been already obſerved, there is a conſiderable difference in the language which muſt be employed; but ſtill there is none in the principles of inveſtigation. We have no proof for the extent of any moral law but an appeal to the feelings of the hearts of men, indicated by the general laws or facts which are obſerved in their actions.

But this is only a queſtion of the propriety of language. And no great inconvenience would ariſe from the reſtriction now mentioned if it were ſcrupulouſly adhered to; but unfortunately this is not always the caſe. Some authors uſe the term natural *law* to expreſs *every* coincidence of fact; and this is certainly the proper uſe of the term. The French writers generally uſe the term *loi phyſique* in this enlarged ſenſe. But many authors, miſled by, or taking advantage of, the ambiguity of language, after having eſtabliſhed a law founded on a copious and perhaps unexcepted induction of the phenomena of the material ſyſtem (in which caſe it muſt be conſidered in its reſtricted ſenſe), have, in their explanation of phenomena, extended their principle much farther than the induction on which they had founded the exiſtence of the phyſical law. They have extended it to the phenomena of mind, and have led their followers into great and dangerous miſtakes. Languages, like every other production of human ſkill, are imperfect. They are deficient in terms, and therefore figurative. The moſt obvious, the moſt frequent, and the moſt intereſting uſes of language, have always produced the appropriated terms, and the progreſs of cultivation has never completely ſupplied new ones. There are certain analogies or reſemblances, or certain aſſociations of ideas, ſo plain, that a term appropriated to one very familiar object will ſerve to ſuggeſt another analogous to it, when aided by the concomitant circumſtances of the diſcourſe; and this with ſufficient preciſion for the ordinary purpoſes of ſocial communication, and without leading us into any conſiderable miſtakes: and it is only the rare and refined diſquiſitions of the curious ſpeculatiſt that bring the poverty and imperfection of language into view, and make us wiſh for words as numerous as our thoughts. There is hardly a ſentence, even of common diſcourſe, in which there are not ſeveral figures either of ſingle words or of phraſes; and when very accurate diſcrimination is required, it is almoſt impoſſible to find words or phraſes to expreſs diſtinctions which we clearly feel. We believe it impoſſible to expreſs, by the ſcanty vocabulary of the Hebrews, the nice diſtinctions of thought which are now familiar to the European philoſopher. In nothing does this imperfection of language appear ſo remarkably as in what relates to mind. Being a late ſubject of ſeparate diſcuſſion, and intereſting only to a few ſpeculatiſts, we have no appropriated vocabulary for it; and all our diſquiſitions concerning its operations are in continual metaphor or figure, depending on very ſlight analogies or reſemblances to the phenomena of the material world. This makes the utmoſt caution neceſſary; and it juſtifies the Britiſh philoſophers, who have been the moſt ſucceſsful in proſecuting the ſtudy of the intellectual ſyſtem, for having, almoſt without exception, reſtricted the terms natural laws, natural cauſes, natural philoſophy, and ſuch like, to the material ſyſtem. With us pneumatology makes no part of phyſics. And we may venture to affirm, that the ſciences have fared better by the reſtriction of the terms. In no country has the ſpirit of liberal diſcuſſion been more encouraged and indulged than in Britain; and her philoſophers have been equally eminent in both branches of ſcience. Their performances in ethics, juriſprudence, and natural theology, are conſidered by all our neighbours as the fountains of knowledge on theſe ſubjects; and Locke and Clarke are names no leſs familiar on the continent than Newton. The licentious and degrading doctrines of the Gallican ſchools have as yet made little impreſſion here; and man is ſtill conſidered among us as a glorious creature, born to, and fitted for, the nobleſt proſpects.

Phyſics, then, is with us the ſtudy of the material ſyſtem, including both natural hiſtory and philoſophy. The term is not indeed very familiar in our language; and in place of *phyſicus* and *diſciplina phyſica*, we more generally uſe the terms *naturaliſt* and *natural knowledge*. The term *natural philoſophy*, in its common acceptation, is of leſs extent. The field of phyſical inveſtigation is ſtill of prodigious extent; and its different quarters require very different treatments, make very different returns, and accordingly have engaged in their particular cultivation perſons of very different talents and taſtes. It is of ſome importance to perceive the diſtinctions, and to ſee how the wants and propenſities of men have led them into the different paths of inveſtigation; for, as has been more than once obſerved, all ſciences have ſprung from the humble arts of life, and both go on improving by means of a cloſe and conſtant correſpondence.

All the phenomena of the material ſyſtem may be arranged into two claſſes, diſtinguiſhed both by their objects and by the proper manner of treating them.

The firſt claſs comprehends all the appearances which are exhibited in the *ſenſible motions* of bodies, and their actions on each other producing *ſenſible motion*.

The ſecond claſs comprehends the appearances which are exhibited in the *inſenſible* motions and actions of the inviſible particles of matter.

Of the phenomena of the firſt claſs we have examples in the planetary motions, the motions of heavy bodies, the phenomena of impulſe, the motions and actions of machines, the preſſure and motions of fluids, the ſenſible actions of magnetical and electrical bodies, and the motions of light.

We have examples of the ſecond claſs in the phenomena of heat and mixture, and thoſe exhibited in the growth of animals and vegetables, and many phenomena of ſolid, fluid, magnetical, electrical, and luminous bodies, in which no change of place can be obſerved.

Thus it appears that there is a diſtinction in the phenomena ſufficiently great to warrant a diviſion of the ſtudy, and to make us expect a more rapid improvement by this diviſion. Nay, the diviſion has been made by nature herſelf, in the acquaintance which men have attained with her operations without ſtudy, before ſcience appeared, and while art conſtituted all our knowledge.

Before man had recourſe to agriculture as the moſt certain means of procuring ſubſiſtence, our acquaintance with external ſubſtances was principally that of the natural hiſtorian; conſiſting of a knowledge of their fitneſs for food, medicine, or accommodation, their places of growth or habitation, and the means of procuring them, depending on their manner of life or exiſtence. It required a ſtudied attention to theſe circumſtances to give riſe to agriculture, which therefore generally made its appearance after men had been in the practice of keeping flocks; by which means they were more at their eaſe, and had ſome leiſure to attend to the objects around them, and in particular to thoſe circumſtances of ſoil and weather which affected the growth of their paſture.

When agriculture and a rude medicine were thus eſtabliſhed, they were the firſt *arts* which had their foundation in a *ſyſtem of laws*, by which the operations of nature were obſerved to be regulated; and with theſe arts we may begin the *general ſtudy of nature*, which was thus divided into two different branches.

The rude phyſician would be at firſt a collector of *ſpecifics*; but by degrees he would obſerve reſemblances among the *operations* of his drugs, and would claſs them according to theſe reſemblances. He would thus come to attend leſs to the drug than to its mode of operation; and would naturally ſpeculate concerning the connection between the operation and the economy of animal life. His art now becomes a ſcientific ſyſtem, connected by principle and theory, all proceeding on the obſervation of changes produced by one kind of matter on another, but all out of ſight. The frequent recourſe to the vegetable kingdom for medicines would cauſe him to attend much more minutely to the few plants which he has occaſion to ſtudy than the huſbandman can do to the multitude he is obliged to rear. The phyſician muſt learn to think, the huſbandman to work. An analogy between the economy of animal and vegetable life could hardly fail to engage the attention of the phyſician, and would make him a botaniſt, both as a claſſifier of plants and as a philoſopher.

He would naturally expect to unite the ſervices of his drugs by combining them in his recipes, and would be ſurpriſed at his diſappointments. Curious and unexpected changes would frequently occur in his manipulations: the ſenſible qualities, and even the external appearances of his ſimples, would be often changed, and even inverted by their mixture; and their medicinal properties would frequently vaniſh from the compound, and new ones be introduced. Theſe are curious, and to him intereſting facts; and he would naturally be inquiſitive after the principles which regulate theſe changes. His ſkill in this would by degrees extend beyond the immediate uſe for the knowledge; and the more curious ſpeculatiſt would lay the foundations of a moſt extenſive and important ſcience, comprehending all the phenomena of heat and mixture.

Along with this, and ſpringing from the ſame ſource, another ſcience muſt ariſe, contemplating the appearances of animal and vegetable life, and founded on a careful obſervation and accurate deſcription of the wonderful machine. The moſt incurious of men have in all ages been affected by the diſplays of wiſdom and contrivance in the bodies of animals, and immediately engaged in inveſtigation into the uſes and functions of their various parts and organs. The phenomena have been gradually diſcriminated and arranged under the various heads of nutrition, concoction, ſecretion, abſorption, aſſimilation, rejection, growth, life, decay, diſeaſe, and death; and, in conformity to the doctrines which have with greater or leſs evidence been eſtabliſhed on theſe ſubjects, the action of medicines, and the whole practice of phyſic and ſurgery, has been eſtabliſhed in the form of a liberal or ſcientific art.

The huſbandman in the mean time muſt labour the ground which lies before him. He too is greatly intereſted in the knowledge of the vegetable economy, and forms ſome ſyſtems on the ſubject by which he regulates his labours: but he ſees, that whatever is the nature of vegetable life, he muſt work hard, and he ſearches about for every thing which can tend to diminiſh his labour. The properties of the lever, the wedge, and the inclined plane, ſoon become familiar to him; and without being able to tell on what their efficacy depends, he uſes them with a certain ſagacity and effect. The ſtrength of timber, the preſſure and force of water, are daily ſeen and employed by him and other artiſans who labour for their mutual accommodation; and ſome rude principles on theſe ſubjects are committed to memory. Many tools and ſimple machines are by this time familiar; and thus the *general* properties of matter, and the general laws of the action of bodies on each other, become gradually matter of obſervation and reflection: and the practical mechanic will be frequently improving his tools and machines. The general aim is to produce a greater quantity of work by the ſame exertion. The attempts to improvement will be aukward, and frequently unſucceſsful. When a man finds, that by increaſing the length of his lever he increaſes his power of overcoming a reſiſtance, a ſmall degree of curioſity is ſufficient to make him inquire in what proportion his advantage increaſes. When he finds that a double length gives him a double energy, he will be ſurpriſed and mortified to find, that at the end of the day he has not performed twice the quantity of work: but, after much experience, he will learn that every increaſe of energy, by means of a machine, is nearly compenſated by an increaſe of time in the performance of his taſk; and thus one of the great and leading principles of practical mechanics was inculcated in a manner not to be forgotten, and the practical mechanic was brought to ſpeculate about motion and force, and by gradual and eaſy ſteps the general laws of ſimple motions were eſtabliſhed.

It is evident that theſe ſpeculations cannot be carried on, nor any conſiderable knowledge acquired, without ſome acquaintance with the art of meaſurement: and the very queſtions which the mechanic wiſhes to ſolve, preſuppoſe ſome advances in this art, which in proceſs of time refined itſelf into mathematics, the moſt perfect of all the ſciences. All the phenomena of ſenſible motion afford employment to the mathematician. It is performed in a double or triple time, through a double or triple ſpace, by a double or triple body, by the exertion of a double or triple force, produces a double or triple effect, is more to the right or to the left, upwards or downwards, &c. In ſhort, every affection of motion is an object of mathematical diſcuſſion. Such a ſcience muſt have appeared ere now in the form of an art, in conſequence of the mutual tranſactions of men. Theſe among an uncultivated people are chiefly in the way of barter. If I want corn from a peaſant, and have nothing to give for it but the cloth which I have made, we muſt fall on ſome way of adjuſting our terms in reſpect of the quantity. We ſhould ſoon diſcover that the length and breadth, and depth, of the box or bag were equally important; and it was not difficult to ſee, that if any of them were doubled or tripled, the quantity of grain would be ſo too; if two of them were doubled, the grain would be quadrupled; and if all the three were doubled, the quantity of grain would be increaſed eight times: the ſame thing would be obſerved with reſpect to my cloth. By ſuch tranſactions as theſe, a few of the properties of plane and ſolid numbers and figures would become known, and the operations of multiplication and diviſion, where arithmetic is combined with geometry: and daily obſervation ſhows us, that the more abſtruſe properties of number and figure, which to the generality of mankind are ſo inſignificant, lay hold on the fancy of ſome individuals with ſuch force, as to abſtract them from every other intellectual entertainment, and are ſtudied with a keenneſs and perſeverance almoſt unequalled in any other walk of ſcience. To moſt men the performance of a machine is a more attractive object than the properties of a figure, and the property of a figure more entertaining than that of a number; but the fact ſeems to have been otherwiſe.

Before Pythagoras had invented the theorem that bears his name (ſee Philosophy, Vol. VII. page 768, and note †), and which is among the firſt elements of geometry, he had reformed the Grecian muſic by the addition of a note to their ſcale, and this addition proceeds on a very refined ſpeculation on the properties of numbers; ſo that among the Greeks arithmetic muſt have made conſiderable progreſs, while geometry was yet in its cradle: and we know to what aſtoniſhing length they proſecuted the ſcience of pure geometry, while their knowledge of mechanical principles was almoſt nothing. Alſo the Arabs hardly made any addition to the geometry of the Greeks, if they did not rather almoſt completely forget it; whilſt they improved their arithmetic into algebra, the moſt refined and abſtracted branch of human knowledge. There is ſuch a diſtance, in point of ſimplicity, between pure mathematics and the moſt elementary mechanics, that the former continued to make rapid ſteps to improvement in more modern times, while the latter languiſhed in its infancy, and hardly deſerved the name of ſcience till very lately, when the great demand for it, by the increaſe and improvement in manufactures, both intereſted many in the ſtudy, and facilitated its progreſs, by the multitude of machines which were contriving on all hands by the manufacturers and artiſans: and even at preſent it muſt be acknowledged, that it is to them that we are indebted for almoſt every new invention in mechanics, and that the ſpeculatiſt ſeldom has done more than improve the invention, by exhibiting its principles, and thus enabling the artiſt to correct its imperfections; and now ſcience and art go hand in hand, mutually giving and receiving aſſiſtance. The demands of the navigator for mathematical and aſtronomical knowledge have dignified theſe ſciences; and they are no longer the means of elegant amuſement alone, but merit the munificence of princes, who have erected obſervatories, and furniſhed voyages of diſcovery, where the mathematical ſciences are at the ſame time cheriſhed and applied to the moſt important purpoſes.

This ſhort ſketch of what may be called *the natural hiſtory of phyſical ſciences* will not, we hope, be thought improper or unprofitable. It tends to confirm an aſſertion often alluded to, that the proſecution of the ſtudy of nature will be more ſucceſsful, if we imitate her mode of proceeding, and divide the labour. It will be ſtill further confirmed by attending to the ſcientific difference of the phenomena, which marks out a different mode of proceeding, and a difference in the knowledge which we ſhall ultimately acquire, after our moſt ſucceſsful reſearches.

In both claſſes of phenomena already diſtinguiſhed we muſt grant, that the principle which connects the pairs of concomitant events, rendering the one the inſeparable companion of the other, is totally unknown to us, becauſe it is not the immediate object of our perception.

But in the phenomena of the firſt claſs, we ſee the *immediate* exertion of this principle, whatever it may be; we can obſerve the exertion with accuracy; we can determine its kind and degree, which are the ſigns and meaſures of the kind and degree of the unperceived cauſe. This exertion, being always ſome modification of motion, allows us to call in the aid of mathematical knowledge, and thus to aſcertain with the preciſion peculiar to that ſcience the energy of the cauſe, judging of the tendency and quantity by the tendency and the quantity of the obſerved effect.

But in the ſecond claſs of phenomena the caſe is very different. In the operations of chemiſtry, for inſtance, the *immediate* exertion of the cauſe is not perceived: all that we obſerve is the aſſemblage of particles which obtains before mixture, and that which takes place when it is completed, and which we conſider as its reſult. The procedure of nature in producing the change is unſeen and unknown. The ſteps are hid from our obſervation. We are not only ignorant of the cauſe which determines one particle of our food to become a part of our body while others are rejected, but we do not ſee the operation. We are not only ignorant of the cauſe which determines a particle of vitriolic acid to quit the foſſil alkali with which it is united in Glauber ſalt, and to attach itſelf to a particle of magneſia already united with the muriatic acid, which alſo quits it to unite with the alkali, but we do not ſee the operation. The particles and their motions are not the objects of our ſenſes; and all that we ſee is the Epſom ſalt and common ſalt ſeparated from the water in which we had formerly diſſolved the ſal mirabile and the muriated magneſia. The motions, which are the *immediate* effects of the changing cauſes, and therefore their *only indications, characteriſtics, and meaſures*, fitted to ſhow their nature, are hid from our view.

Our knowledge therefore of theſe phenomena muſt be leſs perfect than that of the phenomena of the former claſs; and we muſt here content ourſelves with the diſcovery of more remote relations and remote cauſes, and with our ignorance of the very powers of nature by which theſe changes are brought about, and which are cognoſcible only by their immediate effects, *viz.* the motions which they produce unſeen. The knowledge which we do really acquire is ſomewhat ſimilar to what the mechanical philoſopher has acquired when he has diſcovered, by many experiments and inveſtigations, that magnets attract each other by their diſſimilar poles, and repel each other by their ſimilar poles, and do not act at all on any bodies but loadſtones and iron. Here we leave undiſcovered all that is moſt curious in the phenomenon, *viz.* how theſe attractions and repulſions are produced; and even here the magnetical philoſopher has the advantage of ſeeing the agents and the operation.

But philoſophers attending to this circumſtance, that, even in theſe caſes, the changes are produced by motions, or conſiſt in motions, however unperceived theſe may be, have concluded, that the laws according to which nature operates in producing theſe changes are ſimilar to the laws which regulate her operations in the ſenſible actions of bodies, or are included in them; and that the motions, though unſeen, and the moving forces, are perfectly ſimilar. They have therefore employed ſimilar modes of inveſtigation, applying the laws of impulſe, and calling in the aid of mathematical knowledge.

Of this we have many examples in the writings of Dr. Freind, Keil, Bernoulli, Helſham, Boerhaave, Hartley, and others, who have delivered theories of fermentation, ſolution, precipitation, cryſtallization, nutrition, ſecretion, muſcular action, nay even of ſenſation and intelligence, founded, as they think, on the laws of motion, and illuſtrated and ſupported by mathematical reaſoning. Lord Bacon himſelf, that careful and ſagacious diſtinguiſher of intellectual operations, has gone into the ſame track in his explanation of the phenomena of fire and combuſtion: and Sir Iſaac Newton has made ſeveral attempts of the ſame kind, although with peculiarities which always characteriſe his diſcuſſions, and make them very different from thoſe of an inferior claſs.

But the ſucceſs of theſe philoſophers has hitherto been very diſcouraging: indeed they had no title to expect any; for their whole trains of reaſoning have proceeded on analogies which were not obſerved, but aſſumed or *ſuppoſed* without any authority. There is not that ſimilarity in the phenomenon, or in the viſible effect, which is abſolutely neceſſary for a ſucceſsful reaſoning by analogy. We do not obſerve any local motion, any change of place, which alone enables us to reaſon mathematically on the ſubject. And to make the caſe deſperate, this ill-founded analogy has been mixed with hypotheſes completely gratuitous. Certain forms have been aſſigned to the particles, and certain modes of action have been laid down from them, for whoſe reality we have not the leaſt argument or indication: and to complete the matter, theſe fancied forms and laws of action have been ſuch as are either ſelf-contradictory and inconſiſtent, or they have been ſuch as, if allowed to act in a way analogous to what we obſerve in the ſenſible motions of bodies, would produce effects totally different from thoſe which are obſerved. Theſe atomical theories, as they are called, tranſgreſs every rule of philoſophical diſcuſſion, and even the beſt of them are little better than trifling amuſements. By far the greateſt part of them only ſerve to raiſe a ſmile of pity and contempt in every perſon at all acquainted with mechanical philoſophy. Whenever we ſee an author attempting to explain theſe hidden operations of nature by inviſible fluids, by æthers, by colliſions, and vibrations, and particularly if we ſee him introducing mathematical reaſonings into ſuch explanations—the beſt thing we can do is to ſhut the book, and take to ſome other ſubject. That we may not be thought to ſpeak preſumptuouſly on this occaſion, we only beg leave to remind our readers, that the united knowledge of the moſt eminent mathematicians of Europe has not yet been able to give any thing more than an approximation to the ſolution of the problem of three bodies; that is, to determine with accuracy the motions of three particles of matter acting on each other in the ſimpleſt of all poſſible manners, *viz.* by forces varying as the ſquares of the diſtances inverſely: and the vibrations of elaſtic bodies, of any but the very ſimpleſt poſſible forms, are to this day beyond the reach of inveſtigation. What then ſhould be our expectations in caſes where millions of particles are acting at once, of forms unobſerved, and with forces unknown, and where the object is not a determination of an average reſult of many, where the preciſe ſtate of an individual particle need not be known, but where it is this very preciſe ſtate of each ſingle particle that we want to know? What can it be but uncertainty and miſtake?

Notwithſtanding theſe diſcouraging circumſtances, we muſt obſerve that this kind of inquiry has greatly improved of late years, along with the improvement and extenſion of mathematical philoſophy, and ſince philoſophers have given over their inceſſant attempts to explain every thing by impulſe; and we need not deſpair of making ſtill farther advances, if we will content ourſelves with going no farther than Newton has done in his explanation of the planetary motions. He has immortalized his own name, and has added immenſely to our ſtock of uſeful knowledge; yet he has ſtopped ſhort at the diſcovery of the fact of univerſal gravitation; and all who have endeavoured to explain or account for this fact have only expoſed themſelves to pity. We may perhaps be one day able to demonſtrate from the phenomena that the particles of matter have certain mutual tendencies to or from each other, exerted according to fixed or invaried rules; and from theſe tendencies we may be able to explain many other phenomena, and predict the conſequences, with as much certainty and evidence as an aſtronomer calculates a future eclipſe. This would be a great acquiſition, and perhaps more is impoſſible: and the road to this has been hinted by Sir Iſaac Newton, who has expreſſed his ſuſpicion, that as the great movements of the ſolar ſyſtem are regulated by univerſal gravitation, ſo the mutual actions of the particles of matter are produced and regulated by tendencies of a ſimilar kind, *equally* but not *more* inexplicable, and of which the laws of action are to be diſcovered by as careful an attention to the phenomena, and by the ſame patient thinking, which he has employed on the planetary motions. And a beautiful introduction to this new and almoſt unbounded field of inquiry has been given us by the celebrated Abbé Boſcovich, in his Theory of Natural Philoſophy, where he has ſhown how ſuch mutual tendencies, ſimilar in every ultimate particle of matter, and modified by conditions that are highly probable, nay almoſt demonſtrable, will not only produce the ſenſible forms of ſolidity, hardneſs, elaſticity, ductility, fluidity, and vapour, under an inconceivable variety of ſubordinate appearances, and the obſerved laws of ſenſible motion, but will go far to explain the phenomena of fuſion, congelation, ſolution, cryſtallization, &c. &c. &c. both in chemiſtry and phyſiology. We earneſtly recommend this work to the peruſal of all who wiſh to obtain a diſtinct notion of the internal conſtitution of natural bodies, and of the way in which the uniting forces produce their ultimate and ſenſible effects. Any perſon, poſſeſſed of a moderate ſhare of mathematical knowledge, will be convinced that the proceſs of nature is not very different from what he deſcribes; and that much of what we obſerve muſt happen as he ſays, even although the ultimate atoms of matter are not in extended mathematical points, accompanied with attracting and repelling forces.

But we have many ſteps to make before we begin this ſtudy: Nature opens to us an immenſe volume; and we doubt not that our poſterity will long find employment in the peruſal, even though advancing with the eagerneſs and ſucceſs of the laſt century. We have not yet arrived at the threſhold in many parts of this reſearch: In many parts of chemiſty, for inſtance, we are as yet uncertain with reſpect to the phenomena themſelves, which are to be the ſubjects of this diſcuſſion. The compoſition of bodies muſt be fully underſtood before we begin to ſpeak of the forces which unite their particles, or ſpeculate about their modes of action. As long as water was conſidered as an element, we were ignorant of the forces inherent in its particles; we are perhaps ſtill ignorant of this; but we now know that they are extremely different from what we formerly ſuppoſed them to be. It is but in a very few, if in any, caſes of chemical combination, that we even know what are the ingredients: till we know this, it is too ſoon to ſpeculate about their mode of union. Our ignorance in the real events in the animal and vegetable economy is ſtill greater. Our firſt taſk therefore is to proceed, as we are now doing, in the accurate examination and claſſification of the phenomena themſelves; and, without attempting to bring them within the pale of mathematical philoſophy, by attempting what are called mechanical explanations, let us give up the conſideration of theſe hidden operations, and augment to the utmoſt our liſt of ſecondary laws of viſible but remote connections. All the mechanical ſpeculations of the honourable Robert Boyle about the ſenſible qualities of things are now forgotten; but his chemical experiments preſerve all their value, and are frequently referred to. The ſame may be ſaid of the ſagacious Dr. Hales, whoſe fanciful notions of internal conflicts, and colliſions, and vibrations, derogate nothing from the value of the curious facts which he has eſtabliſhed both in the animal and vegetable economy.

This diſtinction in the nature of the phenomena, and this difference in the nature of the knowledge which is to be acquired, and the means which are to be employed for the ſucceſsful proſecution of theſe two branches of general phyſics, has occaſioned a ſtill farther reſtriction (at leaſt in Britain) of the term NATURAL PHILOSOPHY. It is particularly applied to the ſtudy of the phenomena of the firſt claſs, while thoſe of the ſecond have produced the ſciences of CHEMISTRY and PHYSIOLOGY.

Natural philoſophy and chemiſtry have generally been made particular inſtitutions in our ſeminaries of learning, but phyſiology has more commonly been taught in conjunction with anatomy, medicine, and botany.

The phenomena of the firſt claſs have been uſually called MECHANICAL, in order to diſtinguiſh them from thoſe obſerved in the operations of chemiſtry, and in the animal and vegetable economy; and the explanations which have been attempted of ſome of the laſt, by applying the laws obſerved in the phenomena of the firſt claſs, have been called *mechanical explanations*.

As this firſt claſs is evidently but a part of general phyſics, there is ſome impropriety in giving the name *natural philoſophy* to a courſe of doctrines which is confined to theſe alone. Indeed at the firſt inſtitution of univerſities, the lectures given in the *Schola Phyſica* were much more extenſive, comprehending almoſt all the phenomena of the material world: but as all arts and ſciences have improved moſt where the labour has been moſt divided, it was found more conducive to the advancement of knowledge that ſeparate inſtitutions ſhould be founded for the ſtudies of natural hiſtory, chemiſtry, phyſiology, &c; and thus the phenomena, purely mechanical, and a few others in magnetiſm, electricity, and optics, which either were ſuſceptible of mathematical treatment, or had little connection with the ſtudies of chemiſtry and phyſiology, were left to the care of the profeſſor of natural philoſophy.

As the terms *chemiſtry* and *phyſiology* have been applied to two very important branches of general phyſics, we think that a more ſpecific or characteriſtic name might be appropriated to the other, and that it might very properly be termed MECHANICAL PHILOSOPHY.

It only remains to make a few obſervations on the diſtinctive means of proſecuting theſe ſtudies with ſucceſs, and to point out ſome of the advantages which may reaſonably be expected from a careful proſecution of them: and as the ſecond branch has been fully treated under the ſeveral articles of CHEMISTRY, PHYSIOLOGY, &c. we ſhall confine ourſelves to what is uſually called NATURAL PHILOSOPHY.

MECHANICAL PHILOSOPHY may, in conformity with the foregoing obſervations, be defined, "the ſtudy of the ſenſible motions of the bodies of the univerſe, and of their actions producing ſenſible motions, with the view to diſcover their cauſes, to explain ſubordinate phenomena, and to improve art."

The principle upon which all philoſophical diſcuſſion proceeds is, that *every change which we obſerve in the condition of things is conſidered by us as an effect, indicating the agency, characteriſing the kind, and meaſuring the degree of its cauſe.*

In the language of mechanical philoſophy, the cauſe of any change of motion is called a moving or changing FORCE.

The diſquiſitions of natural philoſophy muſt therefore begin with the conſideration of motion, carefully noticing every affection or quality of it, ſo as to eſtabliſh marks and meaſures of every change of which it is ſuſceptible; for theſe are the only marks and meaſures of the changing forces. This being done, it only remains to apply them to the motions which we obſerve in the univerſe.

From the general principle of philoſophical diſcuſſion already mentioned, there flow directly two axioms.

1. *Every body perſeveres in a ſtate of reſt or of uniform rectilineal motion, unleſs affected by ſome moving force.*

2. *Every change of motion is in the direction and in the degree of the force impreſſed.*

Theſe are uſually called the LAWS OF MOTION. They are more properly laws of human judgment, with reſpect to motion. Perhaps they are neceſſary truths, unleſs it be alleged that the general principle, of which they are neceſſary conſequences, is itſelf a contingent though univerſal truth.

By theſe two axioms, applied *in abſtracto* to every variety of motion, we eſtabliſh a ſyſtem of general doctrines concerning motions, according as they are ſimple or compounded, accelerated, retarded, rectilineal, curvilineal, in ſingle bodies; or in ſyſtems of connected bodies; and we obtain correſponding characteriſtics and meaſures of accelerating or retarding forces, centripetal or centrifugal, ſimple or compound.

We have an illuſtrious example of this abſtract ſyſtem of motion and moving forces in the firſt book of Sir Iſaac Newton's Mathematical Principles of Natural Philoſophy. Euler's *Mechanica ſive Scientia Motus*, Herman's *Phoronomia ſive de Viribus Corporum*, and D'Alembert's *Traité de Dynamique*, are alſo excellent works of the ſame kind. In this abſtract ſyſtem no regard is paid to the caſual differences of moving forces, or the ſources from which they ariſe. It is enough to characteriſe a double accelerating force, for inſtance, that it produces a double acceleration. It may be a weight, a ſtream of water, the preſſure of a man; and the force, of which it is ſaid to be double, may be the attraction of a magnet, a current of air, or the action of a ſpring.

Having eſtabliſhed theſe general doctrines, the philoſopher now applies them to the *general* phenomena of the univerſe, in order to diſcover the nature of the forces which really exiſt, and the laws by which their operations are regulated, and to explain intereſting but ſubordinate phenomena. This is the chief buſineſs of the mechanical philoſopher; and it may with ſome propriety be called *the mechanical hiſtory of nature.*

Some method muſt be followed in this hiſtory of mechanical nature. The phenomena muſt be claſſed by means of their reſemblances, which infer a reſemblance in their cauſes, and theſe claſſes muſt be arranged according to ſome principle. We have ſeen no method which appears to us leſs exceptionable than the following.

The principle of arrangement is the generality of the phenomena: and the propriety of adopting this principle ariſes from the probability which it gives us of more readily diſcovering the moſt general actuating forces, whoſe agency is implicated in all other phenomena of leſs extent; and therefore ſhould be previouſly diſcuſſed, that we may detect the diſcriminating circumſtances which ſerve to characteriſe the ſubordinate phenomena, and are thus the marks of the diſtinguiſhing and inferior natural powers.

The moſt general of all phenomena is the curvilineal motion of bodies in free ſpace; it is obſerved through the whole extent of the ſolar ſyſtem.

The mechanical hiſtory of nature begins therefore with aſtronomy. Here, from the general phenomena of the planetary motions, is evinced the *fact* of the mutual deflection of every body towards every other body, and this in the inverſe proportion of the ſquares of the diſtance, and the direct proportion of the quantity of matter. This is the fact of UNIVERSAL GRAVITATION, indicating the agency, and meaſuring the intenſity, of the univerſal force of mutual gravity.

Having eſtabliſhed this as an univerſal fact, the natural philoſopher proceeds to point out all the particular facts which are comprehended under it, and whoſe peculiarities characteriſe the different movements of the ſolar ſyſtem. That is, in the language of philoſophy, he gives a theory or explanation of the ſubordinate phenomena; the elliptical motions of the planets and comets, their mutual diſturbances; the lunar irregularities; the oblate figure of the planets; the nutation of the earth's axis; the preciſion of the equinoxes; and the phenomena of the tides and trade-winds: and he concludes with the theory of the parabolic motion of bodies projected on the ſurface of this globe, and the motion of pendulums.

As he goes along, he takes notice of the applications which may be made to the arts of life of the various doctrines which are ſucceſſively eſtabliſhed; ſuch as chronology, aſtronomical calculation, dialling, navigation, gunnery, and the meaſuring of time.

If a ſquare parcel of ſand be lying on the table, and the finger be applied to any part of it to puſh it along the table, that part is removed where you will, but the reſt remains in its place; but if it is a piece of ſand-ſtone of the ſame materials and ſhape, and the finger is applied as before, the whole is moved; the other parts accompany the part impelled by the finger in all its motions.

From the moon's accompanying the earth in all its motions round the ſun, we infer a moving force which connects the moon and earth. In like manner, we muſt conclude that a moving force connects the particles of the ſtone; for we give the name *force* to every thing which produces motion: we call it the force of COHESION; a term which, like gravitation, expreſſes merely a fact.

This ſeems to be the next phenomenon of the univerſe in point of extent.

Having, from the general phenomenon, eſtabliſhed the exiſtence of this force, the philoſopher proceeds to aſcertain the laws by which its exertions are regulated; which is the aſcertaining its diſtinctive nature and properties. This he does in the ſame way that he aſcertained the nature of planetary gravitation, *viz.* by obſerving more particularly the various phenomena.

Here is opened a moſt extenſive and varied field of obſervation, in which it muſt be acknowledged that very little regular and marked progreſs has been made. The variety in the phenomena, and the conſequent variety in the nature of the connecting forces, appear as yet inconceivably great; and there ſeems little probability of our being able to detect in them all any ſameneſs, combined with the other diſtinguiſhing circumſtances, as we have done in the caſe of gravity. Yet we ſhould not deſpair. Boſcovich has ſhown, in the moſt unexceptionable manner, that although we ſhall ſuppoſe that every atom of matter is endued with a perfectly ſimilar force, acting in a certain determined ratio of the ſmall and imperceptible diſtances at which the particles of matter are arranged with reſpect to each other, the external or ſenſible appearances may, and muſt, have all that variety which we obſerve. He alſo ſhows very diſtinctly how, from the operation of this force, muſt ariſe ſome of the moſt general and important phenomena which characteriſe the different forms of tangible bodies.

We obſerve the chief varieties of the action of this CORPUSCULAR force on the bodies which we denominate *hard, ſoft, ſolid, fluid, vaporous, brittle, ductile, elaſtic*. We ſee inſtances where the parts of bodies avoid each other, and require external force to keep them together, or at certain ſmall diſtances from each other. This is familiar in air, vapours, and all compreſſible and elaſtic bodies.

This is evidently a moſt curious and intereſting ſubject of inveſtigation. On the nature and action of theſe corpuſcular forces depend the ſtrength or firmneſs of ſolids, their elaſticity, their power of communicating motion, the preſſure, and motion, and impulſe of fluids; nay, on the ſame actions depend all the chemical and phyſiological phenomena of expanſion, fuſion, congelation, vaporiſation, condenſation, ſolution, precipitation, abſorption, ſecretion, fermentation, and animal and vegetable concoction and aſſimilation.

Out of this immenſe ſtore of phenomena, this inexhauſtible fund of employment for our powers of inveſtigation, the natural philoſopher ſelects thoſe which lead directly to the production or modification of ſenſible motion.

He will therefore conſider,

1. The communication of motion among detached and free bodies, eſtabliſhing the laws of impulſe or colliſion. This has always been conſidered as the elementary doctrine of mechanical philoſophy, and as the moſt familiar fact obſerved in the material world; and in all ages philoſophers have been anxious to reduce all actions of bodies on each other to impulſe, and have never thought a phenomenon completely explained or accounted for till it has been ſhown to be a caſe of impulſe. This it is which has given riſe to the hypotheſes of vortices, ethers, magnetic and electric fluids, animal ſpirits, and a multitude of fancied intermediums between the ſenſible maſſes of matter, which are ſaid in common language to act on each other. A heavy body is ſuppoſed to fall, becauſe it is impelled by a ſtream of an inviſible fluid moving according to certain conditions ſuited to the caſe. The filings of iron are ſuppoſed to be arranged round a magnet, by means of a ſtream of magnetic fluid iſſuing from one pole, circulating perpetually round the magnet, and entering at the other pole, in the ſame manner as we obſerve the flote-graſs arranged by the current of a brook.

But the philoſopher who has begun the mechanical ſtudy of nature by the abſtract doctrines of dynamics, and made its firſt application to the celeſtial phenomena, and who has attended carefully to the many analogies between the phenomena of gravitation and coheſion, will be at leaſt ready to entertain very different notions of this matter. He will be ſo far from thinking that the production of motion by impulſe is the moſt familiar fact in nature, that he will acknowledge it to be comparatively very rare; nay, there are ſome appearances in the facts which are uſually conſidered as inſtances of impulſion, which will lead him to doubt, and almoſt to deny, that there has *ever been obſerved* an inſtance of one body putting another in motion by coming into abſolute contact with it, and ſtriking it; and he will be diſpoſed to think that the production of motion in this caſe is preciſely ſimilar to what we obſerve when we gently puſh one floating magnet towards another, with their ſimilar poles fronting each other. There will be the ſame production of motion in the one and diminution of it in the other, and the ſame uniform motion of the common centre of gravity: and, in this caſe of the magnets, he ſees completely the neceſſity of a law of motion, which is not an axiom, but is obſerved through the whole of nature, and which receives no explanation from any hypotheſis of an intervening fluid, but is even totally inconſiſtent with them. We mean, "that every action of one body on another is accompanied by an equal and oppoſite action of that other on the firſt." This is uſually called the *equality of action and reaction*: it is not intuitive, but it is univerſal; and it is a neceſſary conſequence of the perfect ſimilarity of the corpuſcular forces of the ſame kinds of matter. This general fact, unaccountable on the hypotheſis of impelling fluids, is conſidered in the planetary motions as the unequivocal indication of the ſameneſs of that gravity which regulates them all. The rules of good reaſoning ſhould make us draw the ſame concluſion here, that the particles of tangible matter are connected by equal and mutual forces, which are the *immediate cauſes* of all their ſenſible actions, and that theſe forces, like gravitation, vary with every change of diſtance and ſituation.

The laws of colliſion and impulſion being now eſtabliſhed, either as original facts or as conſequences of the agency of equal and mutual force which connect the particles of matter, the philoſopher conſiders,

2. The production of motion by the intervention of ſolid bodies, where, by reaſon of the coheſion of matter, ſome of the motions are neceſſarily confined to certain determinate paths or directions. This is the caſe in all motions round fixed points or axes, or along planes or curves which are oblique to the action of the forces.

This part of the ſtudy contains the theory of machines, pointing out the principles on which their energy depends, and conſequently furniſhing maxims for their conſtruction and improvement. But theſe obſervations do not complete the diſcuſſion of the mechaniſm of ſolid bodies: they are not only ſolid and inert, but they are alſo heavy; therefore the action of gravity muſt be combined with the conſequences of ſolidity. This will lead to diſcuſſions about the centre of gravity, the theory and conſtruction of arches and roofs, the principles of ſtability and equilibrium, the attitudes of animals, and many particulars of this kind.

3. The philoſopher will now turn his attention to another form, in which tangible matter exhibits many intereſting phenomena, *viz.* FLUIDITY. The firſt thing to be attended to here is, *What is that particular form of exiſtence?* What is the preciſe phenomenon which characteriſes fluidity? What is the definition of a fluid? This is by no means an eaſy queſtion, and conſiderable objections may be ſtated againſt any definition that has been given of it. Sir Iſaac Newton ſays, that *a fluid is a body whoſe particles yield to the ſmalleſt impreſſion, and by ſo yielding are eaſily moved among themſelves.* It may be doubted whether this be ſufficiently preciſe; what is meant by the *ſmalleſt impreſſion?* and what is *eaſily* moving? Is there any preciſe degree of impreſſion to which they do not yield; and do they oppoſe any reſiſtance to motion? And a ſtronger objection may be made. It is not clear that a body ſo conſtituted will exhibit all the appearances which a body acknowledged to be fluid does really exhibit. Euler offers ſome very plauſible reaſons for doubting whether it will account for the horizontal ſurface, and the complete propagation of preſſure through the fluid in every direction; and therefore prefers ſelecting *this laſt phenomenon*, the propagation of preſſure *quaqua-verſum*, as the characteriſtic of fluidity, becauſe a body having this conſtitution (on whatever circumſtances it may depend) will have every other obſerved property of a fluid. But this definition is hardly ſimple or perſpicuous enough; and we think that the objections againſt Newton's more ſimple and intelligible definition are not unanſwerable. Boſcovich defines a fluid to be, *a body whoſe particles exert the ſame mutual forces in all directions*; and ſhows, that ſuch particles muſt be indifferent, as to any poſition with reſpect to each other. If no external force act on them, they will remain in every poſition, and will have no tendency to arrange themſelves in one poſition rather than another; differing in this reſpect from the particles of ſolid, or ſoft, or viſcid bodies; which require ſome force to change their reſpective poſitions, and which recover theſe poſitions again when but gently diſturbed. He illuſtrates this diſtinction very beautifully, by

comparing a parcel of balls thrown on quickſilver, and attracting each other with a parcel of magnets in the ſame ſituation. The balls will ſtick together, but *in any poſition*; whereas the magnets will always affect a particular arrangement.

When the characteriſtic phenomenon of fluidity has been ſelected, the philoſopher proceeds to combine this property with gravity, and eſtabliſhes the doctrines of HYDROSTATICS, or of the preſſure and equilibrium of heavy fluids, the propagation of this preſſure in every direction; and demonſtrates the horizontality of ſurface aſſumed by all perfect fluids.

Theſe doctrines and principles enable us to determine ſeveral very intereſting circumſtances reſpecting the mutual preſſure of ſolids and fluids on each other; the preſſures exerted on the bottoms and ſides of veſſels; the ſupport and whole mechaniſm of floating bodies, &c.

He then conſiders how fluids will move when their equilibrium of preſſure is deſtroyed; and eſtabliſhes the doctrines of HYDRAULICS, containing all the modifications of this motion, ariſing from the form of the veſſels, or from the intenſity or direction of the preſſure which occaſions it. And this ſubject is completed by the conſideration of the reſiſtance which fluids oppoſe to the motion of ſolid bodies through them, and their impulſe on bodies oppoſed to their action.

Theſe are very important matters, being the foundations of many mechanical arts, and furniſhing us with ſome of our moſt convenient and efficacious powers for impelling machines. They are alſo of very difficult diſcuſſion, and are by no means completely inveſtigated or eſtabliſhed. Much remains yet to be done both for perfecting the theories and for improving the arts which depend on them.

It is evident, that on theſe doctrines depend the knowledge of the motions of rivers and of waves; the buoyancy, equilibrium, and ſtability of ſhips; the motion of ſhips through the waters; the action of the winds on the ſails; and the whole arts of marine conſtruction and ſeamanſhip.

There is another general form of tangible matter which exhibits very different phenomena, which are alſo extremely intereſting; we mean that of VAPOUR. A vapour is a fluid; and all the vapours that we know are heavy fluids: they are therefore ſubject to all the laws of preſſure and impulſe, which have been conſidered under the articles HYDROSTATICS and HYDRAULICS. But they are ſuſceptible of great compreſſion by the action of external forces, and expand again when theſe forces are removed. In conſequence of this compreſſion and expanſion, the general phenomena of fluidity receive great and important modifications; and this claſs of fluids requires a particular conſideration. As air is a familiar inſtance, this branch of mechanical philoſophy has been called PNEUMATICS.

Under this head we conſider the preſſure of the atmoſphere, and its effects, both on ſolid and fluid bodies. It produces the riſe of waters or other fluids in pumps and ſyphons, and gives us the theory of their conſtruction: it explains many curious phenomena of nature, ſuch as the motions in the atmoſphere, and their connection with the preſſure of the air, and its effect on the barometer or weather-glaſs. Air, when in motion, is called *wind*; and it may be employed to impel bodies. The theory of its action, and of its reſiſtance to moving bodies, is therefore to be conſidered in this place.

But beſides their motions of progreſſion, &c. ſuch as we obſerve in winds, compreſſible or elaſtic fluids are ſuſceptible of what may be termed *internal motion*; a kind of undulation, where the contiguous parts are thrown into tremulous vibrations, in which they are alternately condenſed and rarefied; and theſe undulations are propagated along the maſs of elaſtic fluid, much in the ſame way in which we obſerve waves to ſpread on the ſurface of water. What makes this an intereſting ſubject of conſideration is, that theſe undulations are the more ordinary cauſes of ſound. A trembling chord, or ſpring, or bell, agitates the air adjoining to it: theſe agitations are propagated along the air, and by its intervention agitate the organ of hearing. The mechaniſm of theſe undulations has been much ſtudied, and furniſhes a very beautiful theory of muſical harmony.

The philoſopher examines the *law of compreſſibility* of air and other elaſtic fluids; and thus gets the knowledge of the conſtitution of the atmoſphere, and of the action of thoſe fluids when employed to impel ſolid bodies. Gunpowder contains an immenſe quantity of permanently elaſtic air, which may be ſet at liberty by inflammation. When this is done at the bottom of a piece of ordnance, it will impel a ball along the barrel, and diſcharge it from the muzzle in the ſame way that an arrow is impelled by a bow. And thus having diſcovered in what degree this air preſſes in proportion to its expanſion, we diſcover its action on the ball through the whole length of the piece, and the velocity which it will finally communicate to it. Here then is contained a theory of artillery and of mines.

Chemiſtry teaches us, that moſt bodies can be converted by fire into elaſtic fluids, which can be employed to act on other bodies in the way of preſſure or impulſe. Thus they come under the review of the mechanical philoſopher; and they have become intereſting by being employed as moving forces in ſome very powerful machines.

Theſe diſcuſſions will nearly exhauſt all the general mechanical phenomena. There remain ſome which are much more limited, but furniſh very curious and important ſubjects of inveſtigation.

The phenomena exhibited between loadſtones or magnets and iron have long attracted attention; and the uſe to which the polarity of the loadſtone has been applied, namely, the directing the courſe of a ſhip through the pathleſs ocean, has rendered theſe phenomena extremely intereſting. They are ſpecified by the term MAGNETISM. Conſiderable progreſs has been made in the arrangement and generalization of them; but we have by no means been able hitherto to bring them all under one ſimple fact. The attention has been too much turned to the diſcovery of the ultimate cauſe of magnetiſm; whereas we ſhould have rather employed our ingenuity in diſcovering all the general laws, in the ſame manner as Kepler and Newton did with reſpect to the celeſtial phenomena, without troubling themſelves with the cauſe of gravitation. Dr. Gilbert of Colcheſter was the firſt who conſidered the magnetical phenomena in the truly philoſophical manner; and his treatiſe *De Magnete* may be conſidered as the firſt and one of the moſt perfect ſpecimens of the Baconian or inductive logic. It is indeed an excellent performance; and when we conſider its date, 1580, it is a wonder. Æpinus's *Tantamen Theoriæ Magnetiſmi* is a moſt valuable work, and contains all the knowledge which we have as yet of the ſubject.

There is another claſs of mechanical phenomena which has a conſiderable affinity with the magnetical; we mean the phenomena called ELECTRICAL. Certain bodies, when rubbed or otherwiſe treated, attract and repel other bodies, and occaſion a great variety of ſenſible motions in the neighbouring bodies. Philoſophers have paid much attention to theſe appearances of late years, and eſtabliſhed many general laws concerning them. But we have not been more ſucceſsful in bringing them all under the fact, and thus eſtabliſhing a complete theory of them, than in the caſe of magnetiſm. Franklin and Æpinus are the authors who have been moſt ſucceſsful in this reſpect. Dr. Franklin in particular has acquired great celebrity by his moſt ſagacious compariſon of the phenomena; which has enabled him to eſtabliſh a few general laws, almoſt as preciſe as thoſe of Kepler, and of equally extenſive influence. His diſcovery too of the identity of thunder and electricity has given an importance and dignity to the whole ſubject.

There are many phenomena of electricity which cannot be called mechanical, and are of the moſt curious and intereſting kind. As theſe have little connection with any of the other great branches of phyſical ſcience, they have generally been conſidered in treatiſes of natural philoſophy; and along with inquiries into the original cauſe of electricity in general, continue to engage much of our attention.

The appearances which are preſented to us by our ſenſe of ſeeing form another claſs, which have always been conſidered as making a branch of natural philoſophy in all ſeminaries of learning. It does not, however, obviouſly appear, that they are mechanical phenomena. The intimate nature of light is ſtill a ſecret. Fortunately it is not neceſſary to be known to give us a very perfect theory of the chief phenomena. The general laws of optics are ſo few, ſo ſimple, and ſo preciſe, that our theories are perhaps more perfect here than in any other branch of phyſics; but theſe theories are as yet far removed from the rank of primary facts. Many unknown events happen before the phenomenon comes under the hands of the ordinary optician, ſo as to become the ſubjects of the ſimple laws of reflection and refraction. It may even be doubted, and has been doubted, whether the phenomena of optics are caſes of body in motion; whether all the lines which the optician draws are any thing but the directions along which certain *qualities* are exerted. The ſide of a ball which is next the candle may be bright and the other ſide dark, juſt as the ſide of a ball which is next the electrical globe is *minus* and the other ſide *plus*; and all this without any intervening medium. Apparition or viſibility may be a quality of a body, depending on the proximity and poſition of another body, without any thing between them, juſt as weight is; and this body may be cognizable by our faculty of ſeeing alone, juſt as the preſſure of a heavy body is by our feeling alone.

The firſt thing which made it probable that mechanical philoſophy had any thing to do with the phenomena of optics, was the diſcovery of Mr. Roemer, "that apparition was not inſtantaneous;" that ſome time elapſed between the illumination of a body and its being ſeen at a diſtance. He diſcovered, that it was not till 40 minutes after the ſun illuminated one of Jupiter's ſatellites that it was ſeen by an inhabitant of this globe. If therefore a ſun were juſt created, it would be 40 minutes before Jupiter would be illumined by him, and 200 before the Georgian planet would be illuminated. Here then is motion. It is therefore highly probable that there is ſomething moved; but it is ſtill doubted whether this ſomething, which we call LIGHT, is a matter emitted from the ſhining body, and moving with great velocity, and acting on and affected by other bodies, in the various phenomena of optics; or whether it is a *certain ſtate* of a medium which is thus propagated, as we ſee that waves are propagated along the ſurface of water, or ſonorous undulations through the maſs of air, while the water or air itſelf is hardly moved out of its place. Either of theſe ſuppoſitions makes optics a legitimate branch of mechanical philoſophy; and it is the philoſopher's buſineſs to examine both by the received laws of motion, and ſee which of them gives conſequences which tally with the phenomena. This has been done; and we imagine that a complete incompatibility has been demonſtrated between the conſequences of the undulations of an elaſtic medium, and the phenomena of optics; while the conſequences of the other or vulgar notion on this ſubject are perfectly conſiſtent with mechanical laws. There are ſome things in this hypotheſis very far beyond our power to conceive diſtinctly; but they are all ſimilar in this reſpect to many facts acknowledged by all; and there is no phenomenon that is inconſiſtent with the legitimate conſequences of the hypotheſis. This gives it great probability; and this probability is confirmed by many chemical facts, and by facts in the vegetable œconomy, which give ſtrong and almoſt undeniable indications of light being a body capable of a chemical union with the other ingredients of ſublunary bodies, and of being afterwards ſet at liberty under its own form, as the cauſe or medium of viſion.

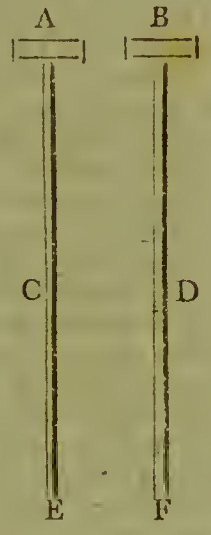
But theſe are queſtions ſimilar to thoſe about the cauſe of gravity, and totally unneceſſary for eſtabliſhing a complete theory of the optical phenomena, for explaining the nature of viſion, the effects of optical inſtruments, the cauſe of colours, the phenomena of the rainbow, halos and perihelions, &c. &c. &c. Only all this theory is unconnected with the principles called mechanical.

Such is the field of obſervation to the mechanical philoſopher of the preſent day. We may hope to extend it, and by degrees apply its doctrines even to the unſeen motions which take place in chemiſtry and phyſiology. But we muſt, in the firſt place, perfect our knowledge and deſcription of the ſenſible motions and actions of bodies. Thoſe of fluids ſtill demand much inveſtigation; and till theſe are thoroughly underſtood, it is not time to attempt penetrating further into the receſſes of nature.

In the proſecution of this ſtudy, it is found that every change which can be obſerved in the ſtate of a body, with reſpect to motion by the action of another body, is accompanied by an equal and oppoſite change in the ſtate of that other body. Thus, in the phenomena of gravitation, it is obſerved that the deflections of the ſun and planets are mutual. The ſame thing is obſerved in the actions of magnets on each other and on iron; it is alſo obſerved in the attractions and repulſions of electrical bodies; and it alſo obtains in all the phenomena of impulſe and of corporeal preſſure. It is therefore an univerſal law of motion, that *action is always equal and oppoſite to reaction*: but this muſt be conſidered merely as a matter of fact, a contingent law of nature, like that of gravitation. The contrary is perfectly conceivable, and involves no contradiction. That this is ſo, is evident from the proceedings of philoſophers, who in every new caſe make it their buſineſs to diſcover by experiment whether this law was obſerved or not. It was among the laſt diſcoveries made by Sir Iſaac Newton in his examination of the celeſtial motions. This being the caſe, it ſhould never be aſſumed as a principle of reaſoning till its operation has been aſcertained by obſervation. It has been owing to this improper procedure that much falſe reaſoning has been introduced into mechanical philoſophy, and particularly into the theory of impulſion or the communication of motion by impulſe. In conſidering this ſubject, a term has been introduced which has occaſioned much wrangling and miſconception; we mean the term INERTIA. It ſerves indeed to abbreviate language, but it has often miſled the judgment. When uſed with cautious attention to every circumſtance, it expreſſes nothing but the neceſſity of a cauſe to the production of any effect: but it is generally uſed as expreſſing a quality inherent in matter, by which it *reſiſts* any change of ſtate, or by which it maintains its preſent ſtate. Matter is ſaid to be inert; and as every thing which changes the motion of a body is called a *force*, and as this inertia of A is ſuppoſed to change the motion of B, it is called *vis inertiæ*; and yet matter is ſaid to be indifferent as to motion or reſt, and to be inactive. Theſe are ſurely very incongruous expreſſions. This obſcure diſcourſe has ariſen from the poverty of all languages, which are deficient in original terms, and therefore employ figurative ones. Force, action, reſiſtance, are all appropriated terms related to our own exertions; and ſome reſemblance between the external effects of theſe exertions and the effects of the connecting qualities of natural bodies has made us uſe them in our diſquiſitions on theſe ſubjects. And as we are conſcious that, in order to prevent our being puſhed by another from our place, we muſt reſiſt exerting force; and that our reſiſtance is the reaſon why this other man has not accompliſhed this purpoſe, we ſay, that the quieſcent body reſiſts being put in motion, and that its inertia is diſcovered by the diminution made in the motion of the impelling body: and upon the authority of this *vis inertiæ* as a firſt principle, the phenomena of impulſion are explained, and the law of equal action and reaction is eſtabliſhed.

But all this procedure is in contradiction to the rules of inductive logic; and the obſcurity and confuſion which have ariſen from this original miſconception, the conſequent incongruity of language, and the aukward attempts that have been made to botch and accommodate it to the real ſtate of things, have occaſioned a diſpute, and the only diſpute in natural philoſophy which has not yet been ſettled, and never can be ſettled, while ſuch miſconceptions are allowed to remain.

If the word *inertia* be taken as expreſſing, not a quality of matter, but a law of human judgment reſpecting matter, as expreſſing our neceſſity of inferring the agency of a moving force whenever we obſerve a change of motion, all difficulties will vaniſh, and the equality of action and reaction will be inferred, as it ſhould be, from the phenomena of colliſion. There will be inferred a *vis inſita corpori impellenti*, not *quâ moventi*, but *quâ corpori*; and this inference will carry us through all the myſteries of corporeal action, as it conducted Sir Iſaac Newton in his grand reſearches.



Let us juſt conſider how we reaſon in a new caſe. Let A and B be two magnets faſtened on the ends of two long wooden laths AE, BF, which turn horizontally on pivots C, D, like compaſs-needles, with their north poles fronting each other, 12 inches apart; and let A be puſhed towards B, ſo that it would move uniformly with the velocity of two inches in a ſecond. The phenomena *which have been obſerved* are as follow: A will gradually diminiſh its velocity; and when it has advanced about nine inches, will ſtop completely. B, in the mean time, will gradually acquire motion; and when it has advanced about nine inches, will have a velocity of about two inches per ſecond, with which it will continue to move uniformly. Now what is inferred from theſe phenomena? Becauſe the motion of A is gradually retarded, we infer that a retarding force, that is, a force in the direction BA has acted on it. And ſince this would not have happened if B had not been there, and always happens when B is there, we infer that B is either its cauſe or the occaſion of its action. The vulgar ſay that B repels A; ſo ſay the dynamiſts. The abettors of inviſible fluids ſay, that a ſtream of fluid iſſuing from B impels A in the oppoſite direction. All naturaliſts agree in ſaying, that an active force connected with B has deſtroyed the motion of A, and conſider this curious phenomenon as the indication and characteriſtic of a diſcovery. The ſame inference is made from the motion produced in B: it is conſidered by all as effected by a force exerted or occaſioned by the preſence of A; and the dynamiſts and the vulgar ſay that A *repels* B. And both parties conclude, from the equal changes made on both bodies, that the changing forces are equal: here acknowledging, that they *obſerve* an equality of action and reaction; and they add this to the other inſtances of the extent of this law of motion.

All this while no one thinks of the inertia or inactivity of B, but, on the contrary, conclude this to be a curious inſtance of its activity; and moſt people conclude that both bodies carry about with them a *vis inſita* both when at reſt and when in motion.

If other phenomena give unqueſtionable evidence that, in ordinary colliſions, there is the ſame changes of motion, produced without mathematical contact, the ſame inferences muſt be drawn; and a ſcrupulous naturaliſt will doubt whether contact ſhould make any change in our reaſonings on the ſubject, and whether actual contact ever has been or can be obſerved. He will alſo be convinced, that while this is the general, or perhaps univerſal, proceſs of nature in producing motion by impulſe, all explanations of the action of bodies *e diſtanti*, by the intervention of ethers and other inviſible fluids, are nothing but multiplying the difficulties; for in place of one fact, the approach of one magnet (for inſtance) to another, they ſubſtitute millions of unſeen impulſes, each of which equally needs an explanation. And if this fluid be ſuppoſed to produce its effects by any *peculiarity* in its conſtitution, as in the caſe of Newton's elaſtic ether propoſed by him to explain gravitation, the hypotheſis ſubſtitutes, in the moſt unqualified manner, millions of ſimilar phenomena for the one to be explained; for there is the ſame want of a ſecond fluid in order to produce that mutual receſs of the particles of the ether which conſtitutes its elaſticity.

And this ſeems to be the limit to our inquiries into all the claſſes of natural phenomena. We find the maſſes or the particles of matter endued in fact with qualities which affect the ſtate of other particles or maſſes, at ſmaller or at greater diſtances from each other according to certain general rules or laws. This ultimate ſtep in the conſtitution of things is inſcrutable by us. It is arrogance in the higheſt degree for us to ſay, that becauſe we do not comprehend how there is inherent in a body any quality by which another body may be affected at any diſtance from it, therefore no ſuch quality *is poſſible*. It is no leſs ſo to ſay, that matter has no active property but that of moving other matter by impulſe; and that becauſe it may be ſo moved, and alſo by the agency of our own minds, therefore, when it is not moved by impulſe, it is moved by minds. The ſame almighty FIAT which brought a particle of matter into exiſtence could bring thoſe qualities equally into exiſtence; and the *how* in both is equally beyond our comprehenſion.

But, on the other hand, we muſt guard againſt the incurious reſting on this conſideration as a ſtop to further inquiry. There may be ſpecies of matter poſſeſſed of the mechanical powers, and which notwithſtanding is not cogniſable by our ſenſes. All the properties of matter are not known to a perſon who is both deaf and blind; and beings poſſeſſed of more ſenſes may perceive matter where we do not; and many phenomena may really be produced by the action of intervening matter, which we, from indolence or from haſte, aſcribe to the agency of inherent forces. The induſtry of philoſophers has already diſcovered intermedia in ſome caſes. It is now certain that air is the conveyer of ſound, and it is almoſt certain that there is ſuch a thing as light. Let us therefore indulge conjectures of this kind, and examine the conjectures by the received laws of motion, and reject them when we find the ſmalleſt inconſiſtency; and always keep in mind that even the moſt coincident with the phenomena is ſtill but a poſſibility.

We may conclude the whole of theſe obſervations with the remark, that theſe queſtions about the activity or inactivity of matter are not phyſical, but metaphyſical. Natural philoſophy, it is true, commonly takes it for granted that matter is wholly inactive; but it is not of any moment in phyſics whether this opinion is true or falſe; whether matter is acted on according to certain laws, or whether it acts of itſelf according to the ſame laws, makes no difference to the natural philoſopher. It is his buſineſs to diſcover the laws which really obtain, and to apply theſe to the ſolution of ſubordinate phenomena: but whether theſe laws ariſe from the nature of ſome agent external to matter, or whether matter itſelf is the agent, are queſtions which may be above his comprehenſion, and do not immediately concern his proper buſineſs.

The account we have now given of natural philoſophy points out to us in the plaineſt manner the way in which the ſtudy muſt be proſecuted, and the helps which muſt be taken from other branches of human knowledge.

The cauſes, powers, forces, or by whatever name we chooſe to expreſs them, which produce the mechanical phenomena of the univerſe, are not obſerved, and are known to us only in the phenomena themſelves. Our knowledge of the mechanical powers of nature muſt therefore keep pace with our knowledge of the motions, and indeed is nothing different from it. In order to diſcover and determine the forces by which the moon is retained in her orbit round the earth, we muſt know her motions. To a terreſtrial ſpectator ſhe appears to deſcribe an ellipſe, having the earth in one focus; but, in the mean time, the earth is carried round the ſun, and the moon's real path, in abſolute ſpace, is a much more complicated figure. Till we know this figure, and the variations in the velocity with which it is deſcribed, we know nothing of the forces which actuate the moon in her orbit.

When Newton ſays that the forces by which ſhe is retained in this elliptical orbit are directed to the earth, what does he mean? Only this, that the deflection from that uniform rectilineal motion which ſhe would otherwiſe have performed is always in this direction. In like manner, when he ſays that theſe forces are inverſely proportionate to the ſquares of her diſtances from the earth, he only means that the deflections made in equal times in different parts of her motion are in this proportion. Theſe deflections are conſidered as the characteriſtics and meaſures of the forces. We imagine that we have made all plain when we call this indicated cauſe a *tendency* to the earth; but we have no notion of this tendency to the earth different from the approach itſelf. This word tendency, ſo faſhionable among the followers of Sir Iſaac Newton, is perverted from its pure and original ſenſe. *Tendre verſus ſolem,* is, in the language of Rome, and alſo of Newton, *to go* towards the ſun; but we now uſe the words, *tend, tendency,* to ſignify, not the *approach,* but the *cauſe* of this approach. And when called upon to ſpeak ſtill plainer, we deſert the ſafe paths of plain language, and we expreſs ourſelves by metaphor; ſpeaking of *niſus, conatus ſeſe mutuo accedende, vis centripeta,* &c. When theſe expreſſions have become familiar, the original ſenſe of the word is forgotten, and we take it for granted that the words never had another meaning; and this metaphor, ſprung from the poverty of language, becomes a fruitful ſource of miſconception and miſtake. The only way to ſecure ourſelves againſt ſuch myſtical notions as are introduced by theſe means into philoſophy, is to have recourſe to the way in which we acquire the knowledge of theſe fancied powers; and then we ſee that their names are only names for phenomena, and that univerſal gravitation is only an univerſal mutual approach among the parts of the ſolar ſyſtem.

There is one caſe in which we fondly imagine that we know the cauſe independent of the effect, and that we could have predicted the phenomenon *à priori*; we mean the caſe of impulſe: and hence it is that we are ſo prone to reduce every thing to caſes of impulſion, and that we have fallen upon all theſe ſubterfuges of ethers and other ſubtile fluids. But we might have ſaved ourſelves all this trouble; for after having, by much falſe reaſoning and gratuitous aſſumptions, ſhown that the phenomenon in queſtion *might have been produced* by impulſe, we are no nearer our purpoſe, becauſe that property by which matter in motion puts other matter in motion, is known to us only *by* and *in* the effect.

The fair and logical deduction from all this is, that we muſt not expect any knowledge of the powers of nature, the immediate cauſes of the motions of bodies, but by means of a knowledge of the motions themſelves; and that every miſtake in the motions is accompanied by a ſimilar miſtake in the cauſes. It is impoſſible to demonſtrate or explain the gravitation of the planets to him who is ignorant of the properties of the ellipſe, or the theory of gunnery to him who does not know the parabola.

A notion has of late gained ground, that a man may become a natural philoſopher without mathematical knowledge; but this is entertained by none who have any mathematics themſelves; and ſurely thoſe who are ignorant of mathematics ſhould not be ſuſtained as judges in this matter. We need only appeal to fact. It is only in thoſe parts of natural philoſophy which have been mathematically treated, that the inveſtigations have been carried on with certainty, ſucceſs, and utility. Without this guide, we muſt expect nothing but a ſchool-boy's knowledge, reſembling that of the man who takes up his religious creed on the authority of his prieſt, and can neither give a reaſon for what he imagines that he believes, nor apply it with confidence to any valuable purpoſe in life. We may read and be amuſed with the trifling or vague writings of a Nollet, a Ferguſon, or a Prieſtley; but we ſhall not underſtand nor profit by the truths communicated by a Newton, a D'Alembert, or de la Grange.

Theſe obſervations, on the other hand, ſhow us the nature of the knowledge which may be acquired, and the rank which natural philoſophy holds among the ſciences.

Motions are the real and only objects of our obſervation, the only ſubjects of our diſcuſſion. In motion is included no ideas but thoſe of ſpace and time, the ſubjects of pure mathematical diſquiſition. As ſoon, therefore, as we have diſcovered the fact, the motion, all our future reaſonings about this motion are purely mathematical, depending only on the affections of figure, number, and proportion, and muſt carry along with them that demonſtration and irreſiſtible evidence which is the boaſt of that ſcience. To this are we indebted for that accuracy which is attained, and the progreſs which has been made in ſome branches of mechanical philoſophy; for when the motions are diſtinctly and minutely underſtood, and then conſidered only as mathematical quantities, independent of all phyſical conſiderations, and we proceed according to the juſt rules of mathematical reaſoning, we need not fear any intricacy of combination or multiplicity of ſteps; we are certain that truth will accompany us, even though we do not always attend to it, and will emerge in our final propoſition, in the ſame manner as we ſee happen in a long and intricate algebraic analyſis.

Mechanical philoſophy, therefore, which is cultivated in this way, is not a ſyſtem of probable opinions, but a *diſciplina accurata*, a demonſtrative ſcience. To poſſeſs it, however, in this form, requires conſiderable preparation. The mere elements of geometry and algebra are by no means ſufficient. Newton could not have proceeded *ſine* "*ſua matheſi facem preferente*;" and, in creating a new ſcience of phyſics, he was obliged to ſearch for and diſcover a new ſource of mathematical knowledge. It is to be lamented that the taſte for the mathematical ſciences has ſo prodigiouſly declined in this country of late years; and that Britain, which formerly took the lead in natural philoſophy, ſhould now be the country where they are leaſt cultivated. Few among us know more than a few elementary doctrines of equilibrium; while, on the continent, we find many authors who cultivate the Newtonian philoſophy with great aſſiduity and ſucceſs, and whoſe writings are conſulted as the fountains of knowledge by all our countrymen who have occaſion to employ the diſcoveries in natural philoſophy in the arts of life. It is to the foreign writers that we have recourſe in our ſeminaries, even for elementary treatiſes; and while the continent has ſupplied us with moſt elaborate and uſeful treatiſes on various articles in phyſical aſtronomy, practical mechanics, hydraulics, and optics, there has not appeared in Britain half a dozen treatiſes worth conſulting for theſe laſt forty years; and this notwithſtanding the unparalleled munificence of our preſent ſovereign, who has given more liberal patronage to the cultivators of mathematical philoſophy, and indeed of ſcience in general, than any prince in Europe. The magnificent eſtabliſhments of Louis XIV. originated from his inſatiable ambition and deſire of univerſal influence, directed by the ſagacious Colbert. And his patronage being exerted according to a regular plan in the eſtabliſhment of penſioned academies, and in procuring the combined efforts of the *moſt eminent* of all countries, his exertions made a conſpicuous figure, and filled all Europe with his eulogiſts. But all this was done without the ſmalleſt ſelf-denial, or retrenchment of his own pleaſures, the expenſes being furniſhed out of the public revenues of a great and oppreſſed nation; whereas the voyages of diſcovery, the expenſive obſervations and geodetical operations in Britain, and the numberleſs unheard-of penſions and encouragements given to men of ſcience and activity, were all furniſhed out of the private eſtate of our excellent ſovereign, who ſeems to delight in repaying, by every ſervice in his power, the attachment of a loyal and happy nation. It is therefore devoutly to be wiſhed, that his patriotic efforts were properly ſeconded by thoſe whom they are intended to ſerve, and that the taſte for the mathematical ſciences may again turn the eyes of Europe to this country for inſtruction and improvement. The preſent ſeems a moſt favourable era, while the amazing advances in manufactures of every kind ſeem to call aloud for the aſſiſtance of the philoſopher. What pleaſure would it have given to Newton or Halley to have ſeconded the ingenious efforts of a Watt, a Boulton, a Smeaton, an Arkwright, a Dollond! and how mortifying is it to ſee them indebted to the ſervices of a Belidor, a Boſſut, a Clairaut, a Boſcovich!

We hope to be pardoned for this digreſſion, and return to our ſubject.

It appears from what has been ſaid, that mechanical philoſophy is almoſt wholly a mathematical ſtudy, and that it is to be ſucceſsfully proſecuted only under this form: but in our endeavours to initiate the beginner, it will be often found to require more ſteadineſs of thought than can generally be expected for keeping the mind engaged in ſuch abſtract ſpeculations. The object preſented to the mind is not readily apprehended with that vivacity which is neceſſary for enabling us to reaſon upon it with clearneſs and ſteadineſs, and it would be very deſirable to have ſome means of rendering the conception more eaſy, and the attention more lively. This may be done by exhibiting to the eye an experiment, which, though but a ſingle fact, gives us a ſenſible object of perception, which we can contemplate and remember with much more ſteadineſs than any mere creature of the imagination. We could, by an accurate deſcription, give ſuch a conception of a room that the hearer ſhould perfectly comprehend our narration of any occurrence in it: but one moment's glance at the room would be infinitely better. It is uſual therefore to employ experiments to aſſiſt the imagination of the beginner, and moſt courſes of natural philoſophy are accompanied by a ſeries of ſuch experiments. Such experiments, connected by a ſlight train of argumentative diſcourſe, may even ſerve to give a notion of the general doctrines ſufficient for an elegant amuſement, and even tending to excite curioſity, and engage in a ſerious proſecution of the ſtudy. Such are the uſual courſes which go by the name of experimental philoſophy: but this is a great miſapplication of the term; ſuch courſes are little more than *illuſtrations* of known doctrines by experiments.

EXPERIMENTAL PHILOSOPHY is the inveſtigation of general laws, as yet unknown, by experiment; and it has been obſerved, under the article PHILOSOPHY, that this is the moſt infallible (and indeed the ſole) way of arriving at the knowledge of them. This is the *Novum Organum Scientiarum* ſtrongly recommended by Lord Bacon. It was new in his time, though not altogether without example; for it is the procedure of nature, and is followed whenever curioſity is excited. There was even extant in his time a very beautiful example of this method, viz. the Treatiſe of the Loadſtone, by Dr. Gilbert of Colcheſter; a work which has hardly been excelled by any, and which, when we conſider its date, about the year 1580, is really a wonderful performance.

The moſt perfect model of this method is the Optics of Sir Iſaac Newton. Dr. Black's Eſſay on Magneſia is another very perfect example. Dr. Franklin's Theory of Electricity is another example of great merit. That the inveſtigation is not complete, nor the concluſions certain, is not an objection. The method is without fault; and a proper direction is given to the mind for the experiments which are ſtill neceſſary for eſtabliſhing the general laws.

It were much to be wiſhed that ſome perſon of talents and of extenſive knowledge would give a treatiſe on the method of inquiry by experiment. Although many beautiful and ſucceſsful examples have been given as particular branches of inquiry, we have but too many inſtances of very inaccurate and inconcluſive inveſtigations. Experiments made at random, almoſt without a view, ſerve but little to advance our knowledge. They are like ſhapeleſs lumps of ſtone, merely detached from the rock, but ſtill wanting the ſkill of the builder to ſelect them for the different purpoſes which they may chance to ſerve; while well-contrived experiments are blocks cut out by a ſkilful workman, according as the quarry could furniſh them, and of forms ſuited to certain determined uſes in the future edifice. Every little ſeries of experiments by Margraff terminates in a general law, while hardly any general concluſion can be drawn from the numberleſs experiments of Pott. Lord Bacon has written much on this ſubject, and with great judgment and acuteneſs of diſtinction; but he has exceeded in this, and has fatigued his readers by his numerous rules; and there is in all his philoſophical works, and particularly in this, a quaintneſs and affectation that greatly obſcure his meaning, ſo that this moſt valuable part of his writings is very little read.

A formidable objection has been made to this method of inquiry. Since a phyſical law is only the expreſſion of a general fact, and is eſtabliſhed only in conſequence of our having obſerved a ſimilarity in a great number of particular facts; and ſince the great rule of inductive logic is to give the law no greater extent than the induction on which it is founded—how comes it that a few experiments muſt be received as the foundation of a general inference? This has been anſwered in very general terms in the article PHILOSOPHY. But it will be of uſe to conſider the ſubject a little more particularly. Our obſervations on this ſubject are taken from the diſſertation on evidence by Dr. Campbell in his *Philoſophy of Rhetoric*.

An attentive conſideration of the objects around us will inform us that they are generally of a complicated nature, not only as conſiſting of a complication of thoſe qualities of things called accidents, ſuch as gravity, mobility, colour, figure, ſolidity, which are common to all bodies; but alſo as conſiſting of a mixture of a variety of ſubſtances, very different in their nature and properties; and each of theſe is perhaps compounded of ingredients more ſimple.

Moreover, the farther we advance in the knowledge of nature, we find the more reaſon to be convinced of her conſtancy in all her operations. Like cauſes have always produced like effects, and like effects have always been preceded by like cauſes. Inconſtancy ſometimes appears in Nature's works at *firſt ſight*; but a more refined experience ſhows us that this is but an apppearance, and that there is no inconſtancy: and we explain it to our ſatisfaction in this way.

Moſt of the objects being of a complicated nature, we find, on an accurate ſcrutiny, that the effects aſcribed to them ought often to be ſolely aſcribed to one or more of theſe component parts, while the others either do not contribute to them, or hinder their production; and the variety of nature is ſo great, that hardly any two individuals of the ſame ſpecies are in every reſpect like any other. On all theſe accounts we expect diſſimilitudes in the phenomena accompanying perfectly ſimilar treatment of different ſubjects of the ſame kind; but we find, that whenever we can be aſſured that the two ſubſtances are perfectly alike, the phenomena ariſing from ſimilar treatment are the ſame: and long and extenſive obſervation teaches us, that there are certain circumſtances which inſure us in the perfect ſimilarity of conſtitution of ſome things. Whenever we obſerve the effect of any natural agent on one, and but one, of theſe, we invariably expect that the ſame will be produced on any other.

Should a botaniſt meet with a plant new to him, and obſerve that it has ſeven monopetalous flowers, he will conclude with the utmoſt confidence that every plant of this ſpecies will have monopetalous flowers; but he will not ſuppoſe that it will have ſeven, and no more than ſeven, flowers. Now theſe two facts ſeem to have no difference to warrant ſuch a difference in the concluſion; which may therefore ſeem capricious, ſince there is but one example of both.

But it is not from this example only that he draws the concluſion. Had he never before taken notice of any plant, he would not have reaſoned at all from theſe remarks. But his mind runs immediately from this unknown ſpecies to all the known ſpecies of this genus, and to all the genera of the ſame order; and having experienced in the *figure* of the flower an uniformity in every ſpecies, genus, and order, which admits of no exception, but, in the *number* of flowers, a variety as boundleſs as are the circumſtances of ſoil, climate, age, and culture, he learns to mark the difference, and draws the abovementioned concluſions. Thus we learn that *perfect* uniformity is not to be expected in any inſtance whatever, becauſe in no inſtance is the ſimplicity of conſtitution ſufficiently great to give us aſſurance of perfect uniformity in the circumſtances of the caſe; and the utmoſt that our experience can teach us is a quick diſcrimination of thoſe circumſtances which produce the occaſional varieties.

The nearer that our inveſtigations carry us to the knowledge of *elementary* natures, the more are we convinced by general experience of the uniformity of the operations of real elements; and although it may perhaps be impoſſible for us ever to arrive at the knowledge of the ſimpleſt elements of any body, yet when any thing *appears* ſimple, or rather ſo exactly uniform, as that we have invariably obſerved it to produce ſimilar effects on diſcovering any *new* effect of this ſubſtance, we conclude, from a general experience of the efficient, a like conſtancy in the energy as to the reſt. Fire conſumes wood, melts lead, and hardens clay. In theſe inſtances it acts uniformly, but not in theſe only. We have always found, that whatever of any ſpecies is conſumed by it in one inſtance, has been conſumed by it on trial at any time. If therefore a trial be made for the firſt time of its influence on any particular ſubſtance, he who makes it is warranted to conclude that the effect, whatever it may be, is a faithful repreſentative of its effects on this ſubſtance in all paſt and future ages. This concluſion is not founded on this ſingle inſtance, but upon this inſtance combined with the general experience of the regularity of this element in its operations.

This general concluſion, therefore, drawn from one experiment, is by no means in oppoſition to the great rule of inductive logic, but, on the contrary, it is the moſt general and refined application of it. General laws are here the real ſubject of conſideration; and a law ſtill more general, viz. *that nature is conſtant in all its operations*, is the inference which is here applied as a principle of explanation of a phenomenon which is itſelf a general law, viz. *that nature is conſtant in this operation.*

The foundation of this general inference from one experiment being ſo firmly eſtabliſhed, it is evident that experiments muſt be an infallible method of attaining to the knowledge of nature; and we need only be ſolicitous that we proceed in a way agreeable to the great rule of inductive logic; that is, the ſubject muſt be cleared of every accidental and *unknown* circumſtance, and put into a ſituation that will reduce the intereſting circumſtance to a ſtate of the greateſt poſſible ſimplicity. Thus we may be certain that the event will be a faithful repreſentative of every ſimilar caſe: and unleſs this be done in the preparation, nothing can reſult from the moſt numerous experiments but uncertainty and miſtakes.

The account which has been given of mechanical philoſophy would ſeem to indicate that experiment was not of much uſe in the farther proſecution of it. The two laws of motion, with the aſſiſtance of mathematics, ſeem fully adequate to the explanation of every phenomenon; and ſo they are to a *certain degree*. But this degree is as yet very limited. Our mathematical knowledge, great as it is in compariſon with that of former times, is ſtill inſufficient for giving accurate ſolutions even of very ſimple (comparatively ſpeaking) queſtions. We can tell, with the utmoſt preciſion, what will be the motions of two particles of matter, or two bodies, which act on each other with forces proportioned to the ſquares of the diſtances inverſely; but if we add a third particle, or a third body, acting by the ſame law, the united ſcience of all Europe can only give an approximation to the ſolution.

What is to be done then in the caſes which come continually before us, where millions of particles are acting at once on each other in every variety of ſituation and diſtance? How ſhall we determine, for inſtance, the motion of water through a pipe or ſluice when urged by a piſton or by its own weight? what will be its velocity and direction? It is impoſſible, in the preſent ſtate of mathematical knowledge, to tell with any preciſion or certainty. And here we muſt have recourſe to experiment. But if this be the caſe, muſt the experiment be made in every poſſible variety of ſituation, depth, figure, preſſure? or is it poſſible to find out any general rules, founded on the general laws of motion, and rationally deduced from them? Or, if this cannot be accompliſhed, will experiment itſelf furniſh any general coincidences which ſhow ſuch mutual dependencies, that we may conſider them as indications of general principles, though ſubordinate, complicated, and perhaps inſcrutable? This can be diſcovered by experiment alone.

The attention of philoſophers has been directed to each of theſe three chances, and conſiderable progreſs has been made in them all. Numerous experiments have been made, almoſt ſufficient to direct the practice in many important caſes, without the help of any rule or principle whatever. But there are many caſes, and theſe of by far the greateſt importance, ſuch as the motion of a ſhip impelled by the winds, reſiſted by the water, and toſſed by the waves, where diſtinct experiments cannot be made.

Newton, Bernoulli, D'Alembert, and others, have laboured hard to deduce from the laws of motion rules for determining what may be called the *average* motion of water in theſe circumſtances, without attempting to define the path or motion of any individual particle; and they have actually deduced many rules which have a great degree of probability. It may here be aſked, why do you ſay *probability?* the rules, as far as they go, ſhould be *certain*. So they are: they are ſtrict deductions from their premiſſes. But the premiſſes are only *ſuppoſitions*, of various degrees of probability, aſſumed in order to ſimplify the circumſtances of the caſe, and to give room for mathematical reaſoning; therefore theſe deductions, theſe rules, muſt be examined by experiment. Some of the ſuppoſitions are ſuch as can hardly be refuſed, and the rules deduced from them are found to tally preciſely with the phenomena. Such is this, "that the velocities of iſſuing water in ſimilar circumſtances are in the ſub-duplicate ratio of the preſſures." And this rule gives a moſt important and extenſive information to the engineer. Other ſuppoſitions are more gratuitous, and the rules deduced from them are leſs coincident with the phenomena. The patient and ſagacious Newton has repeatedly failed in his attempts to determine what is the *abſolute velocity* of water iſſuing from a hole in the bottom of a veſſel when urged by its weight alone, and the attempts of the others have hardly ſucceeded better. Experiment is therefore abſolutely neceſſary on this head.

Thoſe who have aimed at the diſcovery of *rules* purely experimental on this ſubject, have alſo been pretty ſucceſsful; and the Chevalier Buat has, from a compariſon of an immenſe variety of experiments made by himſelf and various authors, deduced an empirical rule, which will not be found to deviate from truth above one part in ten in any caſe which has yet come to our knowledge.

This inſtance may ſerve to ſhow the uſe of experiments in mechanical philoſophy. It is proper in all caſes by way of illuſtration; and it is abſolutely neceſſary in moſt, either as the foundation of a characteriſtic of a particular claſs of phenomena, or as argument in ſupport of a particular doctrine. Hydroſtatics, hydraulics, pneumatics, magnetiſm, electricity, and optics, can hardly be ſtudied in any other way; and they are at preſent in an imperfect ſtate, and receiving continual improvement by the labours of experimental philoſophers in all quarters of the world.

Having in the preceding paragraphs given a pretty full enumeration of the different ſubjects which are to be conſidered in the ſtudy of natural philoſophy, it will not be neceſſary to ſpend much time in a detail of the advantages which may reaſonably be expected from a ſucceſsful proſecution of this ſtudy. It ſtands in no need of panegyric: its intimate connection with the arts gives it a ſufficient recommendation to the attention of every perſon. It is the foundation of many arts, and it gives liberal aſſiſtance to all. Indebted to them for its origin and birth, it has ever retained its filial attachment, and repaid all their favours with the moſt partial affection.

To this ſcience the navigator muſt have recourſe for that aſtronomical knowledge which enables him to find his place in the trackleſs ocean: and although very ſmall ſcraps of this knowledge are ſufficient for the mere pilot, it is neceſſary that the ſtudy be proſecuted to the utmoſt by ſome perſons, that the unlearned pilot may get that ſcanty pittance which muſt direct his routine. The few pages of tables of the ſun's declination, which he uſes every day to find his latitude, required the ſucceſſive and united labours of all the aſtronomers of Europe to make them tolerably exact: and in order to aſcertain his longitude with preciſion, it required all the genius of a Newton to detect the lunar irregularities, and bring them within the power of the calculator; and, till this was done, the reſpective poſition of the different parts of the earth could not be aſcertained. Vain would have been the attempt to do this by geodætical ſurveys independent of aſtronomical obſervation. It is only from the moſt refined mechanics that we can hope for ſure principles to direct us in the conſtruction and management of a ſhip, the boaſt of human art, and the great means of union and communication between the different quarters of the globe.

A knowledge of mechanics not much inferior to this is neceſſary for enabling the architect to execute ſome of his greateſt works, ſuch as the erection of domes and arches which depend on the niceſt adjuſtment of equilibrium. Without this he cannot unite economy with ſtrength; and his works muſt either be clumſy maſſes or flimſy ſhells.

The effects of artillery cannot be underſtood or ſecured without the ſame knowledge.

The whole employment of the engineer, civil or military, is a continual application of almoſt every branch of mechanical knowledge; and while the promiſes of a Smeaton, a Watt, a Belidor, may be confided in as if already performed, the numberleſs failures and diſappointments in the moſt important and coſtly projects ſhow us daily the ignorance of the pretending crowd of engineers.

The microſcope, the ſteam-engine, the thunder-rod, are preſents which the world has received from the natural philoſopher; and although the compaſs and teleſcope were the productions of chance, they would have been of little ſervice had they not been ſtudied and improved by Gilbert, Halley, and Dollond.

But it is not in the arts alone that the influence of natural philoſophy is perceived: it lends its aid to every ſcience, and in every ſtudy.

It is often neceſſary to have recourſe to the philoſopher in diſputes concerning property; and many examples might be given where great injuſtice has been the conſequence of the ignorance of the judges. Knowledge of nature might have prevented many diſgraceful condemnations for ſorcery.

The hiſtorian who is ignorant of natural philoſophy eaſily admits the miraculous into his narrations, accompanies theſe with his reflections, draws conſequences from them, and fills his pages with prodigies, fables, and abſurdity.

It is almoſt needleſs to ſpeak of the advantages which will accrue to the phyſician from this ſtudy. So cloſe is the connection between it and medicine, that our language has given but one name to the naturaliſt and to the medical philoſopher. Indeed, the whole of his ſtudy is a cloſe obſervation of the laws of material nature, in order to draw from them precepts to direct his practice in the noble art of healing. During the immaturity of general knowledge, while natural philoſophy was the only ſtudy which had acquired any juſt pretenſion to certitude either in its principles or method of inveſtigation, the phyſicians endeavoured to bring the objects of their ſtudy within its province, hoping by this means to get a more diſtinct view of it; and they endeavoured to explain the abſtruſe phenomena of the animal functions by reducing them all to motions, vibrations, colliſions, impulſes, hydroſtatic and hydraulic preſſures and actions, with which the mechanical philoſophers were ſo ardently occupied at that time. But unfortunately their acquaintance with nature was then very limited, and they were but little habituated to the rules of juſt reaſoning; and their attempts to explain the economy of animal life by the laws of mechanics did them but little ſervice either for the knowledge of diſeaſes or of the methods of cure. The mechanical theories of medicine, which had conſiderable reputation about the end of laſt century, were many of them very ingenious, and had an impoſing appearance of ſymmetry and connection; but are now forgotten, having all been formed on the narrow ſuppoſition that matter was ſubject only to mechanical laws.

But the diſcovery of error diminiſhes the chance of again going wrong, eſpecially when the cauſe of error has been diſcovered, and the means pointed out of detecting the miſtakes; and the vital principle muſt combine its influence with, or operate on, the properties of rude matter. It appears therefore evident that a knowledge of the mechanical laws of the material world is not only a convenient, but a neceſſary, accompliſhment to the phyſician. We are fully juſtified in this opinion, by obſerving medical authors of the preſent day introducing into medicine theories borrowed from mechanical philoſophy, which they do not underſtand, and which they continually miſapply. Appearance of reaſoning frequently conceals the errors in principle, and ſeldom fails to miſlead.

But there is no claſs of men to whom this ſcience is of more ſervice than to thoſe who hold the honourable office of the teachers of religion. Their knowledge in their own ſcience, and their public utility, are prodigiouſly hurt by ignorance of the general frame and conſtitution of nature; and it is much to be lamented that this ſcience is ſo generally neglected by them, or conſidered only as an elegant accompliſhment: nay, it is too frequently ſhunned as a dangerous attainment, as likely to unhinge their own faith, and taint the minds of their hearers. We hope, however, that few are either ſo feebly rooted in the belief of the great doctrines of religion as to fear this, or of minds ſo baſe and corrupted as to adopt and inculcate a belief which they have any ſuſpicion of being ill-founded. But many have a ſort of horror at all attempts to account for the events of nature by the intervention of general cauſes, and think this procedure derogatory to the Divine nature, and inconſiſtent with the doctrine of his particular providence; believing, that "a ſparrow does not fall to the ground without the knowledge of our heavenly Father." Their limited conceptions cannot perceive, that, in forming the general law, the Great Artiſt did at one glance ſee it in its remoteſt and moſt minute conſequence, and adjuſt the vaſt aſſemblage ſo as completely to anſwer every purpoſe of His providence. There never was a more eager inquirer into the laws of nature, or more ardent admirer of its glorious Author, than the hon. Robert Boyle. This gentleman ſays, that he will always think more highly of the ſkill and power of that artiſt who ſhould conſtruct a machine, which, being once ſet a-going, would of itſelf continue its motion for ages, and from its inherent principles continue to anſwer all the purpoſes for which it was firſt contrived, than of him whoſe machine required the continual aid of the hand which firſt conſtructed it. It is owing to great inattention that this averſion to the operation of ſecondary cauſes has any influence on our mind. What do we mean by the introduction of ſecondary cauſes? How do we infer the agency of any cauſe whatever? Would we ever have ſuppoſed any cauſe of the operations of nature, had they gone on without any order or regularity? Or would ſuch a chaos of events, any more than a chaos of exiſtences, have given us any notion of a forming and directing hand? No ſurely. We ſee the hand of God in the regular and unvaried courſe of nature, only becauſe it is regular and unvaried. The philoſopher expreſſes this by ſaying, that the phenomena proceed by unalterable laws. Greatly miſtaken therefore are they who think that we ſuperſede the exiſtence of mind and of providence when we trace things to their cauſes. A phyſical law, being an unvaried fact, is an indication, and the ſtrongeſt poſſible indication, of an unerring mind, who is incapable of change, and muſt do to-day what He always did: for to change is to deviate from what is beſt. The operations of unerring mind will therefore be regular and invariable. Phyſical laws, therefore, or ſecondary cauſes, are the beſt proofs of unerring wiſdom. Such regularity of conduct is univerſally conſidered as indications of wiſdom among men. The wiſe man is known by the conſtancy of his conduct, while no man can depend on the future conduct of a fool.

And what aſtoniſhing evidences of wiſdom do we not obſerve in the general laws of the material world! They will ever be conſidered by the intelligent philoſopher as the moſt glorious diſplay of inconceivable wiſdom, which has been able, by means ſo few and ſo ſimple, to produce effects which by their grandeur aſtoniſh our feeble underſtandings, and by their inexhauſtible variety elude all poſſibility of enumeration.

While the teachers of religion remain ignorant of the beautiful laws of nature, the great characteriſtics of the wiſdom and goodneſs of the Almighty Creator, their hearers are deprived of much ſublime pleaſure; God is robbed of that praiſe which he would have received from an enlightened people; and the only worſhip he receives is tainted with mean notions of his attributes, and groundleſs fears of his power.

Let not our minds be haunted with fear of the pernicious effects of philoſophy, in conſequence of the dreadful exploſion which the vanity of man has lately made in France. The ruffians who now rule in that unhappy country, through the ſupport of the licentious mob of Paris, are continually imputing to the illumination of philoſophy the ardour which now animates them in the cauſe of liberty; and they are continually ſaying, that juſtice and morality are the order of the day. But their whole phraſeology is equally a perverſion of every thing in language and in ſentiment. The ſacred name of philoſophy is as unfit for their faithleſs and bloody mouths as the names of liberty or virtue, and is equally miſapplied. No wonder that religion fled from the torch of their philoſophy; for their philoſophy conſiſts expreſsly in the confounding the moſt diſtinct claſſes of phenomena and of beings, in aſſimilating the heavenly animating ſpark within us to a piece of rude matter, and in degrading man to the level of the brutes, and thus ſhutting out his faireſt proſpects. It is not by the ordinary dialectics of the theologian that this ſacrilegious confuſion can be rectified: this requires an intimate acquaintance with what is characteriſtic of mind, and what is characteriſtic of matter, and a comprehenſive view of the general laws which regulate the appearances in both claſſes of objects. Thus, and thus alone, will the divine be able to confute the deteſtable ſophiſms of Mirabeau and Diderot, and the other *ſoi-diſant* ſages of France; and perſuade their willing hearers to "render unto Cæſar the things that are Cæſar's, and to God the things that are God's."

But beſides theſe advantages which accrue to different claſſes of men from this ſtudy, there are ſome effects which are general and are too important to be paſſed over unnoticed.

That ſpirit of diſpaſſionate experimental inquiry which has ſo greatly promoted this ſtudy, will carry with it, into every ſubject of inquiry, that preciſion and that conſtant appeal to fact and experience which characteriſe it. And we may venture to aſſert, that the ſuperior good order and method which diſtinguiſh ſome of the later productions in other ſciences, have been in a great meaſure owing to this mathematical ſpirit, the ſucceſs of which in natural philoſophy has gained it credit, and thus given it an unperceived influence even over thoſe who have not made it their ſtudy.

The truths alſo which the naturaliſt diſcovers are ſuch as do not in general affect the paſſions of men, and have therefore a good chance of meeting with a candid reception. Thoſe whoſe intereſt it is to keep men in political or religious ignorance, cannot eaſily ſuſpect bad conſequences from improvements in this ſcience; and if they did, have hardly any pretext for checking its progreſs. And diſcoveries accuſtom the mind to novelty; and it will no longer be ſtartled by any conſequences however contrary to common opinion. Thus the way is paved for a rational and diſcreet ſcepticiſm, and a free inquiry on other ſubjects. Experiment, not authority, will be conſidered as the teſt of truth; and, under the guidance of fair experience, we need fear no ill as long as the laws of nature remain as they are.

Laſtly, ſince it is the buſineſs of philoſophy to deſcribe the phenomena of nature, to diſcover their cauſes, to trace the connection and ſubordination of theſe cauſes, and thus obtain a view of the whole conſtitution of nature; it is plain that it affords the ſureſt path for arriving at the knowledge of the great cauſe of all, of God himſelf, and for forming proper conceptions of him and of our relations to him: notions infinitely more juſt than can ever be entertained by the careleſs ſpectator of his works. Things which to this man appear ſolitary and detached, having no other connection with the reſt of the univerſe but the ſhadowy and fleeting relation of co-exiſtence, will, to the diligent philoſopher, declare themſelves to be parts of a great and harmonious whole, connected by the general laws of nature, and tending to one grand and beneficent purpoſe. Such a contemplation is in the higheſt degree pleaſant and cheering, and cannot fail of impreſſing us with the wiſh to co-operate in this glorious plan, by acting worthy of the place we hold among the works of God, and with the hopes of one day enjoying all the ſatisfaction that can ariſe from conſcious worth and conſummate knowledge; and this is the worſhip which God will approve. "This univerſe (ſays Boyle) is the magnificent temple of its great Author; and man is ordained, by his powers and qualifications, the high-prieſt of nature, to celebrate divine ſervice in this temple of the univerſe."

PHYSIOGNOMONICS, among phyſicians, denote ſuch ſigns as, being taken from the countenance, ſerve to indicate the ſtate, diſpoſition, &c. both of the body and mind: and hence the art of reducing theſe ſigns to practice is termed *phyſiognomy*.

PHYSIOGNOMY,

IS a word formed from the Greek *φυσις nature*, and *γινωσκω I know*. It is the name of a ſcience which occupied much of the attention of ancient philoſophers, and which, ſince the revival of learning, has in a great degree been diſregarded. Till of late it has ſeldom in modern times been mentioned, except in conjunction with the exploded arts of magic, alchymy, and judicial aſtrology. Within the two laſt centuries, no doubt, the bounds of human knowledge have been greatly extended by means of the patient purſuit of fact and experiment, inſtead of the haſty adoption of conjecture and hypotheſis. We have certainly diſcovered many of the ancient ſyſtems to be merely creatures of imagination. Perhaps, however, in ſome inſtances, we have decided too rapidly, and rejected real knowledge, which we would have found it tedious and troubleſome to acquire. Such has been the fate of the ſcience of phyſiognomy; which certainly merits to be conſidered in a light very different from alchymy and thoſe other fanciful ſtudies with which it had accidentally been coupled. The work lately publiſhed by M. Lavater on the ſubject has indeed excited attention, and may perhaps tend to replace phyſiognomy in that rank in the circle of the ſciences to which it ſeems to be entitled.

It does not appear that the ancients extended the compaſs of phyſiognomy beyond *man*, or at leaſt animated nature: But the ſtudy of that art was revived in the middle ages, when, miſled probably by the comprehenſiveneſs of the etymological meaning of the word, or incited by the prevalent taſte for the marvellous, thoſe who treated of the ſubject ſtretched the range of their ſpeculation far beyond the ancient limits. The extenſion of the ſignification of the term was adopted univerſally by thoſe naturaliſts who admitted the theory of ſignatures (ſee SIGNATURE); and phyſiognomy came thus to mean, the knowledge of the *internal* properties of *any* corporeal exiſtence from the *external* appearances. Joannes Baptiſta Porta, for inſtance, who was a phyſiognomiſt and philoſopher of conſiderable eminence, wrote a treatiſe on the phyſiognomy of *plants (phitognomonica)*, in which he employs phyſiognomy as the generic term. There is a treatiſe likewiſe *De Phyſiognomia Avium*, written we believe by the ſame perſon. In the *Magia Phyſiognomica* of Gaſpar Schottus, *phyſiognomia humana* is made a *ſubdiviſion* of the ſcience.

Boyle too adopts the extenſive ſignification mentioned, which indeed ſeems to have been at one time the uſual acceptation of the word.

> They'll find i' the phyſiognomies
> O' th' *planets* all men's deſtinies. HUDIBRAS.

At preſent phyſiognomy ſeems to mean no more than "a knowledge of the moral character and extent of intellectual powers of human beings, from their external appearance and manners." In the Berlin Tranſactions for the years 1769 and 1770 there appears a long controverſial diſcuſſion on the ſubject of the *definition* of phyſiognomy between M. Pernetty and M. Le Cat, two modern authors of ſome note. Pernetty contends, that *all knowledge whatever* is phyſiognomy; Le Cat confines the ſubject to the *human face*. Neither ſeems to have hit the medium of truth. Soon after the celebrated book of Lavater appeared. He indeed defines phyſiognomy to be, "the art of diſcovering the *interior* of *man* by means of his *exterior*; but in different paſſages of his work he evidently favours the extended ſignification of Pernetty. This work gave occaſion to M. Formey's attack upon the ſcience itſelf in the ſame Berlin Tranſactions for 1775. Formey ſtrenuouſly controverts the extent aſſigned by Lavater to his favourite ſcience.

Before the era of Pythagoras the Greeks had little or no ſcience, and of courſe could not be ſcientifical phyſiognomiſts. Phyſiognomy, however, was much cultivated in Egypt and India; and from theſe countries the ſage of Samos probably introduced the rudiments of this ſcience, as he did thoſe of many others, generally deemed more important, into Greece.

In the time of Socrates it appears even to have been adopted as a profeſſion. Of this the well-known anecdote of the deciſion of Zopyrus, or the real character of Socrates himſelf judging from his countenance, is ſufficient evidence. Plato mentions the ſubject; and by Ariſtotle it is formally treated of in a book allotted to the purpoſe.

It may be worth while to give a brief outline of Ariſtotle's ſentiments on the ſubject.

Phyſiognomy, he in ſubſtance obſerves, had been treated of in three ways: Some philoſophers claſſed animals into genera, and aſcribed to each genus a certain mental diſpoſition correſponding to their corporeal appearance. Others made a farther diſtinction of dividing the genera into ſpecies. Among men, for inſtance, they diſtinguiſhed the Thracians, the Scythians, the Egyptians, and whatever nations were ſtrikingly different in manners and habits, to whom accordingly they aſſigned the diſtinctive phyſiognomical characteriſtics. A third ſet of phyſiognomiſts judged of the actions and manners of *the individual*, and preſumed that certain manners proceeded from certain diſpoſitions. But the method of treating the ſubject adopted by Ariſtotle himſelf was this : A peculiar form of body is invariably accompanied by a peculiar diſpoſition of mind ; a human intellect is never found in the corporeal form of a beaſt. The mind and body reciprocally affect each other : thus, in intoxication and mania, the mind exhibits the affections of the body ; and in fear, in joy, &c. the body diſplays the affections of the mind.

From ſuch facts he argues, that when in man a particular bodily character appears, which by prior experience and obſervation has been found uniformly accompanied by a certain mental diſpoſition, with which therefore it muſt have been neceſſarily connected ; we are entitled in all ſuch caſes to infer the diſpoſition from the appearance. Our obſervations, he conceives, may be drawn from other animals as well as from men : for, as a lion poſſeſſes one bodily form and mental character, a hare another, the corporeal characteriſtics of the lion, ſuch as ſtrong hair, deep voice, large extremities, diſcernible in a human creature, denote the ſtrength and courage of that noble animal ; while the ſlender extremities, ſoft down, and other features of the hare, viſible in a man, betray the mental character of that puſillanimous creature.

Upon this principle Ariſtotle treats of the corporeal features of man ; and the correſpondent diſpoſitions, ſo far as obſerved : he illuſtrates them by the analogy juſt mentioned, and in ſome inſtances he attempts to account for them by phyſiological reaſoning.

At the early period in which Ariſtotle wrote, his theory, plauſible certainly, and even probable, diſplays his uſual penetration, and a conſiderable degree of knowledge. He diſtinctly notices individual phyſiognomy, national phyſiognomy, and comparative phyſiognomy. The ſtate of knowledge in his time did not admit of a complete elucidation of his general principles ; on that account his enumeration of particular obſervations and precepts is by no means ſo well founded or ſo accurate as his method of ſtudy. Even his ſtyle, conciſe and energetic, was inimical to the ſubject ; which, to be made clearly comprehenſible, muſt require frequent paraphraſes. Ariſtotle's performance, however, ſuch as it is, has been taken as the groundwork and model of every phyſiognomical treatiſe that has ſince appeared.

The imitators of this great man in the 16th and 17th centuries have even copied his language and manner, which are ſententious, indiſcriminate, and obſcure. His comparative phyſiognomy of men with beaſts has been frequently though not univerſally adopted. Beſides his treatiſe expreſsly on the ſubject, many incidental obſervations on phyſiognomy will be found interſperſed through his other works, particularly in his hiſtory of animals.

Next after Ariſtotle, his diſciple and ſucceſſor Theophraſtus would deſerve to be particularly mentioned as a writer on the ſubject in queſtion. His ethic characters, a ſingular and entertaining performance, compoſed at the age of 99, form a diſtinct treatiſe on a moſt important branch of phyſiognomy, *the phyſiognomy of manners* : but the tranſlations and imitations of La Bruyere are ſo excellent, that by referring to them we do greater juſtice than would otherwiſe be in our power, both to Theophraſtus and to our readers. We cannot, however, omit obſerving, that the accuracy of obſervation and livelineſs of deſcription diſplayed in the work of Theophraſtus will preſerve it high in claſſical rank, while the ſcience of man, and the prominent characteriſtics of human ſociety, continue to be objects of attention.

Polemon of Athens, Adamantius the ſophiſt, and ſeveral others, wrote on the ſubject about the ſame period. Lately there was publiſhed a collection of all the Greek authors on phyſiognomy ; the book is entitled, *Phyſiognomiæ veteris Scriptores Græci. Gr. & Lat. a Franzio Altenb.* 1780, 8vo. From the number of theſe authors, it appears that the ſcience was much cultivated in Greece ; but the profeſſors ſeem ſoon to have connected with it ſomething of the marvellous. This we have cauſe to ſuſpect from the ſtory told by Apion of Apelles : *Imaginem adeo ſimilitudinis indiſcretæ pinxit, ut* (*incredibile dictu*) *Apion Grammaticus ſcriptum reliquerit quemdam ex facie hominum addivinantem* (*quos melapoſcopos vocant*) *ex iis dixiſſe aut futuræ mortis annos, aut præteritæ.* The novitiates of the Pythagorean ſchool were ſubjected to the phyſiognomic obſervation of their teachers ; and it is probable the firſt phyſiognomiſts by profeſſion among the Greeks were of this ſect. They too, to whom, from the nature of their doctrines and diſcipline, myſtery was familiar, were the firſt, it is likely, who expoſed the ſcience of phyſiognomy in Greece to diſgrace, by blending with it the art of divination.

From the period of which we have been treating to the cloſe of the Roman republic, nothing worthy of remark occurs in the literary hiſtory of phyſiognomy. About the laſt-mentioned era, however, and from thence to the decline of the empire under the later emperors, the ſcience appears to have been cultivated as an important branch of erudition, and aſſumed as a profeſſion by perſons who had acquired a ſuperior knowledge in it.

In the works of Hippocrates and Galen, many phyſiognomical obſervations occur. Cicero appears to have been peculiarly attached to the ſcience. In his oration againſt Piſo, and in that in favour of Roſcius, the reader will at the ſame time perceive in what manner the orator employs phyſiognomy to his purpoſes, and find a curious inſtance of the *ancient* manner of oratorical *abuſe*.

Many phyſiognomical remarks are to be found likewiſe in the writings of Salluſt, Suetonius, Seneca, Pliny, Aulus Gellius, Petronius, Plutarch, and others.

That in the Roman empire the ſcience was practiſed as a profeſſion, ample evidence appears in the writings of ſeveral of the authors juſt mentioned. Suetonius, for inſtance, in his *Life of Titus*, mentions that Narciſſus employed a *phyſiognomiſt* to examine the features of Britannicus, who predicted that Britannicus would not ſucceed, but that the empire would devolve on Titus.

The ſcience of phyſiognomy ſhared the ſame fate with all others, when the Roman empire was overthrown by the northern barbarians. About the beginning of the ſixteenth century it began again to be noticed. From that time till the cloſe of the ſeventeenth, it was one of the moſt faſhionable ſtudies. Within that ſpace have appeared almoſt all the approved modern authors on the ſubject*.

It has been unfortunate for phyſiognomy, that by many of theſe writers it was held to be connected with doctrines of which the philoſophy of the preſent day would be aſhamed. With theſe doctrines it had almoſt ſunk into oblivion.

In every period of the hiſtory of literature there may eaſily be marked a prevalence of particular ſtudies. In the early period, for inſtance, of Grecian literature, *mythological morality* claimed the chief attention of the philoſophers. In the more advanced ſtate of learning in Greece and in Rome, *poetry*, *hiſtory*, and *oratory*, held the pre-eminence. Under the latter emperors, and for ſome time afterwards, the hiſtory of *theological controverſies* occupied the greateſt part of the works of the learned. Next ſucceeded *metaphyſics*, and *metaphyſical theology*. Theſe gave place to *alchemy*, *magic*, *judicial aſtrology*, the doctrine of ſignatures and ſympathies, the *myſtic*, *theoſophic*, and *Roſicrucian theology*, with phyſiognomy. Such were the purſuits contemporary with the ſcience which is the object of our preſent inquiry. It is no matter of ſurpriſe, that, ſo aſſociated, it ſhould have fallen into contempt. It is not unuſual for mankind haſtily to reject valuable opinions, when accidentally or artificially connected with others which are abſurd and untenable. Of the truth of this remark, the hiſtory of theology, and the preſent tone of theological opinions in Europe, furniſh a pregnant example.

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* They are, Bartholem. Cocles, Baptiſta Porta, Honoratus Nuquetius, Jacobus de Indagine, Alſtedius, Michael Schottus, Gaſpar Schottus, Cardan, Taiſnierus, Fludd, Behmen. Barclay, Claromontius, Conringius, the commentaries of Auguſtin Niphus, and Camillus Balbus on the Phyſiognomica of Ariſtotle; Spontanus, Andreas Henricus, Joannes Digander, Rud. Goclenius, Alex. Achillinus, Joh. Prætorius, Jo. Belot, Guliel. Gratalorus, &c. They are noticed in the Polyhiſtor of Morhoff, vol. i. lib. 1. cap. 15. § 4. and vol. ii. lib. 3. cap. 1. § 4.

To phyſiognomy, and the exploded ſciences laſt mentioned, ſucceeded *claſſic philology*; which gave place to *modern poetry* and *natural philoſophy*; to which recently have been added the ſtudies of *rational theology*, *chemiſtry*, the *philoſophy of hiſtory*, the *hiſtory of man*, and the *ſcience of politics*.

About the commencement of the eighteenth century, and thence forward, the occult ſciences, as they are termed, had declined very conſiderably in the eſtimation of the learned; and thoſe who treated of phyſiognomy forbore to diſgrace it by a connection with thoſe branches of ideal learning with which formerly it had been invariably conjoined. In Britain, Dr. Gwyther noticed it with approbation. His remarks are publiſhed in the Philoſophical Tranſactions, vol. xviii.; and Dr. Parſons choſe it for the ſubject of the Croonian lectures, publiſhed at firſt in the ſecond ſupplement to the 44th volume of the Philoſophical Tranſactions, and afterwards (1747) in a ſeparate treatiſe, entitled *Human Phyſiognomy explained*.

The obſervations, however, of theſe writers, as well as of Lanciſius, Haller, and Buffon, relate rather to the tranſient expreſſion of the paſſions than to the permanent features of the face and body. The well-known characters of Le Brun likewiſe are illuſtrative of the tranſient phyſiognomy, or (as it is termed) pathognomy. See PASSIONS *in Painting*.

During the preſent century, although phyſiognomy has been now and then attended to, nothing of importance appeared on the ſubject till the diſcuſſion already mentioned between Pernetty and Le Cat, in the Berlin Tranſactions. The ſentiments of theſe authors, in ſo far as relates to the *definition* of phyſiognomy, have been above noticed. Their eſſays are beſides employed in diſcuſſing the following queſtions: *1ſt*, Whether it would or would not be advantageous to ſociety, were the character, diſpoſition, and abilities, of each individual ſo marked in his appearance as to be diſcovered with certainty?

2dly, Whether, on the ſuppoſition that by the higheſt poſſible proficiency in phyſiognomy we could attain a knowledge in part only of the internal character, it would be advantageous to ſociety to cultivate the ſtudy, mankind being in general imperfect phyſiognomiſts?

No reaſoning *a priori* can poſſibly determine theſe queſtions. Time and experience alone muſt aſcertain the degree of influence which any particular acquiſition of knowledge would have on the manners and characters of mankind; but it is difficult to conceive how the *reſult* of any portion of knowledge, formerly unknown, and which mankind would be *permitted* to diſcover, could be any thing but beneficial.

Soon after this controverſy in the Berlin Tranſactions, appeared the great work of M. Lavater, dean of Zurich, which has excited no inconſiderable portion of attention in the literary world. The work itſelf is magnificent: that circumſtance, as well as the nature of the ſubject, which was ſuppoſed to be fanciful, have contributed to extend its fame; and certainly, if we may judge, the book, though many faults may be detected in it, is the moſt important of any that has appeared on the ſubject ſince the days of Ariſtotle. Lavater profeſſes not to give a complete ſynthetical treatiſe on phyſiognomy, but, aware that the ſcience is yet in its infancy, he exhibits fragments only illuſtrative of its different parts. His performance is no doubt deſultory and unconnected. It contains, however, many particulars much ſuperior to any thing that had ever before appeared on the ſubject.

With the ſcholaſtic and ſyſtematic method adopted by the phyſiognomiſts of the laſt and preceding centuries, Lavater has rejected their manner of writing, which was dry, conciſe, indeterminate, and general: his remarks, on the contrary, are for the moſt part preciſe and particular, frequently founded on diſtinctions extremely acute. He has omitted entirely (as was to be expected from a writer of the preſent day) the aſtrological reveries, and ſuch-like, which deform the writings of former phyſiognomiſts; and he has with much propriety deduced his phyſiognomical obſervations but ſeldom from anatomical or phyſiological reaſoning. Such reaſoning may perhaps at ſome future period become important; but at preſent our knowledge of facts, although extenſive, is not ſo univerſal as to become the ſtable foundation of particular deductions. Lavater has illuſtrated his remarks by engravings; a method firſt adopted by Baptiſta Porta. Lavater's engravings are very numerous, often expreſſive, and tolerably executed.

The opinions of this celebrated phyſiognomiſt are evidently the reſult of actual obſervation. He appears indeed to have made the ſcience his peculiar ſtudy, and the grand purſuit of his life. His performance exhibits an extended comprehenſion of the ſubject, by a particular attention to *oſſeal* phyſiognomy, and the effect of *profiles* and *contours*. His ſtyle in general is forcible and lively, although ſomewhat declamatory and digreſſive. His expreſſions are frequently preciſe, and ſtrikingly characteriſtic; and the ſpirit of piety and benevolence which pervades the whole performance renders it highly intereſting.

The defects of the work, however, detract much from the weight which Lavater's opinions might otherwiſe challenge. His imagination has frequently ſo far outſtript his judgment, that an ordinary reader would often be apt to reject the whole ſyſtem as the extravagant reverie of an ingenious theoriſt. He has clothed his favourite ſcience in that affected myſterious air of importance which was ſo uſual with his predeceſſors, and deſcribes the whole material world to be objects of the univerſal dominion of phyſiognomy. He whimſically conceives it neceſſary for a phyſiognomiſt to be a well-ſhaped handſome man. He employs a language which is often much too peremptory and deciſive, diſproportioned to the real ſubſtance of his remarks, or to the occaſion of making them. The remarks themſelves are frequently oppoſite in appearance to common obſervation, and yet unſupported by any illuſtrations of his.

Lavater certainly errs in beſtowing too great a reliance on ſingle features, as the foundation of deciſion on character. His opinions on the phyſiognomy of the ears, hands, nails, and feet, of the human ſpecies, on hand-writing, on the phyſiognomy of birds, inſects, reptiles, and fiſhes, are obviouſly premature, as hitherto no ſufficient number of accurate obſervations have been made, in regard to either of theſe particulars, to authoriſe any concluſion. He has erred in the oppoſite extreme, when treating of the important topic of national phyſiognomy, where he has by no means proſecuted the ſubject ſo far as facts might have warranted. We muſt farther take the liberty to object to the frequent introduction of the author's own phyſiognomy throughout the courſe of his work. His ſingular remarks on his own face do not ſerve to prejudice the reader in favour of his judgment, however much his character may juſtify the truth of them. We muſt regret likewiſe, for the credit of the ſcience, that the author's ſingularly fanciful theory of apparitions ſhould ſo nearly reſemble a revival of the antiquated opinions of the ſympathiſts.

To theſe blemiſhes, which we have reluctantly enumerated, perhaps may be added that high impaſſioned tone of enthuſiaſm in favour of his ſcience every where diſplayed throughout the work of this author, which is certainly very oppoſite to the cool patient inveſtigation befitting philoſophy. To that enthuſiaſm, however, it is probable that in this inſtance (as is, indeed, no unfrequent effect of enthuſiaſm) we are indebted for the excellency which the author has attained in his purſuit; and it poſſeſſes the ſalutary tendency of putting us on our guard againſt a too implicit acquieſcence in his phyſiognomical deciſions.

In the Berlin Tranſactions for 1775, there appears a formal attack upon Lavater's work by M. Formey. This eſſay we have already mentioned. After diſputing the propriety of the extenſive ſignification applied by Lavater and Pernetty to the term phyſiognomy, M. Formey adopts nearly the ſame definition which we conceive to be the moſt proper, and which we have put down as ſuch near the beginning of this article. He allows that the mental character is intimately connected with, and ſenſibly influenced by, every fibre of the body; but his principal argument againſt phyſiognomy is, that the human frame is liable to innumerable accidents, by which it may be changed in its external appearance, without any correſpondent change of the diſpoſition; ſo that it ſurpaſſes the extent of the ſkill of mortals to diſtinguiſh the modifications of feature that are natural from thoſe which may be accidental. Although, therefore, the ſcience of phyſiognomy may be founded in truth, he infers that the Deity only can exerciſe it.

M. Formey further contends, that education, diet, climate, and ſudden emotions, nay even the temperaments of anceſtors, affect the caſt of human features; ſo that the influence of mental character on theſe features may be ſo involved with, or hidden by, accidental circumſtances, that the ſtudy of phyſiognomy muſt ever be attended by hopeleſs uncertainty. Theſe objections are worthy of notice, but they are by no means concluſive.

We ſhall give a ſpecimen of M. Lavater's manner of treating the ſubject on the oppoſite ſide of the queſtion: a ſpecimen not in Lavater's preciſe words, but conveying more ſhortly an idea at once of his ſentiments, and of his manner of expreſſing them.

No ſtudy, ſays he, excepting mathematics, more juſtly deſerves to be termed *a ſcience* than phyſiognomy. It is a department of phyſics, including theology and belles lettres, and in the ſame manner with theſe ſciences may be reduced to rule. It may acquire a fixed and appropriate character; it may be communicated and taught.

Truth or knowledge, explained by fixed principles, becomes ſcience. Words, lines, rules, definitions, are the medium of communication. The queſtion, then, with reſpect to phyſiognomy will thus be fairly ſtated. Can the ſtriking and marked differences which are viſible between one human face, one human form, and another, be explained, not by obſcure and confuſed conceptions, but by certain characters, ſigns, and expreſſions? Are theſe ſigns capable of communicating the vigour or imbecility, the ſickneſs or health, of the body; the wiſdom, the folly, the magnanimity, the meanneſs, the virtue, or the vice, of the mind?

It is only to a certain extent that even the experimental philoſopher can purſue his reſearches. The active and vigorous mind, employed in ſuch ſtudies, will often form conceptions which he ſhall be incapable of expreſſing in words, ſo as to communicate his ideas to the feebler mind, which was itſelf unable to make the diſcovery: but the lofty, the exalted mind, which ſoars beyond all written rule, which poſſeſſes feelings and energies reducible to no law, muſt be pronounced unſcientific.

It will be admitted, then, that to a certain degree phyſiognomical truth may as a ſcience be defined and communicated. Of the truth of the ſcience there cannot exiſt a doubt. Every countenance, every form, every created exiſtence, is individually diſtinct, as well as different, in reſpect of claſs, race, and kind. No one being in nature is preciſely ſimilar to another. This propoſition, in ſo far as regards man, is the foundation-ſtone of phyſiognomy. There may exiſt an intimate analogy, a ſtriking ſimilarity, between two men, who yet being brought together, and accurately compared, will appear to be remarkably different. No two minds perfectly reſemble each other. Now, is it poſſible to doubt that there muſt be a certain native analogy between the external varieties of countenance and form and the internal varieties of the mind? By anger the muſcles are rendered protuberant: are not, then, the angry mind, and the protuberant muſcles, as cauſe and effect? The man of acute wit has frequently a quick and lively eye. Is it poſſible to reſiſt the concluſion, that between ſuch a mind and ſuch a countenance there is a determinate relation?

Every thing in nature is eſtimated by its phyſiognomy; that is, its external appearance. The trader judges by the colour, the fineneſs, the exterior, the *phyſiognomy* of every article of traffic; and he at once decides that the buyer "has an honeſt look," or "a pleaſing or forbidding countenance."

That knowledge and ſcience are detrimental to man, that a ſtate of rudeneſs and ignorance is preferable, and productive of more happineſs, are tenets now deſervedly exploded. They do not merit ſerious oppoſition. The extenſion and increaſe of knowledge, then, is an object of importance to man: and what object can be ſo important as the knowledge of man himſelf? If knowledge can influence his happineſs, the knowledge of himſelf muſt influence it the moſt. This uſeful knowledge is the peculiar province of the ſcience of phyſiognomy. To conceive a juſt idea of the advantages of phyſiognomy, let us for a moment ſuppoſe that all phyſiognomical knowledge were totally forgotten among men; what confuſion, what uncertainty, what numberleſs miſtakes, would be the conſequence! Men deſtined to live in ſociety muſt hold mutual intercourſe. The knowledge of man imparts to this intercourſe its ſpirit, its pleaſures, its advantages.

Phyſiognomy is a ſource of pure and exalted mental gratification. It affords a new view of the perfection of Deity: it diſplays a new ſcene of harmony and beauty in his works; it reveals internal motives, which without it would only have been diſcovered in the world to come. The phyſiognomiſt diſtinguiſhes accurately the permanent from the habitual, the habitual from the accidental, in character. Difficulties, no doubt, attend the ſtudy of this ſcience. The moſt minute ſhades, ſcarcely diſcernible to the unexperienced eye, denote often total oppoſition of character. A ſmall inflexion, diminution, lengthening or ſharpening, even though but of a hair's breadth, may alter in an aſtoniſhing degree the expreſſion of countenance and character. How difficult then, how impoſſible indeed, muſt this variety of the ſame countenance render preciſion! The ſeat of character is often ſo hidden, ſo maſked, that it can only be detected in certain, perhaps uncommon, poſitions of countenance. Theſe poſitions may be ſo quickly changed, the ſigns may ſo inſtantaneouſly diſappear, and their impreſſion on the mind of the obſerver may be ſo ſlight, or theſe diſtinguiſhing traits themſelves ſo difficult to ſeize, that it ſhall be impoſſible to paint them or deſcribe them in language. Innumerable great and ſmall accidents, whether phyſical or moral, various incidents and paſſions, the diverſity of dreſs, of poſition, of light or ſhade, tend to diſplay the countenance often in ſo diſadvantageous a point of view, that the phyſiognomiſt is betrayed into an erroneous judgment of the true qualities of the countenance and character. Such cauſes often occaſion him to overlook the eſſential traits of character, and to form a deciſion on what is purely accidental. How ſurpriſingly, for inſtance, may the ſmallpox disfigure the countenance, and deſtroy or conſound, or render imperceptible, traits otherwiſe the moſt deciſive!

We ſhall, then, continues Lavater, grant to the oppoſer of phyſiognomy all he can aſk; and yet we do not live without hopes that many of the difficulties ſhall be reſolved which at firſt appeared inexplicable.

He then proceeds to a ſpecific illuſtration of his ſubject under a great variety of titles, in which he treats of human nature in general, and of each particular feature ſeparately.

To enumerate the different diviſions of his book would not be more ſatisfactory to our readers than the peruſal of the *contents* of the book itſelf: and an attempt to epitomize even the eſſential ſubſtance of the vaſt multiplicity of matter contained in his eſſays, (which are yet only *fragments*, and to which indeed he himſelf does not pretend to give any higher appellation,) would extend this article to a diſproportionate length. Such an abridgment, after all, would convey no ſolid information on a ſubject which merits all the time and ſtudy that an attentive peruſal of Lavater's works at large would require.

From the hiſtorical deduction of the literary progreſs of phyſiognomy which we have thus attempted to lay before our readers, it appears, that although the ſcience has fallen into diſrepute, there can ſcarcely be mentioned a period in which any cultivation of ſcience took place when phyſiognomy was not likewiſe the ſtudy, nay ſometimes even the profeſſion, of men of the moſt eminent abilities and the greateſt learning.

The reaſons why at preſent ſo little attention is paid to the ſubject probably are,

1ſt. That it has been treated in conjunction with ſubjects now with propriety exploded: And,

2dly. That it has been injured by the injudicious aſſertions and arguments of thoſe who have undertaken its defence.

Sometimes, however, the wiſe and the learned may err. The uſe of any thing muſt not be rejected for no better reaſon than that it is capable of abuſe. Perhaps the era is not diſtant when phyſiognomy ſhall be reinſtated in the rank which ſhe merits among the valuable branches of human knowledge, and be ſtudied with that degree of attention and perſeverance which a ſubject deſerves ſo eſſentially connected with the ſcience of man.

That there is an intimate relation between the diſpoſitions of the mind and the features of the countenance is a fact which cannot be queſtioned. He who is ſinking under a load of grief for the death of an affectionate wife or a dutiful child, has a very different caſt of features from the man who is happy in the proſpect of meeting his miſtreſs. A perſon boiling with anger has a threatening air in his countenance, which the moſt heedleſs obſerver never miſtakes; and if any particular diſpoſition be indulged till it become habitual, there cannot be a doubt but that the correſponding traces will be ſo fixed in the face as to be diſcernible by the ſkilful phyſiognomiſt, under every effort made to diſguiſe them. But when we attempt to decide on a man's intellectual powers by the rules of this ſcience, we are often deceived: and in this reſpect we have reaſon to believe that Lavater himſelf has fallen into the groſſeſt miſtakes.

Some ſketches from Lavater are given in the plates annexed to the article Drawing, and may afford at leaſt a partial illuſtration of ſome of the ſubjects here ſpoken of.

PHYSIOLOGY,

IS a Greek word, which, in ſtrict etymology, ſignifies that which diſcourſes of nature: but in its common uſe, it is reſtricted to that branch of phyſical ſcience which treats of the different functions and properties of living bodies; while by living bodies are meant thoſe which are by a certain organized ſtructure enabled to grow, and propagate their kind.

By this definition, phyſiology muſt neceſſarily have for its object the explanation of that internal organical economy in plants and animals, which nature has deviſed for the preſervation of the individual, and for the continuance and propagation of the ſpecies.

It is naturally divided into two kinds, particular and general. The former treats of the properties and functions of the individual or ſpecies, as may be ſeen in the article Anatomy; the latter is the ſubject of our preſent diſcuſſion, and treats of thoſe functions and properties which are general or common to all living bodies.

To the genuine naturaliſt no ſubject preſents ſuch a field of amuſement and inſtruction. When as complete as the ſtate of cotemporary ſcience will admit, it will exhibit a general reſult of all thoſe experiments and obſervations that have purpoſely been made or occaſionally contributed to illuſtrate the phenomena of animated matter; and when it ſhall reach that ſummit of perfection to which the efforts of genius may carry it, it may be enabled to diffuſe a light, of which the naturaliſt of the preſent day can have no juſt or adequate conception: particularly in phyſic, anatomy, botany, and in natural hiſtory, its happy effects may be numerous and great. On many occaſions it may there introduce order for confuſion, certainty for doubt; and may be expected to enthrone ſcience in various places which are now occupied by fancy and conjecture.

Of all the branches of phyſical ſcience it certainly makes the neareſt approach to the region of metaphyſics; but yet there is a difference between theſe, though it may not be very eaſy to point out the preciſe line of termination. Phyſiology, as already defined, being that ſcience which has for its object the organical economy of living bodies, the word organical, we think, here ſhould mark the diſtinction.

Wherever the economy of living bodies indicates deſign, and cannot reſult from any combination or ſtructure of organs, it muſt be ſuppoſed the effect of ſomething different from matter, and whoſe explanation belongs to that which is called *metaphyſics*, or which we might term the *philoſophy of mind*. By aſcribing indeed to the glandular contents within the cranium, and to that fiction animal ſpirits, the motives of action, the ſuperficial and ill-informed may have been led to an opinion that perception, memory, and imagination, are the functions of the cerebrum, the medulla oblongata, and cerebellum; that the ſoul is a conſequence of organization; and the ſcience which treats of it only a particular branch of phyſiology. But mind and its faculties are now ſo well underſtood and inveſtigated, that this opinion can ſeldom prevail but where penetration is not remarkable for its acuteneſs, or where reflection, reading, and reſearch, have long been confined within the limits of a narrow circle.

Inſtead of mind being the effect of organization, we readily allow that every living ſyſtem of organs ſuppoſes mind, and that in the ſtudy of ſuch ſyſtems the phyſiologiſt muſt often meet with many phenomena that are leſs ſingular than ſimple perception, and yet for which he cannot account by any knowledge which he poſſeſſes of organic powers. This truth we partly acknowledge, when, like ancient Athens erecting her altars to unknown gods, we retreat to thoſe aſylums of ignorance, the vis inſita, the vis nervea, the vis vitalis, the vis medicatrix, and a number of others of the ſame kind.

We chooſe here to mark preciſely the bounds of phyſiology, becauſe we have always been led to imagine that it would be extremely fortunate for ſcience that all its diviſions were accurately defined, that each were reſtricted to its own ſphere, where alone it is uſeful, and were never allowed to make encroachments on the province of another, where its only tendency can be to miſlead and ſubvert all ideas of arrangement.

In its progreſs of improvement, phyſiology has been much and often retarded from a want of attention to this circumſtance. The time has been when its place was occupied almoſt entirely by an abſurd and ridiculous philoſophy, which accounted for every thing by an hypotheſis, and which pretended to cure wounds a hundred miles diſtant by a powder of ſympathy.

Nay, as if its nature were not yet aſcertained, in ſome books whoſe titles promiſe much information on the functions of organs, we meet with only a pleaſing account of deſign and intelligence, and a few leſſons, when the fancy is warm, how to exclaim and how we ſhould wonder; or, after ſimilar profeſſions in the titles of others. we are preſented with only a curious diſplay of the art of logic. To a fact or two we ſee numerous chains of reaſoning appended. On theſe chains are hanging important and general concluſions; and theſe concluſions afterwards uniting, ſuſpend an elaborate ſyſtem of pathology. The whole has a wonderfully ſpecious appearance; but upon applying the touchſtone of experiment, the ſyſtem falls, the concluſions turn out to be falſe, the chains are found connected with the fact by only a conjecture or ſome popular opinion of the time; moſt of their links are creations of fancy, and their joinings ſuch logical aſſociations as have no analogy or prototype in nature.

Inſtead of logic, however, a pompous parade of mathematical learning has been *ſometimes* introduced. This has always an impoſing aſpect, and its preſence here may require to be examined with ſome care. It muſt be allowed, that it would have indeed been rather ſurpriſing if logic and metaphyſics had been employed, and mathematics carrying ſcience in their name had not been thought of. Their character had always been deſervedly high; and there was ſcarcely a department of knowledge to which they had not in ſome reſpect contributed their aid: their reſearches, too, had not been confined to mere number and quantity alone; they had explained the momentum of bodies, and all thoſe motions which ariſe from percuſſion and gravitation; they had aſcertained the diſtance of the ſtars, the velocity, magnitude, and orbits of the planets; they had accounted for the phaſes of the moon, the phenomena of eclipſes, and return of comets; and bringing their knowledge from the heavens to the earth, they had ſhown the cauſes of the days and nights, of the years and the ſeaſons, in all their varieties throughout the globe: they had taught the chronologer how to diſpoſe of the periods of time, and how he might beſt aſſiſt the hiſtorian to arrange his events: they had pointed out the origin of tides; had informed the mariner how to direct his courſe through the ocean; and had taught the geographer how to deſcribe the regions of the earth, and aſſiſt the traveller in his laudable purſuits after knowledge and ſcience: they, in ſhort, had unfolded the wonders of mechaniſm; and, diffuſing light over every branch of that philoſophy which is called *mechanical*, and has long been dignified with the name of *natural*, had afforded the fineſt ſpecimens of reaſoning with which the human mind is acquainted.

A ſcience of ſuch diſtinguiſhed utility could hardly fail to excite the admiration of all who knew it, or even had heard of it. And at a period when it was faſhionable, it was ſcarcely poſſible for the phyſiologiſt to paſs it unnoticed: the truth is, he very ſoon diſcovered its excellency. Bellini of Florence firſt introduced it; and it was at laſt ſo warped with phyſiology, that there were ſome who could hardly conceive a phyſiology exiſting without it. The juſtly celebrated Profeſſor Borelli, one of its moſt enthuſiaſtic admirers, employed it ſo well in ſhowing how the muſcles acted as ropes and the bones as levers, that he thence explained with the happieſt effect the phenomena of ſtanding, of walking, of leaping, of flying, and of ſwimming, in different animals: this taſk he performed in the firſt part of his famous work *De Motu Animalium*. But, wiſhing to know more of the animal economy, and feeling himſelf inſpired with new hopes, he ventured in the ſecond to explain alſo in the ſame way the interior motions and their proximate cauſes on the principles of mechaniſm: he there gives a minute account of the motion of the muſcles, of the heart and its pulſation, of the circulating blood, of the office of the lungs, the kidneys, and the liver, of the nervous fluid and the ſeminal ſecretion; of vegetation, generation, nutrition, of hunger and thirſt, of pain, of laſſitude, and the heat of fever.

Mathematics by him were conſidered as almoſt univerſal interpreters; for except the mechanical he ſeemed to acknowledge no other ſecondary powers in nature. He thought, with Plato, that God himſelf was always geometriſing; and was fully perſuaded that phyſical knowledge could not be acquired but through the medium of geometrical demonſtrations and forms. Theſe opinions had begun to be general, when his learned work was publiſhed at Rome in the year 1676; and they were no unequivocal ſymptoms that the reigning philoſophy of that time was now in the laſt ſtage of decay.

Still, however, as the ſpirit of that philoſophy was not wholly extinguiſhed, phyſiology continued to be much infeſted with its metaphyſical and logical diſputes, and with its phyſical doctrines of forms of particular ferments, its antipathies, ſympathies, its occult qualities, and ſubtile atoms.

For theſe reaſons, in his inaugural diſſertation at Leyden, delivered in the year 1692, the learned Pitcairn expreſſes a wiſh that medicine were made a diſtinct ſcience; that it were eſtabliſhed on mechanical principles, on fewer poſtulates, and more data; and that it were ſupported by a clear train of mathematical reaſoning, which would defy the attacks of the ſophiſt, and which would not be liable to the fluctuations of opinion and prejudice. Theſe ſentiments were warmly ſupported by the great Boerhaave, who, in his Aphoriſms, has founded his reaſonings on the ſtructure of the parts and the laws of mechanics, and to whom an edition of Borelli was dedicated in 1710.

Pitcairn, however, was not content with barely expreſſing his wiſhes. Seeing with regret that the ſtate of medicine could never be improved as long as it was connected with the philoſophy which was then in faſhion, he ſeemed anxious to effect a ſeparation; and for ſuch a ſtep he wiſhed to have only ſome plauſible pretext. This pretext *was not long wanting*; and was, to be ſure, one of the moſt whimſical that could well have preſented itſelf to his fancy. It occurred to him that the ſtudy of medicine was prior to philoſophy; that it had begun its courſe with aſtronomy, at the time when diſeaſes were ſuppoſed the conſequence of offended Deity; that, as it had all along ſhared the fate of aſtronomy, and had equally ſuffered in the common diſgrace of judicial aſtrology, it was highly reaſonable, in his opinion, that it ſhould ſtill follow the fate of its friend; that it ſhould be eſtabliſhed on ſimilar principles, and ſhould be demonſtrated by that reaſoning which might experience the ſhock of ages without being moved. So attached was he to the geometrical mode of demonſtration, that in his Diſſertations he appeared to conſider it as indeed the only ſpecies of evidence, excepting the ſenſes, that could be relied on. But here he was certainly venturing too far; ſo raſh an opinion, and one which, had he previouſly conſulted with prudence, might have been ſuppreſſed, was fatal to his cauſe. We muſt here therefore date the commencement of thoſe attacks to which his ſyſtem was afterwards expoſed.

Such an indiſcreet ſpecies of pedantry was but ill calculated to procure a generally favourable reception for a book with ſo extraordinary a title as the *Phyſico-mathematical Elements of Medicine.* Many learned and ingenious men, the greater part of whoſe knowledge had depended chiefly on the evidence of teſtimony, were now diſpoſed to examine, with a ſteady and awakened eye, his boaſted demonſtrations. The conſequence was that which might have been expected: the reſult of their inquiries was wholly inauſpicious to thoſe new applications of geometry; they found that his facts and experiments were few, that his poſtulates were endleſs, and that no mathematical reaſoning whatever could extract truth from a falſe hypotheſis, or could fairly deduce a general concluſion from particular premiſes. The Doctor, they obſerved, had impoſed upon himſelf, in imagining that either certainty or truth was naturally inherent in any mere geometrical forms; theſe forms, they ſaid, had been often abuſed: Plato had thought them ſomewhat divine; the ſuperſtitious had employed them as charms; Pythagoras had made them the ſymbols of his creed; and even in the writings of the learned Profeſſor himſelf, they frequently ſerved no other purpoſe but to give an air of importance to trifles; to beſtow on error the appearance of ſcience; and to give a ſimple and a trite remark the look of reſearch, and of acute and profound erudition.

It is unneceſſary to recall here the ſatirical wit, or more properly the ſcurrilous abuſe, with which this ſyſtem and its author were treated. The mechanic phyſiology has now ſunk into ſuch contempt, that the moſt illiterate affect to ſmile at the mention of its name; they ſeem to forget, or, what is more probable, they never knew, that it once was honoured with the great names of Borelli, of Boerhaave, and of Newton; and their reading perhaps cannot inform them that it was a noble ſtep to improvement; that it explained the ſtructure of the eye, the movement of the bone, and force of the muſcle, and that it may yet perhaps be the means of many intereſting diſcoveries in the living body: diſcoveries, however, which Heaven will reſerve for other minds than thoſe which it makes merely to receive the impreſſions of the day.

A frequent miſtake into which the mechanical philoſophers had fallen, was their hopes of being able to account for digeſtion by the muſcular force and action of the ſtomach. The more they reaſoned from this ſuppoſition, the more widely they wandered from the truth. A thought of Valliſneri, that, in acting mechanically, the ſtomach was as liable to be affected as its contents, gave a hint to Reaumur. On this hint he began immediately a ſet of experiments; and, from a number that were clear and deciſive, concluded that digeſtion was performed by a ſolvent. Here was a fair introduction to chemiſtry; the action of ſolvents was never yet ſatisfactorily explained by mechanic powers. A new era therefore commences; and chemiſtry now, in phyſiological inveſtigations, holds that place which was formerly poſſeſſed by geometry and mechanics.

Nor is chemiſtry undeſerving of this rank. From a ſmall beginning, and from modeſtly profeſſing to obſerve merely the different phenomena which are the effects of heat and of mixture, it has riſen like aſtronomy to the firſt eminence among the ſciences. By its numerous reſearches it has found widely diffuſed over nature a variety of ſingularly active bodies, which are called *ſalts.* Of theſe ſalts it has noticed ſome which change a blue vegetable tincture into green, and others which change that tincture into red: the former of theſe it has called *alkalis,* and the latter are known by the name of *acids.* It has obſerved, that when acids and alkalis are brought into contact, and either of them nearly in a fluid ſtate, they encounter with violence, effervеſcence and heat, and form a ſalt, which, being neither acid nor alkaline, is called *neutral.* It has been remarked that all theſe ſalts, whether volatile or fixed, whether fluid or concrete, have each permanently uniform characters; and that, though ſometimes blended in a mixture, or made to evaniſh in a ſolution, yet, when they are ſeparated, they reſume their taſte, their ſmell, their colour, and their form, and exhibit, as before, the ſame power in diſſolving earths, metals, and ſtones, and in making inflammable bodies to ſmoke, to kindle, and explode with a loud noiſe. All, however, act not alike upon all bodies; thoſe acids which diſſolve iron remain quite harmleſs upon gold. And chemiſtry here has been led to obſerve, that particular ſalts ſhow a preference for particular bodies, that there is in them an appearance of choice, and that their character is never to be known but by ſtudying their different elective attractions.

Beſides ſalts, chemiſtry of late has alſo diſcovered a number of bodies that are ſtill more wonderful, ſtill more active, and ſome of them at leaſt ſtill more widely diffuſed over nature. Theſe are certain aeriform fluids, which are called *gaſes:* theſe gaſes, like the mind itſelf, are diſcernible only by their effects; all are elaſtic, and all are combined with the principle of heat. Their kinds are various; ſome are inflammable, ſome are ſaline and ſoluble in water, ſome are neither the one nor the other, and ſome diſtinguiſhed by the name of *airs,* maintaining combuſtion and reſpiration: their importance is ſuch, that there is not a ſingle proceſs in chemiſtry, nor perhaps one regular proceſs in nature, "in which the phenomena of the diſengagement or fixation of heat, and the diſengagement or fixation of elaſtic fluids, are not obſerved either ſeparately or together." Two of theſe fluids compoſe water, two the nitric acid, two ammonia, and three of them are found in atmoſpheric air; one of them is thought, with a good deal of reaſon, to be the alkaligenous principle in bodies, and two of them to be the conſtituents of oil: the principle of acidity is already known to be one of the two which compoſe water. The ſame fluid oxidates metals, ſupports flame during combuſtion, communicates heat to the circulating blood, and maintains life in the act of reſpiration.

By that knowledge which it thus has acquired of ſalts and of gaſes, by its more ingenious modes of analyſis, and by ſome diſcoveries which it has made concerning the nature of heat and of light, chemiſtry is now able to account for many phenomena that before were inexplicable. In France particularly it has been recently extending its reſearches with a good deal of ardour towards the phenomena of both the animal and vegetable kingdoms: it has there found its ſalt and its gaſes, its heat and its light, active and buſy.

It is more than a century ſince it obſerved that plants were nouriſhed by pure water and atmoſpheric air; that from theſe alone they derived their extracts, their mucilage, their oil, their coal, their acids, their alkalis, and aroma. But ſince the diſcovery of different kinds of elaſtic fluids, it has farther remarked, that they grow rapidly in hydrogenous gas[*], and in air mixed with carbonic acid; that aſſiſted by light their leaves abſorb hydrogene from water, carbone from the acid of which they are ſo fond; and, thus decompoſing the one and the other, diſengage from both the oxigenous principle, or vital air, and reſtore to the atmoſphere ſalubrity and health.

Leaving vegetables, which, by analyſis in cloſe veſſels and in red-hot pipes, it has reduced to hydrogene, oxigene, azote, and charcoal, it has made diſcoveries no leſs important in the animal kingdom. It has found that the food of the nobler animals, which immediately or remotely is prepared by vegetables, is generally acted upon by a ſolvent: it has proved by exper ment, that the animal organs can fix azote; can decompoſe atmoſpheric air; can form lime, iron, and carbonic acid, as well as vegetables, produce a number of ſaline ſubſtances, which no art could detect in their food. Nor is it here that ſuch diſcoveries are meant to terminate; theſe ſeemingly creative powers of vegetation and of animalization, with other phenomena in the ſtructure and economy of living bodies, chemiſtry imagines that it will yet be able to explain. We may ſafely venture, however, to predict, that ſomething more than its preſent knowledge of the various effects of heat and of mixture will in this caſe be found neceſſary to enſure ſucceſs. The late diſcovery of elaſtic fluids and their ſingular properties affords the ſtrongeſt reaſons to ſuſpect that we yet may be ignorant of many agents which nature employs in the functions of bodies. But whatever be the truth, we are almoſt certain that theſe agents diſcovered by the chemiſts are not alone concerned. Electricity, magnetiſm, and what have been called animal electricity and animal magnetiſm, muſt not be excluded from acting ſome part. The growth of plants, it is well known, is conſiderably affected by the electrical ſtate of the atmoſphere; it is ſenſibly promoted by a proper uſe of the vegeto-electrometer, and has been ſaid to indicate a difference between the negative and poſitive electricities, whether theſe be kinds or ſtates of the fluid. Such too is our preſent knowledge, that electricity as yet ſeems the only cauſe to which we can aſcribe the ſeeming chemical affinities of the dew; its conſtant practice in avoiding ſome bodies, its predilection for others, and particularly its attachment to the living points of plants and of leaves: nor is this electricity wholly unconnected with the animal kingdom; when we think of its ſingular fondneſs for points, it occurs that one intention of our hairs may probably have been to collect and diffuſe it. It is plainly excited in croſs rubbing the hair of ſome animals; and when we wear ſilk, it is frequently accumulated upon the ſurface of our own bodies.

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[*] Hydrogenous gas acts with more energy than any other ſubſtance in diſſolving carbone; it mixes with carbonic acid and with azote, and ſometimes holds in ſolution ſulphur and phoſphorus. See Fourcroy's Diſcourſe on modern Chemiſtry.

The iron found in plants and in animals is certainly ſomewhat of a ſtriking circumſtance, and cannot be denied to be one reaſon why magnetiſm ſhould not be wholly overlooked.

As for ANIMAL ELECTRICITY, or what has been called ſo, it is now, we believe, generally allowed to hold an important place in the ſyſtem. It is very perceptible in all thoſe nerves which are ſubſervient to voluntary motions; nor is it limited to theſe alone. In ſeveral inſtances where metals were applied to the nerves of the heart, which nature has deſtined to ſpontaneous motions, they were ſeen to awaken the dormant powers in the muſcular fibres of that viſcus. We here ſpeak only of the nerves; but the Torpedo, the Gymnotus electricus, and Silurus electricus, poſſeſs a particular ſtructure of organs for collecting this fluid, for diſcharging it at pleaſure, and for giving a ſhock. If thoſe who are accuſtomed to the common kind of electrical experiments may at firſt be ſurpriſed that this electric fluid in the animal is not diſcharged from the nerves by water, or any other metallic conductor that is pure and unmixed, another fact, which is fully as ſtriking, though it has not been hitherto mentioned by any obſerver known to us, appears to merit equal attention: Cut away the leg of a frog, uncover a part of the crural nerve, place the limb now on a table on which an electrifying machine is working, you will ſee the muſcles ſtrongly convulſed at every ſpark which you draw from the conductor, but remaining motionleſs upon the diſcharge of the Leyden phial. See Plate 11. Vol. III.

Animal electricity naturally ſuggeſts animal magnetiſm. This laſt has been productive of more wonders in the human frame than all the preceding agents together. Under the management of Meſmer at Paris, and his pupil Deſlon, it filled all who obſerved its effects with ſurpriſe and aſtoniſhment. It ſeemed to unhinge the powers of the mind, and affect the whole animal economy; it excited the moſt extraordinary emotions; it rouſed and allayed the different paſſions; it changed averſion into love, and love into averſion; it created pain, it healed wounds, and cured diſeaſes as if by inchantment.

Theſe diſcoveries were made by a quack, who knew not the cauſe by which he produced ſo ſingular appearances. The celebrated Franklin, who firſt ſuppoſed that the electrical fluid was the thunder, was placed at the head of thoſe gentlemen who demonſtrated that this ſpecies of magnetiſm was the ſame power that had long been known under the name of *imagination*.

This laſt diſcovery, if the bluſhing pride of modern philoſophy could but ſtoop to improve an important hint, though originally ſuggeſted by an empiric, might greatly enlarge our knowledge of mind, and explain ſome things in the animal economy which appear yet to require a ſolution. At any rate, it ſufficiently proves that the influence of mind is very extenſive in the higher parts of animal creation. Many facts would argue that it increaſes as we riſe in the ſcale: but the ſole intention here was to ſhow, that chemical agents are neither almighty nor every where preſent; that in the internal organical economy of living bodies they act but a part; and that, like the other agents in nature, they are obliged to confine their operations within thoſe limits which the great Author of being has preſcribed.

The aid which anatomy affords to phyſiology is now to be conſidered. Phyſiology in general and the ſtudy of anatomy are ſo cloſely connected, that, as Haller imagined, they can hardly be ſeparated even in idea. In his opinion, the man who ſhould attempt to become a phyſiologiſt without anatomy, would act as wiſely as the mathematician who, without ſeeing the wheels or the pinions, or without knowing the ſize, the proportions, or the materials of any machine, would yet preſume from mere calculation to determine its powers, its properties, and uſes. In this compariſon, the importance of anatomy, we are really perſuaded, is not repreſented in a light too ſtrong; nor does that medium through which it has been viewed appear to have been magnified beyond nature.

Whether art or ſcience, ANATOMY is one of thoſe eminent accompliſhments without which no one is able to proſecute his ſtudies with half that pleaſure and ſucceſs which he might in either the animal or vegetable kingdoms. Having been always accuſtomed to aſſign it one of the higheſt and moſt honourable places among thoſe branches of human knowledge which are ſtyled liberal, we muſt be excuſed if we dwell a little in expoſing an attempt to convert it to a craft.

It is with ſurpriſe, and a mixture of regret, that we ſee a writer of diſtinguiſhed merit wiſhing thus to degrade it, and ſeeking to confine it as well as phyſiology to that profeſſion which chanced to be his own. The dignity of a ſcience, which he conſidered as his glory and his pride, ſhould have certainly extinguiſhed in a generous mind the low and diſguſting policy of his trade. It is indeed with reaſon that he thinks it unfortunate, "that thoſe who, from the nature of their education, are beſt qualified to inveſtigate the intricacies, and improve our knowledge of the animal economy, are compelled to get their living by the practice of a profeſſion which is conſtant employment." We lament the misfortune as much as he can; but we reaſon not from it in the ſame way. Inſtead of complaining that "idle profeſſional men," particularly "of the church, ſhould become philoſophers and phyſiologiſts as it were inſtinctively," we are happy to learn that men of enlightened and cultivated minds are thus ſo readily diſpoſed to aſſiſt us; that nature conducts them as it were by inſtinct; and that happily they enjoy all that leiſure which is deemed ſo neceſſary for ſuch an undertaking. The genius of ſome, and the liberal education which they all muſt have had opportunities of acquiring, by no means impreſs us with any unfavourable ideas of their aid.

Our author allows them to look through microſcopes and examine the red globules of the blood: They may too, he ſays, view animalculæ, and give us a candid relation of what they ſee; but ſhould not preſume to carry their reaſoning into a ſcience of which they can know nothing, or hope to throw light on a ſubject which it is impoſſible they can underſtand. But, to ſpeak freely, after conſidering the great phyſiological diſcovery of Prieſtley with reſpect to *reſpiration*, the moſt important probably, not even excepting that of the *ſyſtem of abſorbents*, that the ſcience has witneſſed in the preſent age, we ſee no grounds for preſcribing ſuch laws or fixing ſuch limits: and although he may treat the illuſtrious Reaumur and Abbé Spallanzani as nothing more than makers of experiments, and declare a reſolution to place no confidence in thoſe which are made by *gentlemen* and *prieſts*; he will not certainly deny that others have as well as he a juſt right to think for themſelves.

Were ſuch ſentiments to become univerſal, it is difficult to ſay what would be the conſequence. In this country, the law and the church require from their members a formal certificate, that, beſides the profeſſional, they have alſo attended ſome literary claſſes at the univerſity. To our medical claſſes boys are admitted from the ſhop and from the ſchool, and may afterwards paſs the two colleges of ſurgeons and phyſicians, by exhibiting a little ſkill in their art, or at leaſt by paying the ſtated fees. On theſe accounts, being anxious already for the fate of a profeſſion which we reſpect, and conſidering the degeneracy to which it is expoſed, not we hope the degeneracy into which it is ſinking, we ſhould be ſorry to ſee it deprived of that reſpectability which it may derive from the countenance of men poſſeſſing general literature and ſcience.

It is very true, that gentlemen and prieſts may not be anatomiſts; and not a few anatomical diſputes might ſeem to inſinuate, that perſons may be very eminent anatomiſts without being either gentlemen or prieſts. Still, however, there is nothing incompatible in thoſe characters; and, were we to judge from their writings, it was certainly a thing of which Bacon, Newton and Locke never dreamed, that the ſtudy of the prieſt, or the mere circumſtance of being a gentleman, was to blunt their acuteneſs for phyſical reſearch, or in after times to affect their reputation as men of genius.

“ When men have begun to reaſon correctly (ſays Dr. Hunter), and to exerciſe their own judgment upon their obſervations, there muſt be an end to deluſions. Many doctrines of old phyſicians and of old women will meet with proper contempt; the tyranny of empty pomp and myſtery of phyſic will be driven out of the land, and forced to ſeek ſhelter among leſs cultivated ſocieties of men.”

If the learned profeſſions wiſh to be reſpected, let them reſpect each other: for our part, we eſteem them all; and whatever aſſiſtance either they or others may afford to phyſiology, they may be aſſured that they will not find us anywiſe diſpoſed to detract from its merit. Diveſted of prejudice, we value as highly the diſcovery of Prieſtley, which explains reſpiration, as if it had come from Albinus or Haller; and with as much readineſs acknowledge obligations to the celebrated painter Leonardo da Vinci, as if he had been a doctor of phyſic.

But while we are thus impartial to others, we would not be unjuſt to profeſſional anatomiſts. Their learning, their patience, and ardour, have been great; and candour obliges us to aſſert their claim to the moſt numerous and important diſcoveries that have yet been made in phyſiological ſcience. The pains which they have taken, the prejudices which they have ſurmounted, and thoſe feelings which they have ſacrificed in deſcribing the parts of the dead body, place their labours beyond all praiſe.

But their diſcoveries have not been confined to a mere knowledge and deſcription of parts. In the ſtill fabric, juſt as in a time-piece or a broken orrery without motion, the whole preſents a very confuſed and even an unintereſting appearance. In this caſe, ſhould the man of reflection happen to aſk, where are the organs of the different functions? all would be ſilence, and nothing would be found to make a reply to ſuch an inquiry. The arterial ſyſtem is relaxed and empty; the muſcular fibre cannot be rouſed; the heart has ceaſed from its wonted beatings; and the nerve refuſes to convey ſenſations. On this ſcene the eye of the anatomiſt could not be expected to dwell long with much ſatisfaction. Curioſity would induce him to look beyond it, and ſtudy the deſign. He would ſoon perceive, that, to know the uſes of the ſeveral parts, they muſt be ſeen alive and in action. But here new difficulties would ariſe, and feelings of compaſſion would exclaim againſt any further purſuit. The natural zeal, however, of inquiry, the good of mankind, and the love of ſcience, in a generous mind are not eaſily reſiſted.

To his laſting praiſe, and the ſingular improvement of true phyſiology, the anatomiſt has examined the living body, and has there obſerved, that all motion proceeds immediately from the muſcular fibre; that the muſcular fibre again derives its power from the nerve, which terminates in the brain; that fibre and nerve, and the whole ſyſtem, are nouriſhed by the blood which comes from the heart; and that the waſte of blood is ſupplied by the lacteals, which abſorb nutritious matter from the food as it paſſes along the inteſtinal canal.

He has alſo obſerved, that the blood, which is in continual motion, has a circular courſe; that other veſſels along with the lacteals are employed to abſorb; and by means of injection has ſhown the route of the different fluids as clearly in the dead as they could have been ſeen in the living ſubject.

When his eyes have failed in tracing objects that were too minute for unaided ſight, he has called in the help of the microſcope, and diſcovered the red globules of the blood, animalculæ in the ſemen, and the anaſtomoſes of the arteries and veins; and when the microſcope could lead him no further, he has had recourſe to chemical analyſis, and made diſcoveries equally important in demonſtrating the bodies which compoſe the ſeveral fluids and the ſolids.

Beſides theſe ſervices which the anatomiſt has rendered to phyſiology, the ſcience is likewiſe greatly indebted to him for thoſe various and ingenious methods which he has taken to diffuſe his knowledge. Whatever has occurred remarkable or rare he has ſtudied to preſerve, either dried, or in fluids that reſiſt putrefaction. By corroding the parts which he has injected in a certain acid, he has given an idea of the vaſcular ſyſtem, which is at once inſtructive and elegant. Where it has been neceſſary to deſtroy the parts when incapable of preſervation, or where the preſervation would have been expenſive, he has not neglected to repreſent them in models of wax, or to perpetuate them in accurate caſts of lead or of ſtucco: and, laſtly, that the valuable fruits of his labours might not be confined in his room of preparations or to his pupils, he has deſcribed moſt of them in drawings, has multiplied his drawings by correct engravings; he has even publiſhed his numerous engravings, and, to render them intelligible, has illuſtrated each with copious explanations.

From this account it might be ſuppoſed that the anatomiſt has done all that can be reaſonably expected from him. If we drew, however, ſuch a concluſion, we might certainly be charged with precipitation. His views have hitherto been too confined, nor have they been directed with all that ſkill which a rational and comprehenſive phyſiology would require. As if chiefly guided by the rant of the poet, that “ the nobleſt ſtudy of mankind is man,” he has cultivated his art principally with an eye to medicine and ſurgery: and while he has diſſected the human body with a tedious minuteneſs, he has ſeldom looked into thoſe of brutes but when he has wiſhed to illuſtrate a theory or eſtabliſh an hypotheſis.

As ſome apology for ſuch a conduct, there is indeed but little immediate or pecuniary advantage to be derived from comparative anatomy; and thoſe who have heard of the fox and the grapes will readily perceive, that few will be diſpoſed to commend a ſcience which reflects not much credit on their knowledge, and which they are led from ſentiments of pride to treat as either contemptible or uſeleſs. The deciſive tone and affected air of ſuperior diſcernment being not unuſually a very tender part of the character, they often form that mark of diſtinction which is ſeldom reſigned but with the utmoſt degree of reluctance. It is, however, allowed, that any oppoſition from theſe cauſes ought not to frighten an aſpiring genius. His nobler mind ſhould look beyond pecuniary proſpects; and he ought to have fortitude enough to deſpiſe the ſneers and malevolence of pompous ignorance. The other difficulties which he has to encounter in his own eſtimation may not be ſo ſmall.

In ſeeking to enlarge the field of inquiry, he will ſoon experience that he wants a language, or at leaſt a nomenclature fitted to expreſs the different objects which muſt neceſſarily occur in his reſearches. He will find too that he wants thoſe proper claſſifications of the animal kingdom, which are equally neceſſary both to abridge and direct his labours. *See* ANATOMY.

The firſt nomenclature of the anatomiſt was formed upon the diſſection of brutes; and moſt of its terms, as the *rete mirabile*, are now uſeleſs, or tend to miſlead thoſe who employ them in their diſſections of the human body. The few of its parts which are ſtill retained, as the different names and diviſions of the gut, are much more applicable to the uſual appearances in certain quadrupeds than to any thing which we meet with in man.

This firſt nomenclature declined with the ſtudies which gave it birth, and with the decline of that ſuperſtition which permitted no other ſtudies of the kind. Since the days of Veſalius the human body has been chiefly diſſected; and the nomenclature which has thence ariſen, and has ſince been aſſuming the form of a language, if adapted at all, is peculiarly adapted to that ſubject. Were we now therefore diſpoſed to examine the internal economy of animals in general, we ſhould ſee at once that the preſent nomenclature is as ill ſuited to comparative anatomy as the former nomenclature was to the diſſection of the human body. The ſeveral facts which confirm this aſſertion are but too numerous. To give one or two: In a late work, *The Phyſiology of Fiſhes*, the celebrated author is obliged to inform his reader in a note, that when he makes uſe of the following terms, ſuperior, inferior, anterior, and poſterior, the fiſh is ſuppoſed to be ſtanding erect in the attitude of man: and in his ingenious *Contemplation on Nature*, Bonnet, beſides the abſurd practice of calling nerve by the name of marrow, has been pleaſed to obſerve, that in certain inſects the ſpinal marrow is not in the ſpine, but in the oppoſite ſide of the body, running longitudinally along the breaſt.

Applying occaſionally this nomenclature to the ſmall number of birds and quadrupeds which we have diſſected, it was much ſtrained with reſpect to their ſkeletons. Even forced analogy could not bring it to expreſs many diſtributions of the nerves and blood veſſels; and when it was employed in naming the muſcles, in moſt caſes it turned out to be uſeleſs or abſurd.

We were firſt led to obſerve its defects on hearing of the nameleſs bones of the pelvis, called the os ilium, the os iſchium, and the os pubis, united behind by an os ſacrum, which is tipt with a coccyx or bone of a cuckow: we thought it likewiſe ſomewhat remarkable to find a goat, a boat, and a conch ſhell, among the external parts of the ear; and within the tympanum a hammer and its ſhaft, a ſtithy, a ſtirrup, and a periwinkle. But theſe defects were moſt ſeriouſly felt in raiſing the different muſcles of a dog, and comparing them ſeverally with Albinus's tables. Theſe tables and muſcles, to our great ſurpriſe, did not reflect that mutual light upon one another which we expected. To obtain here more accurate ideas, we got the comparative myography of Douglas. At one glance the etymological table of this work demonſtrated the confuſion and the imperfection of the nomenclature. In his, as in other books of myography, the muſcles are explained by deſcribing their origins, inſertions, and uſes: but the table ſhows, that their names are never, excepting only in a few caſes, derived from any of theſe three circumſtances, which in every deſcription are uniformly noticed in all muſcles. Their names, on the contrary, are frequently taken from their particular form and appearance in the human body, or from thoſe circumſtances which are conſtantly varying in every animal; juſt as if muſcles of the ſame origin, inſertion, and uſe, ſhould in all animals have a ſimilar colour, a ſimilar mode of inſertion and origin, a ſimilar compoſition and variety of parts, a ſimilar courſe and direction of fibres, a ſimilar figure and ſhape, a ſimilar paſſage through certain places, a ſimilar proportion with reſpect to one another, or ſhould be formed of a ſimilar ſubſtance.

If we paſs to the membranes, as expreſſed in this nomenclature, we ſhall not diſcover that their names are more philoſophical. A perioſteum covers the bones, a pericranium the ſkull; the cavity of the thorax is lined with a pleura, that of the abdomen with a peritoneum; and, what is ſurely ſomewhat remarkable, bones which are hollow have a perioſteum on their inſide: the membranes in the ſkull are by way of diſtinction denominated *mothers*; the one which lies next to the cranium is the dura mater, or hard-hearted mother, while that which immediately enwraps the brain is the mater pia, or the affectionate mother.

Of all the terms, however, that occur, the cavity of the ſkull contains the moſt extraordinary collection: we there meet with a Turkiſh ſaddle and with the feet of a ſea-horſe, with a ring, with a lyre, with a ſickle, with a bridge, with a writing-pen, and a wine-preſs. A few of theſe names belong to the ſubſtance of the brain itſelf; where one part is called from its hardneſs the callous body, another from ſome fancied analogy the medullary ſubſtance, and a third from being on the outſide is named the corticle, and from its colour the cineritious. Theſe are not all: there are beſides footſtalks of the cerebrum and cerebellum; the thighs and arms and fore and hind legs of a grand diviſion, the medulla oblongata; there is alſo a vault and two or three pillars, one pair of ſtriated bodies, two beds, and a couple of horns; ſome cavities which, from a ſuppoſed reſemblance to ſtomachs, are called ventricles and choroid coats; two bodies named from the olive, two from a pyramid, and one from a pine, which is chiefly remarkable for having once been thought the reſidence of the ſoul. At ſome diſtance in the cerebellum we are however pleaſed to meet with a name that is ſomewhat elegant, the *tree of life*. In this there is a degree of refinement, which muſt ſtrike one as it comes unexpectedly. The following names are in the loweſt ſtyle of obſcenity: they are wormlike and mammillary proceſſes, they are nates, teſtes, an anus, and a vulva; which, in order to ſave the bluſhes of our readers, we ſhall leave in the language in which they were conceived. A ſingular part is placed immediately under a funnel, and is named from its uſe the pituitary gland; it was meant originally to ſecrete a phlegm, but it holds that office now as a ſinecure*.

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* That our readers may judge whether or not theſe names be fairly tranſlated, we ſubjoin the originals here in a note. In the ear, *tragus*, *ſcapha*, *concha*, *malleus*, *incus*, *ſtapes*, *cochlea*: in the cavity of the ſkull, *ſella Turcica*, *pedes hippocampi*, *annulus*

Ridiculous and whimſical as many of theſe appellations are, they generally have ſome alluſion to their ſubject, and are by no means the moſt exceptionable in this nomenclature. The names of diſcoverers which have been impoſed upon various parts, contain no deſcription at all; and the only purpoſe which they can ſerve is, not to promote the intereſt of ſcience, but to immortalize the anatomiſts. As many of thoſe have not been more than inſenſible to fame, they or their friends have taken the freedom to introduce parts to our notice, not by telling us what is their nature, but by demonſtrating who was the firſt that obſerved them. Upon reading, therefore, the catalogue of names that occur in anatomy, one would imagine that many of theſe ingenious diſſectors had ſuppoſed themſelves not the diſcoverers but the inventors of ſeveral parts in the animal economy.* In our vaſcular ſyſtem is the ring of Willis, the vein of Galen, and the large wine-preſs of Herophilus. We have in our brain the bridge of Varolius; and in our nerves we poſſeſs the property of various diſcoverers. The holes of Vidius, and the caverns of Highmore, are in our bones; ſome ſmall muſcles in the ſole of our foot is the fleſhy maſs of Jacobus Sylvius; a part of our eye is the membrane of Ruyſch; and in thoſe caſes where they are to be found, Couper lays claim to particular glands; two canals from our mouth to our ears are the tubes of Euſtachius; the duct of our pancreas is the right of Virſungus; Poupart has a ligament almoſt in our groin; a lobe of our liver belongs to Spigelius; and the female would certainly ſtare at being told, that among the diſtinguiſhing marks of her ſex are the tubes of Fallopius, a tench's mouth, and ſeveral veſtiges of the devil's teeth (morſus diaboli).

The man who will readily obſerve the defects of this nomenclature, is not he who has learned it already, and who no longer is acquiring his ideas through its imperfect and confuſed medium; nor is it he whoſe ſtudies are confined to the human body, the particular ſubject on which it was formed: He who will ſenſibly feel its inconvenience is the young anatomiſt, who muſt receive his knowledge through its channel, commit its vocables to his memory, and uſe them afterwards in recalling his ideas. Another who muſt ſoon perceive its failings, is he who engages in comparative anatomy, and who is anxious to extend his views beyond that which the fooliſh indolence of conceited bombaſt has called the *microcoſm*. A third will be he who has remarked the numerous ſynonymes which different authors have thought themſelves warranted to ſubſtitute in place of the old terms: for theſe repeated attempts at amendment are a ſtrong proof of that eſtimation in which it is held by the anatomical writers in general: And, laſtly, that man cannot heſitate long to paſs upon it a condemnatory ſentence, who, like Wilkins, Locke, Condillac, and Reid, is a perſon of extenſive and profound reflection, who is well acquainted with the intimate connection between accurate expreſſions and accurate ideas; who knows how much the improvements of language are able to facilitate the progreſs of ſcience; or who has experienced the wondrous effects that have already reſulted from the example and labours of Linnæus, and particularly from the new nomenclature in chemiſtry, which can hardly be too much valued and admired.

Our intention here is, not to ſuggeſt a particular plan for any new anatomical nomenclature: the ſtate of our knowledge may in this reſpect be yet too imperfect, and perhaps it may be neceſſary to ſee more of the animal economy, before we ſhould venture on ſuch an undertaking. We may however, in general, obſerve, that this nomenclature, like the languages of nations, ought not to be formed with any view to an individual, a ſpecies, or genus; and after that be careleſsly extended by fanciful analogies to new objects, and from theſe again be extended to others; thus making metaphor to ſpring out of metaphor without end, until the original figure be loſt, and revived and loſt again, times without number. It ought to contain as many as poſſible of thoſe terms which, underſtood in their primary ſenſe, might apply to the whole animal kingdom and living bodies, without any metaphorical expreſſions, if, in deſcribing the taſtes and colours, ſuch expreſſions can be avoided. Inſtead of the words anterior, poſterior, inferior, and ſuperior, which are perpetually ſhifting their meaning with a change of attitude, it ought to have words of one conſtant invariable import, expreſſing the regions of the head and the back, and their two oppoſites. Theſe terms, with right and left, would be found in anatomy to anſwer nearly the ſame purpoſe that the degrees of longitude and latitude, or the points of the compaſs, do in geography. Every part would then be conſidered as lying within, or as pointing to, ſix different regions, the right, the left, the head, the back, and their two oppoſites. If more particular deſcriptions were wanted, the definitive terms might then be taken from the more immediately ſurrounding parts: thus, giving an account of the ethmoid bone, D'Azyr borrows the definitive words from the regions of the cranium, the ſincipital, baſilar, facial, and occipital; or from the regions in immediate contact, the cerebral, palatine, naſal, and ſphenoidal.

If an object attainable, this nomenclature too ſhould be derived from one origin, and not like the preſent be a wild incoherent Babyloniſh gibberiſh of a number of mixtures. It ought to aim at conveying its ideas with clearneſs and preciſion, and yet fully, conciſely, and promptly. In point of ſimplicity it ought to ſtudy the eaſe of the memory, in receiving, retaining, and in recollecting. To prevent a needleſs multiplicity of terms, it ought to avoid puerile minutiæ, which ſerve no end but to render deſcription tedious and confuſed; it ought to avoid ſuch trivial diviſions, as thoſe of the gut into duodenum, jejunum, ileum; or thoſe of the artery into ſubclavian, axillary, brachial; and, laſtly, it ought to be formed on a plan containing certain rules of conſtruction for giving names not only to parts already diſcovered, but to thoſe parts which are ſtill unknown, or which diſtinguiſh individual and ſpecies.

In impoſing names, it might perhaps be of ſome advantage to examine, not only together but ſeparately, the great conſtituent parts of the ſyſtem; as the bones, the ligaments, the cartilages, the muſcles, the membranes, and the glands; the nervous, the ſanguiferous, and abſorbent ſyſtems; and all theſe with their properties and uſes perſpicuouſly arranged. How far a regularity in compoſition, and a uniform variety of terminations, might be of uſe in this nomenclature, can beſt be conjectured from their great importance in the new philoſophical language of chemiſtry.

It has been obſerved, that ſuch a nomenclature, to encourage and aſſiſt the comparative anatomiſt, is ſtill wanting; and it alſo was remarked, that we yet are unacquainted with proper claſſifications of animals, peculiarly fitted to direct and abridge the anatomiſt's labour, and to ſatisfy the inquiries of the phyſiologiſt.

Our preſent phyſiological arrangements are, like our nomenclature, principally ſuited to the human body. To take

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Williſii, pſalloides vel lyra, falx duræ matris, pons Varolii, calamus ſcriptorius, torcular Herophili, corpus calloſum, ſubſtantia medullari, ſubſtantia corticalis vel cinerea, pedunculi cerebri et cerebelli, femora, brachia, crura anteriora et poſteriora medullæ oblongatæ, fornix, corpora ſtriata, thalami nervorum opticorum, cornua nervorum opticorum, corpora olivaria, corpora pyramidalia, glandula pinealis, arbor vitæ, tubercula mammillaria, appendices vermiformes.

our inſtance from the celebrated Haller, he begins his Outlines with the ſimple fibre, and the cellular texture, of which he is anxious to compoſe as many of the ſolids as he can. He then proceeds to more of the organs, deſcribing with great erudition and care their different uſes and ſtructure in man. Theſe organs, however, which he deſcribes, and thoſe analogous with reſpect to their ſtructure, are confined to a part of the animal creation. As different claſſes of the animal kingdom have with ſimilar functions varieties of organs, and as one function is conſequently performed in different ways, it is evident that organs ought not to form the general diviſions in any phyſiological ſyſtem of arrangement, becauſe we ſhould then have a new arrangement for every new ſpecies of organs. Of this truth Haller and others have not been ignorant. They have alſo divided their ſubject into functions; but ſtill they are functions in the manner performed by the human body. This body has engroſſed ſo much of phyſiology, that we often ſee the functions explained with ſcarcely any alluſion to their organs; as theſe are ſuppoſed to be always the ſame, and already known from the uſual diſſections.

Haller's phyſiology is profeſſedly that of the human body. His conduct here was ſeemingly the effect of general cuſtom: it did not ariſe from any contempt of comparative anatomy. There have been few who eſteemed it ſo highly, who have ſtudied it more, or applied it ſo ſkilfully. He declares there are many parts of our bodies whoſe functions can never be fully explained, unleſs we examine their ſtructure in quadrupeds, in birds, in fiſhes, and even in inſects; though he therefore had diſſected of human ſubjects to the number of 350, yet the number which he diſſected of brutes, and, what is more, diſſected alive, was much greater. Numerous, however, as were his diſſections, they were too confined for general phyſiology. That requires a range more extenſive; and, to ſhorten the labour, different claſſifications of animals from any of thoſe to be uſually met with. This aſſertion hardly needs a proof.

There is nothing more certain, than that, were the anatomiſt to diſſect animals as they occur in the ſyſtem of Linnæus, or any other naturaliſt, his toil would be immenſe, and the knowledge which he thence would acquire of functions would ſcarcely be found to bear to it even the ſmalleſt proportion. By this obſervation we mean not to object to thoſe ingenious claſſifications which Linnæus and others have employed to facilitate the ſtudy of zoology. All their claſſifications may be uſeful; and many diſplay that extent and clearneſs of comprehenſion, that diſtinguiſhing acuteneſs, and that laudable ardour for the intereſt of ſcience, which ought to render their authors immortal, and entitle them to the gratitude of future ages. Yet theſe ſyſtems are formed with a view different from that which principally ought to direct the phyſiologiſt. They were meant to contain a full enumeration of the objects of zoology ſo far as known; to exhibit them arranged in different claſſes and ſubordinate diviſions, according to ſuch obvious and diſtinct marks as might ſtrike at a glance, or appear on a curſory examination. To him who is entering on the ſtudy of zoology, they ſhow at once the extent of his ſubject; they elevate his mind by the grandeur of the proſpect; and when better employed than in pleaſing the fancy, or in rouſing the rapturous feelings of a poet, they draw his attention to thoſe ſignificant and marked ſigns in which the language of nature is written. They aſſiſt his judgement in the art of arrangement, and give to his memory a power of recollection which it had not before. To the natural hiſtorian they perform a ſervice equally important, if not eſſential, to his undertaking: to him they ſupply the place of chronology; and inſtruct his readers by the chain of connection which they give to his thoughts, and by that perſpicuity which they invariably beſtow on his language.

Theſe arrangements, however, with all their advantages, are not the arrangements which the phyſiologiſt would wiſh the anatomiſt to obſerve in his diſſections. They are certainly uſeful in ſtudying the manners, diſpoſitions, and habits of different animals, and all that part of the outward economy which indicates ſomething of their wiſdom and deſign. But they little illuſtrate that internal ſtructure on which this outward economy is founded, or tend to explain the more ſecret functions, which, not depending on the will of the creature, only diſplay the power and omniſcience of him who made it. This conſequence is eaſily conceived, from conſidering the difference between zoology, and what has been here defined phyſiology. Zoology is chiefly led to examine the animal kingdom as it uſually preſents itſelf to the eye, including a great variety of objects; phyſiology, only that ſingle part of the animal economy which is chiefly made known by anatomy and chemiſtry. Zoology has been wont to divide its kingdom into ſo many claſſes or orders of animals; phyſiology would naturally divide its economy into ſo many functions. Zoology has ſubdivided its claſſes by certain obvious and exterior marks, as the teeth and the claws; phyſiology would naturally ſubdivide its functions by the many varieties of thoſe organs which are deſtined to perform them, as the different kinds of lungs and of ſtomachs. Zoology but curſorily mentions the functions as forming a part of the hiſtory of animals; phyſiology takes notice of animals only when they are of uſe to illuſtrate its functions. From this compariſon it will readily appear, that things which are primary in a zoological will often be ſecondary in a phyſiological ſpecies of arrangement; and that things which are primary in a phyſiological will often be no more than ſecondary objects in a zoological. This is very conſpicuouſly the caſe in one of the grand diviſions of Linnæus into mammalia, where the important ſecretory organs of the milky fluid are noticed only, like the colour of hair or the length of a tail, as a good outward mark of diſtinction; and likewiſe in the excellent table of D'Aubenton, where the function of digeſtion is not even alluded to at all; although he had complained that there was more of art than of nature in the common arrangements, that claſſification by outward marks had confounded things of a different ſtructure, and that the leſſer diviſions ſhould be made only by marks relating to the functions.

<table>
<tr><th colspan="8">ANIMALS.</th></tr>
<tr><td colspan="7">With a Head.</td><td>The moſt part without a Head.</td></tr>
<tr><td colspan="6">Noſtrils.</td><td colspan="2">Without Noſtrils.</td></tr>
<tr><td colspan="6">Ears.</td><td colspan="2">Without Ears.</td></tr>
<tr><td colspan="3">Two Ventricles in the Heart.</td><td colspan="3">One Ventricle in the Heart.</td><td colspan="2">The Heart variouſly formed or unknown.</td></tr>
<tr><td colspan="3">Warm Blood.</td><td colspan="3">Blood nearly cold.</td><td colspan="2">A whitiſh Fluid inſtead of Blood.</td></tr>
<tr><td colspan="3">Inſpiration and Expiration of the Air at ſhort Intervals.</td><td colspan="2">Inſpiration and Expiration of the Air at long Intervals.</td><td>Admiſſion of Air by Gills.</td><td>Admiſſion of the Air by Spiracula.</td><td>No apparent Entrance to admit air.</td></tr>
<tr><td colspan="2">Viviparous.</td><td colspan="6">Oviparous.</td></tr>
<tr><td colspan="2">With Teats.</td><td colspan="6">Without Teats.</td></tr>
<tr><td>1ſt Order.
Quadrupeds.</td><td>2d Order.
Cetaceous Animals.</td><td>3d Order.
Birds.</td><td>4th Order.
Oviparous Quadrupeds.</td><td>5th Order.
Serpents.</td><td>6th Order.
Fishes.</td><td>7th Order.
Insects.</td><td>8th Order.
Worms.</td></tr>
<tr><td>Four Feet and hairy Skin.</td><td>Fins and no Hair.</td><td>Feathers.</td><td>Four Feet and no Hair.</td><td>Scales without Feet or Fins.</td><td>Scales with Fins.</td><td>Antennæ.</td><td>Neither Feet nor Scales.</td></tr>
</table>

It is plain from this table, and from what we have mentioned concerning Haller, that it would be injuſtice to anatomiſts and naturaliſts to ſay they have never paid any attention to the phyſiological modes of arrangements. It can only be ſaid that they have not paid to them all that attention which they deſerve; and that no general phyſiological ſyſtem of arrangement, excepting D'Azyr's, has, ſo far as we know, been yet attempted.

How ſuch an arrangement ought to be made is eaſily deſcribed, though by no means very eaſily executed. It needs not a proof that functions ſhould form its primary diviſions; that its ſubdiviſions ſhould be the varieties of theſe functions; that the whole ſhould be both diſtinguiſhed and explained by the kinds and varieties of thoſe organs by which they are performed; that the deſcriptions of theſe organs might partly be collected from the ſeveral works of natural hiſtorians and comparative anatomiſts, as from the diſſections of the French academy, from numerous fragments of the *Curieux de la Nature*, from the collections of Blaſius and Valentini, from the writings of Haller, from the works of the celebrated Hunters and Monros, from the publications of Hewſon and Cruikſhank, and thoſe who have lately been making diſcoveries in the ſyſtem of abſorbents. D'Azyr has mentioned a great many more. He particularly recommends Perrault, Du Verney, Collins, and D'Aubenton, on Birds and Quadrupeds; Charas, Roeſel, and Fontana, on Reptiles; Ray and Willughby, Artedi, the Gouans, and Brouſſonet, on Fiſhes; Swammerdam, Malpighi, and Reaumur, the Geoffroys, Bonnet, and Lyonnet, on Inſects; and, laſtly, the curious reſearches of Willis, Ellis, and Donati; of Trembley, Baker, Baſter, and Boadſch; of Forſkal, of Adanſon, of Muller, Pallas, Spallanzani, and Diquemare, concerning Worms, Zoophytes, and Polypes. Where any errors are to be corrected, or where any deficiencies are to be ſupplied, it is needleſs for us to obſerve, that recourſe muſt be had to new examinations and to new diſſections, where it may be of ſome uſe to attend to the foods of animals, to their places of abode, and their modes of life, as circumſtances leading to ſome internal varieties of ſtructure. To the liſt of authors we might have added Campfer on Fiſhes; and we ſhould not forget the excellent writings of D'Azyr himſelf, whoſe table of phyſiological arrangement is a work of merit that beſpeaks reflection, ingenuity, and labour, and which follows here, with only a ſmall variation in form.

A TABLE *of the* FUNCTIONS *or* PROPERTIES *of* LIVING BODIES.

1. DIGESTION.
2. NUTRITION.
3. CIRCULATION.
4. RESPIRATION.
5. SECRETION.
6. OSSIFICATION.
7. GENERATION.
8. IRRITABILITY.
9. SENSIBILITY.

Every body in which one or more of theſe functions are obſerved is to be conſidered as poſſeſſing organization and life.

1 DIGESTION.	Living Bodies	Which have	One or more ſtomachs, eaſily diſtinguiſhable from the œſophagus and inteſtinal canal,	Man. Quadrupeds. Cetaceous animals. Birds. Cruſtaceous animals.
			A ſtomach diſtinguiſhable only by certain expanſions from the œſophagus and inteſtinal canal,	Oviparous quadrupeds. Serpents. Cartilaginous fiſhes. Fiſhes properly ſo called.
			An alimentary canal, not diſtinguiſhable into œſophagus, ſtomach, and inteſtines,	Inſects. Worms. Zoophytes.
			Neither ſtomach nor inteſtines,	Plants.
2 NUTRITION.	Living Bodies	Whoſe nutritious juices are abſorbed	By veſſels beginning from internal cavities,	Man. Quadrupeds. Cetaceous animals. Birds. Oviparous quadrupeds. Serpents. Cartilaginous fiſhes. Fiſhes properly ſo called. Inſects. Cruſtaceous animals. Worms.
			By veſſels opening upon the external ſurface,	Plants.

3 CIRCULATION.	Living Bodies	With blood	Having a heart with two ventricles and two auricles,	Man. Quadrupeds. Cetaceous animals. Birds.
			With one ventricle divided into ſeveral cavities and two auricles,	Oviparous quadrupeds. Serpents.
			With one ventricle and one auricle,	Cartilaginous fiſhes. Fiſhes properly ſo called.
		With a whitiſh fluid	Whoſe heart is formed of one longitudinal veſſel, tuberous and contractile, in which there is a whitiſh fluid inſtead of blood,	Cruſtaceous animals. Inſects. Worms. In ſome cruſtaceous animals there is obſerved ſomething reſembling a heart.
		With juices	In which no heart has been yet obſerved, but only veſſels filled with juices of a nature different from that of blood,	Zoophytes. Plants.
4 RESPIRATION.	Living Bodies	Which reſpire	By lungs free from all adheſion, and ſpongy,	Man. Quadrupeds. Cetaceous animals.
			By lungs free from all adheſion, veſicular, and muſcular,	Oviparous quadrupeds. Serpents.
			By lungs adhering to the ribs, and provided with appendages,	Birds.
			By gills of different forms,	Cartilaginous fiſhes. Fiſhes properly ſo called. Cruſtaceous animals.
			By ſtigmata or holes in different rings,	Inſects. Earth worms.
			By an opening called trachea, or by external fringes,	Aquatic worms.
			By tracheæ,	Plants.
			In which there have been diſcovered neither ſtigmata nor tracheæ,	Polypes.
5 SECRETION.	Living Bodies			There are no bodies in which ſecretions are not carried on.
6 OSSIFICATION.	Living Bodies	Whoſe ſkeleton is	Internal and oſſeous,	Man. Quadrupeds. Cetaceous animals. Birds. Oviparous quadrupeds. Serpents. Fiſhes properly ſo called.
			Internal and cartilaginous,	Cartilaginous fiſhes.
			External and corneous,	Perfect inſects. Lithophytes.
			External and cretaceous,	Cruſtaceous animals. Shell-fiſh. Madrepores. The greateſt part of zoophytes.
			External and ligneous,	Plants.
			Which have no ſkeleton,	Inſects in their firſt ſtate. Worms. Polypes.

7 GENERATION.	Living Bodies	Which are	Viviparous,	Man. Quadrupeds. Cetaceous animals.
			Oviparous, whether the evolution of the eggs takes place within or without the female,	Birds. Oviparous quadrupeds. Serpents. Cartilaginous fiſhes. Fiſhes properly ſo called. Inſects. Cruſtaceous animals. Worms. Plants.
			Which propagate by ſlips,	Worms. Polypes. Plants.
8 IRRITABILITY.	Living Bodies	Which have	A body muſcular or contractile,	Greateſt part of inſects in the firſt ſtate of their transformation. Worms. Polypes.
			Muſcles covering the ſkeleton,	Man. Quadrupeds. Cetaceous animals. Birds. Oviparous quadrupeds. Serpents. Cartilaginous fiſhes. Fiſhes properly ſo called.
			A ſkeleton covering the muſcles,	Perfect inſects. Cruſtaceous animals.
			No muſcular power; no ſpontaneous movements.	Plants.
9 SENSIBILITY.	Living Bodies	Which have	Nerves and brain eaſily diſtinguiſhable from the ſpinal marrow,	Man. Quadrupeds. Cetaceous animals. Birds. Oviparous quadrupeds. Serpents. Cartilaginous fiſhes. Fiſhes properly ſo called.
			Nerves and brain ſcarcely diſtinguiſhable from the ſpinal marrow,	Inſects. Cruſtaceous animals. Worms.
			In which there have not yet been diſcovered nerves or brain, or ſpinal marrow,	Zoophytes. Plants.

The above table, which has its diviſions marked by the functions, and their kinds and varieties by the kinds and varieties of thoſe organs by which they are performed, differs conſiderably from a zoological. Borrowing its ſeveral marks of diſtinction from internal characters, it more clearly demonſtrates the difference between the mineral, vegetable, and animal, than any ſyſtem that attempts to arrange by outward appearances.

No minerals, whatever be their forms or the regularity and beauty of their figures, were ever ſaid to poſſeſs any thing like organs of nutrition; and however frequently ſome may recover their loſt ſhapes, they are never ſuppoſed either to produce, or aſſiſt in producing, their own kind by generative powers. And no plants, however much may be ſaid of animals that want a nervous ſyſtem and a heart, and are fixed, without the power of loco-motion, to one place; we ſay, no plants, though ſome may repreſent a few of the ſimpler effects of ſenſation, and others may be free to float through the ocean, were ever ſaid to diſcover any ſigns of voracity, to poſſeſs any thing reſembling a ſtomach, to diſtend their body by ſwallowing their food, to apply their food to the mouths of abſorbents opening internally; and, when the nutritious juices were extracted, to eject it *in cumulo*. It has been ſaid that zoophytes preſent ſimilar phenomena. But what are zoophytes? One half of their name would imply that they are animals, and another half would inſinuate that they are plants. D'Aubenton reaſons with clearneſs on this ſubject. True, ſays he, the greateſt part of them are branched like plants, and like plants are compoſed of concentric circles. Some have a ſoft exterior ſubſtance which is called bark, and a hard interior which is called wood. Along their branches, and at their extremities, they put forth veſicles which reſemble buds; and when a part falls from the whole, it is ſufficient, like a vegetable ſlip, to produce a zoophyte; but do theſe appearances prove that they are plants?

If ramifications conſtitute a plant, then many cryſtallizations will be plants; the ſhootings of froſt on our windows will be plants; the ſilver tree of Diana a plant; our veins will be plants, our arteries plants; and our very feet, which ramify into toes, and our hands into fingers, will have ſome title to be called plants. The truth is, ramification is not univerſal in the vegetable kingdom; and although it be general, it is no more peculiar to plants, than ſwimming is to fiſhes or flying to birds. If concentric circles conſtitute a plant, ſome bones of animals will then be plants, and ſome minerals muſt alſo be plants. The wood and the bark are only two metaphorical expreſſions, which with equal propriety might have been uſed of the bone and perioſteum. But once ſuppoſe the zoophyte a plant, it was natural to carry on the analogy, and certainly neceſſary to have it provided with wood and bark; though it muſt be allowed that a corneous ſubſtance is not what we commonly mean by bark, nor an evidently hard calcareous ſubſtance what we mean by wood. The ſmall veſicles, except in appearance, have no ſimilarity to buds or fruits; they are the reſidences of ſmall polypes, to whom the whole ſtructure has been owing, by whom the whole either is now or has been inhabited, and to whom it anſwers the ſame purpoſe as the ſhell does to teſtaceous animals.

After thus endeavouring to point out the boundaries between the mineral, the plant, and the animal *, before we begin to treat of the functions, we muſt alſo take notice of another diſtinction; the want of which has occaſioned much unneceſſary trouble, and has given riſe to not a few ridiculous diſputes. This is the diſtinction between living bodies and ſome ingenious contrivances of art, which are called machines. It has not been aſſerted that any machine can either grow or propagate its kind; that it can aſſimilate the particles of matter that come in contact; that it is able to repair the injuries which it may ſuffer; that it can accommodate itſelf to circumſtances, can create heat when the cold is keen, or cold when the heat becomes too violent: yet it has been ſuppoſed, from eſtabliſhed prejudices, and from the ſucceſſive evolution of parts in plants and in animals, that there is an analogy between a machine and a living body. The living body has been called a machine; and notwithſtanding the acknowledged truth of that obſervation, ſo often repeated ſince the days of Hippocrates, That the whole is a circle, that nothing is firſt and nothing laſt in the animal economy, we are ſtill talking as if living bodies were nought but machines; we are ſtill reaſoning as if their parts had exiſted in ſucceſſion, had acted in ſucceſſion, were combined in ſucceſſion; we are ſtill ſeeking for what is prior and what is poſterior, for what is derived and what is original in point of ſtructure, as if we were examining a work of art; we ſpeak gravely of the viſcera, of the thorax deriving a coat from the membranous pleura, the abdominal viſcera from the peritoneum, and the branches of nerves deriving a pair from the dura and pia mater of the head; we argue with people who maintain that faſciæ are nervous expanſions, and the muſcles themſelves but nervous productions: and although we be hardly able to conceive how the brain could be nouriſhed without blood thrown from the heart, or the heart move without the aſſiſtance of nerves from the brain, we are ſtill diſputing about which was prior and which was poſterior in point of exiſtence; a diſpute that will probably terminate as ſoon as that of the ancients, whether the firſt eggs were from birds, or the firſt birds were hatched out of eggs.

Theſe dark and inſcrutable myſteries of nature we preſume not to explain; they point out almoſt the creative hand, and bring us almoſt into the immediate preſence of that Being by whom we live, move, and exiſt; and before whom the truly feeling and elevated mind is leſs diſpoſed to examine than adore. We are only to obſerve, that from this coeval formation of parts which the microſcopic part of anatomy has often diſtinguiſhed from their evolutions, and from this mutual dependence of organs one on another, we are left at freedom to begin at any part of the circle, and treat of the general properties and functions of living bodies.

We now venture on a rude ſketch of the order and manner in which theſe properties may be explained, and in which the facts in general phyſiology may be afterwards arranged. Another opportunity may produce ſomething more full and correct. In the preſent ſketch, many imperfections will no doubt be found; we already are able to foreſee many, from our own inability to treat the ſubject according to its merit. And perhaps the reader, who is poſſeſſed of temper and candour, will impute ſome to the newneſs of the plan, and the preſent infant ſtate of the ſcience.

Without blaming the arrangement of D'Azyr, whoſe genius and labours we ſhall always reſpect, we have been induced to adopt the following, from thoſe reaſons with which the reader is now to be acquainted.

Attending minutely to a living body, which already has eſcaped from the ſeed, the egg, or membranes of the parent, which is wholly diſengaged from the placenta, and depends for the future on the operations of its own organs †, we may obſerve, that in order to live, it muſt be allowed the free uſe of air, as applied by the organs of—*Reſpiration.*

That, in order to grow, it muſt have likewiſe a ſupply of food, which is a ſubſtance ſomehow adapted to its conſtitution; and which, on being received into the ſyſtem, is

Prepared by—*Digeſtion,*
Taken up by—*Abſorption,*
Diſtributed by—*Circulation,*
Aſſimilated by—*Nutrition,*
And the whole carried on by means of—*Secretion.*

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* It is curious to obſerve how careleſs we are in annexing preciſe ideas to our words. Bonnet ſuppoſes that in ſome world more perfect than ours, the rocks may be organized, plants may feel, brutes may reaſon, and men may be angels. In this paſſage, the form was all that ſeems to have entered into his idea of the man and the brute; and ſo new was his notion of a perfect world, that one who believed in the metempſychoſis would naturally imagine that he here had been fancying a ſtate for the damned, where angry Heaven was to fetter the angel in the form of a man, a man in that of a brute, a brute in that of a vegetable, and a vegetable in that of an uncouth rock. How much to be pitied would the creatures be that reaſoned and felt, and were at the ſame time more incapable of moving than an oyſter or a limpet!

† To give a general view of the manner in which living bodies are nouriſhed and ſupported in the egg and uterus, and before they begin to depend entirely on their own organs, we have ſubjoined a plate (ſee Plate I.) repreſenting embryos of various kinds. Fig. 1, 2, 3, are from Swammerdam: the firſt is the membrane containing the inſect, the ſecond the membrane after the eſcape of the inſect, the third is the inſect itſelf, fed by abſorbents opening on different parts of the body.

Fig. 4, 5, and 6, are from Grew: Fig. 4. is a bean, ſpreading its ſeminal roots into the lobes. In the fifth and ſixth the lobes of the ſeed are ſeen converted into ſeminal leaves.

Fig. 7 to 12 repreſent the transformations of the chick in ovo: the firſt of theſe figures is from Aquapendens; the reſt are from Blaſius, who got them from Malpighi.

The remaining figures are from Aquapendens; the two laſt repreſent a fiſh that is ſometimes oviparous, ſometimes viviparous.

Plants and animals are here obſerved ſpreading their roots in a ſimilar manner. The proper proportions are overlooked, not being neceſſary to convey the idea which is here intended.

We next may obſerve, that in order to enjoy the free exerciſe of theſe functions, it muſt be ſecured from the more common and external injuries of its ſituation; and that this is done by certain integuments originally produced, and, when it is neceſſary, afterwards renewed by that function; which, till we receive a new nomenclature, we ſhall venture to call by what may be rather an uncouth word—*Integumation.*

We again may perceive, that theſe functions are all dependent on a general principle—*Irritability:*

By which the ſyſtem is rendered by ſtimulants ſuſceptible of—*Motion;*

Accommodates itſelf to different circumſtances by means of—*Habit;*

Alters its ſhape by ſucceſſive—*Transformation;*

Produces the ſpecies by—*Generation;*

And when the buſineſs of life is finiſhed, is, after many a languid affection from the influence of—*Sleep,*

At laſt ſubjected to the general fate of all living bodies—*Death.*

Theſe we imagine are the general properties of living bodies; and ſuch is the order in which we are now to take a ſhort and curſory view of them.

SECT. I. *Reſpiration.*

Is that function by which air is brought into the ſyſtem, and by which it is prepared in particular organs, that in ſome reſpect ſucceed the placenta in the general economy. For, as any interruption of the uſual intercourſe between the placenta and fœtus in ovo proves ſoon fatal; ſo, when that communication naturally ceaſes, and the new one ſucceeds between the lungs and external air, it is likewiſe found, that any preternatural interruption of this laſt is in all living bodies preſently attended with various ſymptoms of increaſing languor, and in many with an almoſt inſtantaneous death.

So eſſential is reſpiration to the ſyſtem, that ſnails, chameleons, and ſome other animals, can live for years upon air alone. We have ſeen a chameleon that lived and was vigorous for twenty-two months without any food, and which might have continued to live much longer but for an unfortunate bruiſe by a fall.

Other phenomena equally demonſtrate the importance of air to the living body. The frog leaps away wanting its heart; it ſurvives the loſs of the greateſt part of its ſpinal marrow. Without its head, it lives for ſome days, and its heart continues to circulate its blood[*]. Spallanzani took one from the back of a female, cut off his head, and, after performing this whimſical experiment, ſaw the gallant return to his miſtreſs, graſp her in his arms, and finiſh the taſk which he had begun. And Borelli found, that eels and ſerpents, though their bodies be opened, and the whole of their viſcera be taken out, are able to move for a day after; and yet notwithſtanding, in all theſe animals, the life is obſerved to be ſuddenly extinguiſhed when the all-vivifying air is excluded. Even the ſmalleſt inſect has died, and the plant loſt its vegetative power, when retained for any while in a vacuum. The fiſh itſelf, when placed under the exhauſted receiver, has ſtarted anxiouſly to the ſurface of the water in queſt of freſh air; and, finding none, has ſunk to the bottom and expired in convulſions.

If objections ſhould be made to theſe trials performed in a vacuum; if it ſhould be ſaid, that under the receiver the ſhrivelled fruit ſwells and turns plump, that the body of the frog is ſtrangely inflated, that its turgid eyes grow prominent in its head, and that thin phials corked full of air are broke by its expanſion; ſtill there are facts which do not admit of the like equivocal interpretation. All living bodies will die in the air which they have reſpired; and when ice covers the whole of the water, many of the fiſhes are known to periſh; or, if an opening be made in the ice, to haſten to the air, and, rather than retire, quietly ſuffer themſelves to be caught.

To this general dependence of life upon reſpiration there occur but few things like an exception: theſe are, ſome ſerpents and worms and cruſtaceous animals found alive in the hearts of ſtones, ſome inſects that were found in wood, and a number of toads which in different places have been taken from the hearts of trees and of rocks, where they left an impreſſion, and where they were ſuppoſed in ſome caſes to have lived for centuries without air. Theſe facts, real or pretended, have been the cauſe of much ſpeculation. Some philoſophers, who imagine that nature is always obliged to act agreeably to thoſe ideas which they have already formed of her laws, are, notwithſtanding the high authorities by which ſome of theſe facts are atteſted, diſpoſed to doubt them. General analogy, which regularly oppoſes ſingular phenomena, is upon their ſide; and without her concurrence, they will grant exiſtence to no living body that will not ſubmit to the old eſtabliſhed modes of reſpiration. Others again, who would not preſume to dictate for nature, who have long experienced that ſhe is not forward to obtrude her ſecrets, and who can believe that ſhe may have ſtill ſome to communicate, conſider theſe facts as ſomething new which ſhe means to impart; and as one of the inſtances where ſhe ſeems to deviate from general analogy, in adhering to her grand accommodating principle, by which ſhe fits every living body for a certain range of varying circumſtances.

Theſe laſt, receiving the facts as ſufficiently authenticated, have ſtudied only how to account for them. When ſtones therefore were thought coeval with the world itſelf, they ſuppoſed their toads to have ſprung from the ova that were ſcattered through the earth at its firſt formation; they did not recollect, that if the earth muſt have exiſted before theſe ova could have been ſown, and that if the ſtones were coeval with the earth, the ova could not have entered their ſubſtance. When they afterwards learned that the conſolidation of ſtones is an operation ſtill carried on in the mineral kingdom, they acknowledged their ova to be leſs ancient, but did not perceive that all theſe ova involved ſuppoſitions that cannot be admitted by ſound reaſon. For, how was an ovum to grow without air and without food? and how particularly was it to grow with ſuch a force as to make an impreſſion in a ſolid rock? This would imply a power of expanſion ſcarcely to be equalled by gun-powder, and which we ought not to be raſh in aſcribing to the nutritive effects of abſtinence and nothing. Were it not for the toad, the expanſion itſelf might have found a ſolution in *a theory of the earth*, which has caſt all its ſtones in a foundery under the water, where the moiſture might have rendered them apt to be formed with numerous cavities.

Perhaps the way to remove theſe difficulties concerning the toad, would be to aſcertain its mode of exiſtence in the heart of the ſtone. Suſpecting that the air communicated ſomehow with the ſolitary cell, we procured a toad that was crawling out from its den in the evening. It was put into a glaſs juſt large enough to hold it with eaſe. The mouth of the glaſs was filled with cork ſufficiently cloſe to retain water; the glaſs was then laid on its ſide, and the animal reſpired for ſeveral days without diſcovering ſigns of uneaſineſs: but ſuppoſing that air might ſtill be admitted, the cork received a covering of wax, and the animal died ten hours after.

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[*] "Two days (ſays Dr. Monro) after cutting off the head of a frog at its joining with the firſt vertebra, I found it ſitting with its legs drawn up in their uſual poſture; and when its toes were hurt it jumped with very conſiderable force. Its heart likewiſe continued to beat about forty times in a minute, and ſo ſtrongly as to empty itſelf and circulate the blood.

"In ſeveral frogs, after cutting off the back part of the ſix undermoſt true vertebræ, I took out all that part of the ſpinal marrow with the cauda equina which they cover. The lower extremities were rendered inſenſible to common injuries, and lay motionleſs: yet the frogs lived ſeveral months thereafter, and the wounded parts of their backs cicatriſed, and the bones of their legs which I fractured were reunited, the blood circulating freely in their veſſels." *Experiments on the Nervous Syſtem*, made chiefly with the view of determining the nature and effects of animal electricity.

From this experiment, and the fate of toads when put under an exhauſted receiver, from an air paſſage in the cruſt of chryſalids, from the porous texture of the white ſpeck, or the opening which the ſnail leaves in the membrane that is ſpread over the mouth of its ſhell, we were led to think on D'Aubenton's remark, that the incloſed toads might have breathed, and that the wood has been always cleft, and the ſtone broken, before it was ſhown how the external air was excluded.

On farther reflection, our own experiment appeared inconcluſive; and D'Aubenton's remark, after cloſe examination, ſeemed not entitled to much attention. He would have it ſuppoſed that a toad is lurking in every block of ſtone and of wood; and on this ſuppoſition would have an inquiry to be regularly made, whether or not there be any communication between this ſuppoſed animal and air; becauſe, when the ſtone or wood is in fragments, the attempt to diſprove ſuch communication is in his opinion impoſſible.

But are we certain that the admiſſion of external air would remove the difficulty? We are not ſo poſitive now as we were upon this ſubject. In the ſummer months we recollect to have drowned frogs which were living in the fields, by keeping them ſome hours under water; but if we allowed them to riſe to the ſurface, and reſpire at pleaſure, they became at laſt ſo accuſtomed to that element, that, if the temperature was not much above that of ſpring-water, they lay in the bottom not only for days but for weeks together.

In the winter ſeaſon, it is well known that frogs are ſometimes diſcovered in cluſters below ſtones and under water in the neighbourhood of ſprings; and often ſeen in the bottom of ponds, marſhes, and ditches, where water is collected, and the whole ſurface covered with ice. In this ſituation, we have frequently examined their ſides and their noſtrils, and can venture to aſſert, that they did not reſpire in the ſame manner that they did when on land: for, the moment that this animal is put under water, the palpitating motions of its ſides and its noſtrils are obſerved to ceaſe; and Chaptal has ſeen them ſuſpending reſpiration as it were at pleaſure even when in air.

While they move, however, and exhibit indications of active life, we would not ſay that air is excluded. In the roots of plants, in aquatic worms, in polypes, and in the placenta itſelf, the ſame organs ſeem to perform the double office of lungs and abſorbents. When under water, what are the functions of theſe organs in frogs and in toads? It is not diſputed that in moiſt places they can live longeſt without food; and ſome phenomena which have been obſerved relating to this ſubject appeared to us not unworthy of attention. In the beginning of the ſummer, 1793, while we were making a few experiments on the nervous influence with ſome metals, a frog was taken out of the water in the duſk of the evening, and put into a deep and wide-mouthed glaſs till next morning: but next morning a quantity of water was found in the glaſs, the animal was dead, its mouth full of foam, and the greater part of its body covered with froth. The following autumn a boy came with a couple of toads wrapt up in tow. Till we had leiſure to make our experiments, they were allowed to remain as they were for three days in the corner of a room. When taken out, their colour was pale, their bodies much ſwelled, and a quantity of water collected between the ſkin and the muſcles. When held in the hand with their head upwards, the water was evacuated downwards by the anus. It was one of theſe toads that afterwards died when confined in the glaſs without air. Its body was put into a ſolution of madder for two days; and when the ſkin and muſcles were removed, the bones, which are ſtill preſerved, were found red. A live frog in the ſame ſolution, though allowed to breathe, expired in a few hours. In three days its bones became of the red colour, but not ſo deep as that of the toad's. Another frog died in the ſolution; but the bones, from age or ſome other cauſe, did not receive the colour of the madder. In all caſes the ſkins were found red.

As we know not how far the great accommodating principle of nature may be extended, perhaps the abſorbents opening externally may in theſe animals ſometimes ſupply the place of the lungs, as the lungs ſupplied the place of the gills which they uſed when tadpoles, and as the gills had formerly ſupplied the place of a placenta, or the primary abſorbents, through which they derived their nouriſhment in ovo.

Thoſe ſtones which incloſe animals are known to be ſuch as have gradually aſſumed the ſolid form, and thoſe animals which have been incloſed are known to be ſuch as in other caſes have been ſubjected to the torpid ſtate: But this ſtate has not been examined with all the attention which it deſerves. From this ſtate, Bonnaterre ſays, in his introduction to Ereptology in the *Encyclopedie Methodique*, that it is impoſſible to rouſe the animal by the loudeſt noiſe, the rudeſt ſhock, or the deepeſt wound; the internal motion is juſt ſufficient to preſerve the ſyſtem from that decompoſition to which animal ſubſtances are expoſed. It retains only the form of what it was. It appears neither to live nor to grow; and the whole maſs, if what is expoſed to the air be excepted, is not ſenſibly altered while the torpor continues. All the ſenſes are ſhut up; all their functions are entirely ſuſpended: digeſtion is no longer in the ſtomach; all reſpiration has apparently ceaſed; and it has been doubted whether or not this function be in ſome caſes at all retained. When the genial warmth, however, returns, in ſix, in eight, or in ten months, according to that variety of climates between the frigid poles and the tropics, the animal revives. But the queſtion is, if the firſt circumſtances in which the animal became torpid had been artificially or naturally continued, how long in this way might the different functions of life have been ſuſpended; and how far are we warranted by the analogy of ſeeds and of eggs to lengthen this period of their exiſtence, without ſuppoſing a decompoſition or deſtruction of organs?

Experiments muſt tell what are the limits which nature has here preſcribed to herſelf. New eggs, when covered with varniſh, or placed under the exhauſted receiver, are ſecured againſt the attacks of corruption. Bomare, in his Dictionary, has mentioned three, which, protected from air, were found freſh in the wall of a church after a period of 300 years*. And if it be true that a ſnake found in a block of marble died as ſoon as expoſed to the air, or if the parts in contact with air be the only ones which in torpid animals appear to be changed, it would ſeem probable that a total excluſion of this varying and active element would tend more to the preſervation of torpid animals, in certain inſtances, than a free admiſſion, which, in thoſe caſes where all vital functions have ceaſed, is regularly found a principal agent in their diſſolution.

M. Heriſſant of the French Academy was the firſt philoſopher who, by means of experiment, thought of interrogating

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* See Bomare, under the article ŒUF; and a fuller account of the ſame eggs in the *Dictionnaire de Merveilles de la Nature*, under ŒUF.

Nature herſelf upon this ſubject. On the 21ſt of February 1771, he with great accuracy ſhut up three toads from the air, two of which were taken out alive on the 8th of April 1774. D'Aubenton ſays, after a period of 18 months; but in this inſtance we depend more on the friend of Fontana, who has mentioned the dates. The two toads were again incloſed, and Heriſſant died before there was a ſecond inſpection. D'Aubenton ſays, that when taken out their bodies were hard and ſhrivelled, and their whole moiſture totally abſorbed. A fourth toad that had been incloſed was heard to croak whenever the box in which it was confined happened to be ſhaken. Since that period the practice is common of confining ſnails in a ſealed phial, where they exiſt in torpor for years.

Theſe phenomena ſtill excite wonder; but to wonder leſs, and examine more, would ſooner procure us that information which we are wanting. In theſe obſervations concerning toads, have no circumſtances been overlooked? Has it been determined whether they lived in the heart of ſtones, or, exiſting merely in a torpid ſtate, had come alive when expoſed to air? We have ſeen a toad that was dead for two days; its body was opened; its heart was ſeen motionleſs; but, expoſed to air, in a few ſeconds it began to beat. Conſidering the complex function of abſorbents, we perhaps might conceive how a toad could live in the clefts of rocks, or the hearts of trees, where there is moiſture; but has it yet been determined whether all ſtones in which toads have been found ſupplied them with moiſture? We at leaſt are certain that they did not abſorb the animal fluids, like the plaſter uſed by the French academicians.

One of the toads was heard to croak after being incloſed. In making their experiments, has it, therefore, been thought a matter of indifference by the French philoſophers, whether the animal was immured alive in the full exerciſe of all its functions, or exiſting only in its torpid ſtate? And with reſpect to this ſingular ſtate, (might not the queſtions be fairly put?) have its ſeveral kinds, have the cauſes which induce it, or thoſe degrees to which it may be carried in different animals, been yet aſcertained? Is not our knowledge of the torpid ſtate at this moment principally the reſult of caſual obſervation? Has it not been oftener than once ſuppoſed that the torpor of all animals is ſimilar, or takes place to a ſimilar degree? Have not torpid animals been therefore ſpoken of in general terms? and has it not been aſſerted that they retain a portion of heat and internal motion? though ſome have been found congealed in the ice, and many been dried to ſuch a degree that they could be revived only by moiſture.

"That ſnakes and fiſhes, after being frozen, have ſtill retained ſo much of life as when thawed to reſume their vital functions, is a fact," ſays Mr. Hunter, "ſo well atteſted, that we are bound to believe it." How came it, we would aſk, that fiſhes which had been frozen by this truly ingenious phyſiologiſt never recovered? He recovered parts of different animals which had been frozen. Had the ſnakes and fiſhes of which he had heard been only partially congealed in the ice? or had the fiſhes which he ſelected for theſe experiments been properly choſen? or may all animals with equal fairneſs be made the ſubject of ſuch experiments? and may all tranſitions from heat to cold, and from cold to heat, whether ſlow or rapid, if not in the extremes, be viewed as nearly of the ſame conſequence? Are all ſeaſons and conditions of body equally favourable to this ſtate of torpor? and will theſe cauſes which induce torpor by operating externally in the months of autumn be able to continue it by the like action in the months of ſpring? We can anſwer, No.

It has been ſaid that animals ſubſiſt in their torpid ſtate by the reabſorption of fat. Has it therefore been proved that all animals, not to ſay living bodies, are poſſeſſed of fat? or, if they be, has it been demonſtrated that they have a ſuperfluous quantity to be reabſorbed? Has it been ſhown that their waſte of fat is always occaſioned by this reabſorption? or has this reabſorption in all caſes been of that kind to counteract the effects of abſtinence? If it has not been proved that all animals contain fat, and that this fat is reabſorbed in their torpid ſtate, ought not the general aſſertion to be limited? Granting that in many reſpects it were true, have not philoſophers been here amuſing themſelves with logic, where they could have been employed in making experiments? Have they not ventured to give us concluſions, where we had reaſon to expect facts? And, on this account, has not their conduct been ſomewhat ſimilar to that of navigators, who, ſailing along the coaſt of Patagonia on one ſide, and obſerving a few men of an uncommon ſtature, have from thence peopled the whole of the country with a race of giants? or rather to that of ſome calculators, who, from ſeeing a few parts of a continent, have ventured to give a map of the whole, to deſcribe kingdoms that are yet unexplored; and, by their ſkill in addition and ſubtraction, to exhibit the figure, the extent, and proportion of lands unknown?

Leaving therefore the torpid ſtate as one of thoſe ſubjects with which we at preſent are little acquainted, and of which we therefore cannot ſpeak with certainty in the general abſtract language of ſcience; it will naturally be aſked, In what reſpect is air ſo neceſſary to all living bodies in their active ſtate, and how contributes it to the regular performance of the different functions?

The ancients, who were led by the heat of the blood to ſuppoſe a vital ſpark in the heart, who had noticed the appearance of ſmoke in the breath, and who had obſerved that fire was extinguiſhed when deprived of air, naturally inferred that the end of reſpiration was to ſupport their imaginary flame, to ventilate the blood in the arteries and lungs, and to keep alive their vivifying ſpark. They were far, however, from being agreed as to the manner how this was effected. Some were of opinion that a certain principle of the air was abſorbed, to which they gave the name of *the provender of life*, or the food of the ſpirit; while others were perſuaded that the air acted as a refrigeratory, and was merely intended to moderate the fire, to aſſiſt in expelling the fuliginous vapour, and preſerve the ſyſtem in an equal temperature.

The moderns, who, after all their reſearches, have been unable to diſcover this vital ſpark of the ancients, are more puzzled to aſſign an adequate cauſe for the heat than for any cold which they diſcover. To account for this ſingular phenomenon, they have been ranſacking nature for cauſes; and, perceiving that putreſcence, mixture, and friction, are in many inſtances accompanied with heat, have thence conjectured that they ſometimes operate in producing the warmth of the living body. But theſe are theories which have been imported from the hot-bed, the laboratory, and mechanic's ſhop, and which have never yet been countenanced by phyſiological facts and obſervations. No one has been able to ſhow that putreſcence exiſts in a healthy ſtate, except in the fæces: no one has proved that any mixture which regularly occurs in the alimentary canal or veſſels, generates heat; and though friction has been a favourite hypotheſis, yet thoſe circumſtances, in which it evidently produces heat, have not been diſcovered in the living body; and it is not determined whether it be there a friction of the fluids, a friction of the ſolids, or a friction of the fluids and ſolids together.

Of animal heat the moſt rational theory, we think, is one which properly belongs to the laſt century; it is confirmed by modern diſcoveries, and has aſcribed this heat to reſpiration. Many had obſerved, that thoſe animals which reſpire moſt have the warmeſt blood *. Lower demonſtrated, that this blood received a new and a brighter colour in paſſing through the lungs[†]. Verheyen and Borelli both proved, that the air loſt ſomething by coming in contact with that organ[‡]. Mayow ſhowed, that this ſomething which the air loſes is contained in nitre[§]. Experience taught the workers in nitre, that this ſomething was abſorbed from the air[‖]: and Verheyen remarked, that it is alſo abſorbed by the lungs; and is probably that which maintains combuſtion; which qualifies the air for giving ſupport to animal life, and imparts to the blood the vermilion colour[¶].

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* Quod autem animalia calidiora fortius reſpirent, non probat reſpirationem illis potius datam eſſe, ad ſanguinis refrigerium,

How well the whole of this reaſoning was founded, is proved by the late diſcoveries of Prieſtley and other chemiſts. There is now obtained, in a ſeparate ſtate, an aerial fluid, which maintains both life and combuſtion, and gives a vermilion colour to the blood. It is extracted in a very large quantity from nitre; is one of the component parts of the atmoſphere, and the vital principle of that element; without which, in moſt animals, life is extinguiſhed. From ſome phenomena which happen in combuſtion, it has been termed *principium ſorbile.* It was called dephlogiſticated air by Prieſtley, the firſt diſcoverer; as the great acidifying cauſe in nature, the French nomenclature has given it the name of *oxygenous gas*; and, as one of the cauſes on which the exiſtence both of fire and of life depends, it is named *empyreal* or *vital air*.

Late diſcoveries have ſhown farther, how this air may in reſpiration produce heat. From the moſt accurate inveſtigations, it appears, that caloric, or the principle of heat, is a diſtinct ſubſtance in nature; that it combines with different bodies in different degrees; that it is the cauſe of fluidity in all; and that, in proportion to that capacity which they have for it, and to that diſtance at which they are removed from the fluid ſtate, the more or leſs caloric they contain. Aeriform bodies being all therefore exceedingly fluid, it muſt be evident, that when they are fixed or condenſed in the blood, and made to approach nearer ſolidity, a quantity of heat muſt be evolved. A part of this is very plainly evolved in the lungs where the air is abſorbed, as appears by the breath; and a part evolved by the action of veſſels, as appears from nearly an equal heat over the ſyſtem, from the partial heat of a morbid part, and the ſudden tranſition from heat to cold, and from cold to heat, over the ſurface, when the veſſels are affected by either internal or external ſtimuli. When the heat, thus evolved by the gradual fixation of that body with which it was combined, has been ſucceſsful in making its eſcape by the lungs and integuments, the blood returns in a dark and a ſluggiſh ſtream by the veins, and mingles again with the genial fluid, which before gave it ſpring, activity, and life.

Of that oxygene which remains in the ſyſtem, part is employed in forming different ſaline combinations and ſupplying the waſte occaſioned by that conſtant reabſorption; which, from many experiments that have been made with ſolutions of matter, is known to take place in the ſolid bones. The uſe of that oxygenous gas which returns with the breath, is beſt underſtood after knowing its affinities. Its baſis oxygene, combining with hydrogene, which is the baſis of inflammable air, forms water; and, combining with carbone, the carbonic acid. It carries, therefore, back with the breath a part of the carbone produced by the ſlight combuſtion of the blood, and a quantity of hydrogene ariſing from the watery fluid decompoſed.

But oxygenous gas does not alone enter the lungs. Of 100 parts of the atmoſphere, but 28 are oxygenous gas, $\frac{1}{200}$ is carbonic acid, and 72 are azotic gas[*]. Theſe laſt, though intended chiefly for other beings different from man, which are in immenſe numbers on the globe, but which, like him and the nobler animals, are not formed to breathe the empyreal air, muſt notwithſtanding be of ſome important and eſſential uſe to all living bodies. It has accordingly been found by experiment, that pure and unmixed oxygenous gas cannot be breathed for any very conſiderable time without danger; that ſome azote is contained in the blood, and has been extracted from the muſcular fibre, when properly treated with the nitric acid. According to Berthollet, five of its parts with one of hydrogene form ammonia or volatile alkali; which diſpels the glandular tumours of the body, and prevents the coagulation of blood and the thickening of mucus which ariſe from acids[†]. The azotic gas may therefore in part unite with hydrogene, may prevent the coagulation of ſerum, the catarrhous formation of viſcid mucus, and many combinations that oxygene might form, injurious to the ſyſtem. The carbonic acid, which is $\frac{28}{100}$ of carbone and $\frac{72}{100}$ of oxygene, may alſo be neceſſary in regulating the effects of the other two. In aerated water, its uſes are very generally known: it allays the pain of the urinary bladder when excited by calculus; it has been employed in the cure of wounds, and been thought uſeful in the pulmonary phthiſis.

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quam calorem illum intenſum produci a validiori reſpiratione: imo poſterius non tantum æque, at magis probabile apparet: quia ſecundum omnium ſententiam calido vivimus, frigido extinguimur. Ut proinde non videatur aliquid a natura datum eſſe, quo intenditur frigus vitæ contrarium. *Verheyen*, Tract. 2. cap. 7. *de Uſu Reſpirationis.*

[†] Poſtquam circulatio ſanguinis innotuit, diu creditum fuit ſanguinem venoſum colore illo coccineo rurſus indui in ventriculis cordis, et præcipue ubi calor, quem judicabant iſtius coloris authorem, eſt intenſior: At negotium iſtud peragi in pulmonibus, nempe reſpirationis beneficio, evidenter oſtendit cl. Lowerus experimentis. *Ibid.*

[‡] Inquiramus quale ſit iſtud aëreum adeo nobis et multis animalibus neceſſarium, ut ejus defectu vita extinguatur citiſſime. Vulgaris enim aër dici non poteſt, cum illum per meatus notabiliores ſanguini immitti conveniret, ſitque experientia certiſſimum, animalia reſpirantia non tantum aëre ſimpliciter; ſed etiam recenti continuo indigere, unde concludendum eſt tantummodo aliquas particulas ſubtiliores ab aëre ſecerni, et maſſæ ſanguinis immiſceri, quibus ſpoliatus ad ulteriorem reſpirationem ſit inidoneus.

[§] Et quidem veriſimile eſt, inquit Mayow, particulas quaſdam indolis nitroſalinæ, eaſque valde ſubtiles, agiles, ſummeque fermentativas ab aëre pulmonum miniſterio ſecerni, inque cruoris maſſam tranſmitti. Adeo enim ad vitam quameunque ſal iſtuc aëreum neceſſarium eſt, ut ne plantæ quidem, in terra, ad quam aëris acceſſus precluditur, vegetari poſſint; ſin autem terra iſta aëri expoſita, ſale hoc fæcundante denuo impregnetur, ea demum plantis alendis iterum idonea evadet.

[‖] In aëre autem quid nitroſum contineri norunt ipſi vulgaris nitri confectores, qui terram aut laterum fragmenta ex quibus nitrum elixiviare intendunt, aëri liberiori diu multumque exponunt; utque ab eodem undique ea tangente ac perfluente uberius impregnetur, ſæpius vertunt, atque ita ſuorum ſumptuum et laborum ampliorem meſſem mercedemque referunt.

[¶] Inſuper, ſi poſt confectionem nitri terra aut laterum fragmenta exponantur libero aëri, ea denuo poſt aliquod temporis ſpatium, quodam ſale nitroſo abundabunt. Eſt autem veriſimile, aërem gratia ejuſdem materiæ et vitæ noſtræ continuationi et ignis accenſioni neceſſarium eſſe; præcipue cum rurſus experientia doceat ruborem ſanguinis e corpore educti, per additionem ſalis nitri intenſum iri in eodem prorſus modo ſecuti, per reſpirationem in corpore vivente. *Ibid.*

[*] Theſe are nearly the proportions.

[†] Weak volatile alkali diſſolves mucus, whoſe morbid viſcidity Fourcroy has aſcribed to a too great abſorption of oxygene.

It is generated in the lungs of thoſe animals which reſpire oxygene. In ſmall proportions it favours the growth of the vegetable tribes. Theſe tribes readily decompound it; and, with the addition of other prepared oxygene from water, reſtore what is pure to the general maſs of the vital fluid, that plants and animals might thus live by the mutual performance of kind offices.

We return again to animal heat. Every theory that pretends to account for animal heat, ought alſo to account for that ſingular equality of heat which the ſyſtem preſerves, or endeavours to preſerve, in different temperatures. The above theory explains it ſimply in the following manner.

Venous blood, if expoſed to the air, is known to abſorb a portion of oxygene, and aſſume that colour which it has in the pulmonary veins and aorta. Suppoſe an abſorption of a ſimilar kind taking place in the lungs, a fact which may be proved by deciſive experiments; it is plain that the oxygene by this abſorption muſt recede from its gaſeous or fluid ſtate; that a quantity of heat muſt be therefore evolved, which, along with the heat of the refluent blood, is carried away by that vapour which iſſues from the lungs. In the courſe of circulation, the oxygene will naturally incline with hydrogene to form water; it will tend likewiſe to the formation of many other compounds; and, as it enters into new ſtates, and is farther removed from gaſeous fluidity, it muſt ſtill be giving out a portion of heat. If the ſurrounding temperature be cold, this ſeparation will be eaſily effected. The caloric will, in that caſe, be greedily abſorbed from the interior ſurface of the lungs and exterior ſurface of the whole body. The oxygene, meeting with the neceſſary temperature, will readily paſs into new forms; and the venous blood, returning to the lungs, will demand a ſupply which will be either greater or leſs according as the cold, by favouring the eſcape of the caloric, and promoting new combinations with oxygene, had removed it from the point of uſual ſaturation.

The gradual evolution of heat is a proof that the temperature muſt be ſometimes reduced before the oxygene can properly enter into all the uſual combinations of the ſyſtem. Suppoſe the body then to be placed within a hot circumambient atmoſphere. This atmoſphere, if warmer than the animal, will be more apt to part with heat than to receive it; and the oxygene abſorbed, being thus unable to diſpoſe of its caloric, will be prevented from paſſing into thoſe combinations and forms where heat is evolved. The venous blood will therefore conduct it back to the lungs, and make a demand for a new ſupply; but proportionally leſs according as the hot circumambient air, by preventing the eſcape of the caloric, and the uſual facility of new combinations, has confined its removal to a ſmaller diſtance from the point of ſaturation.

In this laſt caſe the thing principally entitled to notice is a very curious effort of nature to reſiſt the growing increaſe of heat. In the warm atmoſphere, as during violent muſcular exertion, the exhaling vapour is commonly diſcharged in a greater quantity from the ſurface of the body; and conſequently the heat furniſhed with an excellent temporary conductor, that in ſome meaſure counteracts the dangerous effects from without.

After all, the reader is not to ſuppoſe that he here has received a general theory of reſpiration. All living bodies are not ſupported by the ſame kind of aerial food. Oxygenous gas has indeed been honoured with the flattering appellation of vital air; and nitrogenous gas been uſually diſtinguiſhed by that degrading epithet azotic, a word which ſignifies deſtructive of life. But though man, and all the warm-blooded animals that have yet been examined, may die in reſpiring the nitrogenous gas, this gas however, which conſtitutes more than two thirds of the whole atmoſphere, may in general be called the vital air of the vegetable tribes, and of not a few of the orders of inſects which thrive and live in it. For while man, and others which reſpire as he does, emit both the hydrogene and carbone, and return the nitrogene not ſenſibly diminiſhed; moſt vegetables and many inſects eagerly inhale them, and emit oxygene as noxious or uſeleſs. Theſe effects are the indications of a radical difference in conſtitution. Even the fibres of thoſe living bodies which exhale oxygene, will, after death, attract it ſo powerfully, as to decompoſe the nitric acid; but thoſe bodies which inhale nitrogene have ſo very weak an affinity to oxygene, and ſo ſtrong a one to ſome of the bodies with which it is combined, that they can eaſily decompoſe water and carbonated air.

What fiſhes reſpire is not aſcertained. Neither the change of the air, nor of the water which they occaſion when in cloſe veſſels, have, ſo far as we know, been fully examined. Chaptal is aſſured, that, like other animals, they are ſenſible of the action of all gaſes. Fourcroy ſays, that they do not generate the carbonic acid; and that the air which Prieſtley and he found in the air veſicles of carp was nitrogene gas. Their thermometrical heat is ſo low, that in D'Aubenton's table they are reckoned among the cold-blooded animals.

The temperature of plants is ſtill lower. The heat of a tree which the very ingenious Hunter examined, though ſeveral degrees above that of the atmoſphere when below the 56th diviſion of Fahrenheit, was always ſeveral degrees below it when the weather was warm. When taken out, the ſap was obſerved to freeze at 32°, while in the tree it would not freeze below 47°. The very profuſe perſpiration of vegetables greatly moderates the heat in their ſurface; and as air which abſorbs moiſture expands, and becomes thereby ſpecifically lighter, there is a regular current produced, and evaporation rapidly promoted by the denſe air diſplacing the rarefied.

To adopt here a general language with reſpect to the heat which is developed in all living bodies, it is proportioned to the quantity of matter which is by means of the vital powers reduced to a ſtate more nearly approaching ſolidity; to the kinds of the ſubſtances which are reduced, and to the degrees and kinds of the reduction.

In all living bodies there appear to be certain degrees of heat, peculiarly fitted for carrying on their various economical operations. What theſe are, in the different kinds of plants and animals, is not known. The bear, the hedge-hog, the dormouſe, and the bat, may probably not digeſt when reduced to 70°, 75°, or 80°. The frog, however, will digeſt at 60° [*]; and the birch before it arrives at 47° [†]. It would ſeem that reſpiration, beſides imparting aerial food, was intended to preſerve and regulate theſe different degrees of heat. It raiſes the heat after a meal; it ſuffers it to fall in the time of ſleep; it withdraws the ſupply when the atmoſphere is warm, and increaſes it again when the atmoſphere is cold. It ſhould therefore be remembered, that heat merely is not the object which is ſolely aimed at in reſpiration. All living bodies have their congenial degrees of heat. The regulation of theſe is important: on the one ſide, it prevents the diſſipation, on the other the coagulation, of their fluids; it preſerves the living power of their organs; and, by a natural and proper temperature, aſſiſts their action in mixing, compoſing, in decompoſing, and in variouſly preparing the different parts for ſecretion, excretion, abſorption, reabſorption, and aſſimilation [*].

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[*] See Obſervations on certain parts of the animal economy by Mr. Hunter. We allude here to his experiments and obſervations on animals, with reſpect to the power of producing heat.

[†] See Dr. Walker's excellent Paper on the motion of the ſap in trees, 1ſt volume of *Philoſophical Tranſactions, Edinburgh*.

As various fixations of the vaſcular fluid are regularly taking place in the different parts of the living body, and as air is not the only fluid concerned, it would almoſt be unneceſſary again to obſerve, that the whole of the heat is not evolved in the lungs, nor the whole that is evolved diſengaged from air.

It may farther be remarked, that the whole of the air does not enter by the lungs; much is contained in the liquid and ſolid parts of the food. It is extricated often in the proceſs of digeſtion; and, when the organs are vigorous and healthy, is made ſubſervient to the general economy. If the organs, however, ſhould happen to be languid, it ſcorns their authority, which cannot be enforced; from being friendly, it ſoon becomes inimical to the ſyſtem, and, threatening danger, accumulates not only in the ſtomach and inteſtines, but in other cavities. It has been found in the cellular membrane; in certain veſicles formed for itſelf; in the uterus; in an abſceſs; and in gun-ſhot wounds: it has ſometimes burſt from the vagina with a ſort of noiſe. And in a nephritic complaint of a horſe, we have obſerved it flowing in a ſtream from what the farriers denote the *ſheath*.

In ſome kinds of aquatic plants, in eggs, and in a variety of fiſhes, there are certain veſicles containing air, which ſeem to have certain neceſſary functions allotted them by nature. In the plants and in fiſhes they were once ſuppoſed to have been wholly intended for ſwimming [†]. It was remarked, that thoſe fiſhes which remain conſtantly at the bottom of the water have no air-veſicle; and that a fiſh whoſe veſicle was burſt by means of the Torricellian vacuum, though it lived for a whole month after in a pond, was never able to riſe to the ſurface. The practice, however, which ſome fiſhes have of aſcending at times to inhale air, and deſcending after their veſicle is filled; the communication which, in ſome fiſhes, this air-veſicle has with the ſtomach; that power in the pigeon and ſome other birds of introducing air into the crop; and, laſtly, the air which is uniformly found in impregnated eggs—would tempt us to believe that theſe natural collections of air, with their other uſes, may perform ſome eſſential ſervice in nutrition.

Having explained the general intention of reſpiration, we are now to inquire, what are the kinds of reſpiratory organs, and in what manner their functions are performed? The preceding table has in ſome meaſure made us acquainted with this ſubject. Some animals breathe by a trachea and lungs; inſects, by either ſtigmata or tracheæ, opening into air-veſſels; plants, by air-veſſels and leaves; fiſhes, and numbers of the watery element, if they do not breathe, at leaſt receive air by their gills; the fœtus in ovo, the polypus tribe, and many more organized bodies, by the ſame organs which convey their food.

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[*] The ingenious Dr. Crawford has publiſhed a theory of animal heat different from that which we have here preſented to our readers. Aſſuming as a fact, that heat and phlogiſton are two oppoſite principles in nature, he goes on as follows:

"Animal heat ſeems to depend upon a proceſs ſimilar to a chemical elective attraction. The air is received into the lungs containing a great quantity of abſolute heat; the blood is returned from the extremities highly impregnated with phlogiſton; the attraction of the air to that of the phlogiſton is greater than that of the blood. This principle will therefore leave the blood to combine with the air: by the addition of the phlogiſton, the air is obliged to depoſit a part of its abſolute heat; and, as the capacity of the blood is at the ſame moment increaſed by the ſeparation of the phlogiſton, it will inſtantly unite with that portion of heat which had been detached from the air.

"We learn from Dr. Prieſtley's experiments with reſpect to reſpiration, that arterial blood has a ſtrong attraction to phlogiſton (become a vague word with different meanings in different authors). It will conſequently, during the circulation, imbibe this principle from thoſe parts which retain it with the leaſt force, or from the putreſcent parts of the ſyſtem: and hence the venous blood, when it returns to the lungs, is found to be highly impregnated with phlogiſton. By this impregnation its capacity for containing heat is diminiſhed. In proportion, therefore, as the blood which had been dephlogiſticated by the proceſs of reſpiration becomes again combined with phlogiſton in the courſe of circulation, it will gradually give out that heat which it had received in the lungs, and diffuſe it over the whole ſyſtem.

"To account for the ſtability of animal heat, he obſerves, that as animals are continually abſorbing heat from the air, if there were not a quantity of heat carried off equal to that which is abſorbed, there would be an accumulation of it in the animal body. The evaporation from the ſurface, and the cooling power of the air, are the great cauſes which prevent this accumulation: and theſe are alternately increaſed and diminiſhed in ſuch a manner as to produce an equal effect. When the cooling power of the air is diminiſhed by the ſummer heats, the evaporation from the ſurface is increaſed: and when, on the contrary, the cooling power of the air is increaſed by the winter colds, the evaporation from the ſurface is proportionally diminiſhed." See *Crawford on Animal Heat*, p. 73—84.

Beſides, ſuppoſing that the principles of fire and inflammability are oppoſites in nature; this theory ſuppoſes that the blood, while in the lungs, gives out phlogiſton and takes in heat; but that, during the remaining courſe of circulation, it gives out heat and takes in phlogiſton: it ſuppoſes, that this phlogiſton is collected from parts that retain it with little force, or from the putreſcent parts of the ſyſtem; it is not ſaid where: it ſuppoſes that the blood, in paſſing through the lungs, receives heat only: that the whole of this heat is evolved in the lungs by precipitation; and is thence diffuſed over the ſyſtem as from a centre or focus: in which caſe, we muſt alſo ſuppoſe that the lungs are the warmeſt part of the body; and that the heat of the other parts will be in proportion to their diſtance from the lungs, or the length of the veſſels through which it has paſſed.

As for the ſtability of animal heat, this theory aſcribes it entirely to foreign cauſes; to the different degrees of evaporation; or to the varying ſtates of the air.

The ſingular meaning which this theory gives to the word *phlogiſton*, muſt ſtrike every one who knows the etymology of that word. The celebrated Stahl found it in the Greek; and applied it naturally to ſignify pure elementary fire, or the moſt pure and ſimple inflammable principle in a ſtate of combination. Mr. Kirwan has ſince uſed it to expreſs hydrogene: Dr. Prieſtley has called the azotic phlogiſticated air: and Dr. Crawford, who ſeems to take phlogiſton in the ſenſe of Mr. Kirwan, ſpeaks likewiſe as if he underſtood it in the ſenſe of Dr. Prieſtley. Mr. Kirwan's phlogiſticated air, however, will not kindle without oxygene: Dr. Prieſtley's will extinguiſh fire: and Dr. Crawford's is directly oppoſed to that principle. Theſe are not the ancient doctrines of Stahl: they are new ideas expreſſed in one of his antiquated words; the meaning of that great man is neglected. The ſounds which he uttered, like the dead language of an old ritual, are among a few ſtill in veneration.

[†] Borelli has ſhewn how, by contracting the air-veſicle or allowing it to expand, the fiſh can riſe, ſink, or remain ſtationary in the water. *Borelli de Natatu.*

The abſorbents appear to be the firſt and moſt general way by which living bodies are ſupplied with air: the mouths of theſe veſſels are like ſmall tubercles, ſcattered over the body of the inſect while wrapt in its membrane. In the horſe and the bird they are blood-veſſels ſpreading on a membrane, and deriving nouriſhment from the uterus or egg, that had been itſelf nouriſhed by abſorbents. In a cow, they are veſſels which, ſpreading on a membrane, terminate in glands; theſe glands being oppoſite to others which adhere to the uterus; and the membranous and uterine glands, when in contact, incloſing a third gland like a kernel. In man, they are veſſels ſpreading on a membrane, and entering a large glandular body called the *placenta*. In the mouſe and the hare, they are likewiſe veſſels branching on a membrane, and entering a placenta: this placenta, when it happens to be fixed, receives large veins from the parent, and which may be either inflated or injected from the cavity of the uterus.

Thoſe which are properly reſpiratory organs exerciſe not their function till circulation and nutrition are begun: though, if the obſervation of Garman be juſt, that the air may become a real food for the claſs of ſpiders; or if it be true that the larvæ of ants, as well as of ſeveral inſects of prey, increaſe in bulk, and undergo their metamorphoſes without any other nouriſhment than air, this law is not univerſal. It may, however, be doubted, whether ſome moiſture be not abſorbed. With regard to the ant, we have reaſon to ſuſpect that the obſervations on which ſuch a concluſion was founded have not been accurate.

Not only are the reſpiratory organs thus late in exerciſing their functions; in many vegetables a great part of them is annually renewed, and laid aſide in the torpid ſtate. In thoſe inſects which undergo the moſt remarkable kinds of transformation they ſuffer a change; and in all thoſe animals which ſpend their earlier days in the water, and afterwards come to live in the air, they are altered in kind.

In all living bodies the proper function of one part of the reſpiratory organs is, to ſecrete from the water or air that particular aeriform fluid which mingles with their juices, and which is neceſſary to life and nutrition. In many caſes theſe organs are placed externally, and are always in contact with the air or water from which they ſecrete. In other caſes they are lodged internally; and air or water are then alternately admitted and expelled by varieties of organs which ſerve as auxiliaries.

The plants ſecrete their aeriform fluid from water and air. They receive air along with the liquids of their abſorbents, which open on the roots, the trunk, and the branches, and upon the inferior ſurfaces of leaves; or, if nature has plunged theſe leaves under water, the abſorbents open and imbibe their fluids on both ſides. In many, however, the upper ſurface of the leaf is intended to inhale air. Bonnet obſerved, that when this ſurface was applied to the water the leaf died ſoon; but that when the lower ſurface was applied, it lived for months. It has alſo been remarked, that the upper ſurfaces of ſome leaves will repel water; and that the death of the leaf will enſue when its breathing pores are obſtructed with oil. We hence learn why aquatic plants riſe up to the ſurface of the water and ſpread their leaves in the open air: and as it is proved by Ingenhouſz and others, that the reſpiration of many leaves is aſſiſted by light, we ſee a reaſon why plants growing in a dark room turn to the place where light is admitted; why the flowers and the leaves of many plants follow the diurnal courſe of the ſun; why the branches of trees, which require much light, die when placed in a thick ſhade; why moonſhine in autumn contributes ſo much to the ripening of grain; and why leaves and branches are arranged in ſuch a manner as leaſt to intercept that quantity of light which nature has allotted to the genius of each.

The air-veſſels in the body of plants are thoſe veſſels which contain juices but at certain times, and which during the greateſt part of the ſeaſon are filled with air. This air is collected from the ſap of the roots as it paſſes along the diametral inſertions, and from thoſe veſſels which open upon the trunk and upon the leaves. Like pulmonary tubes, which are ſeen branching through the bodies of inſects, they perform an office ſimilar to that of the tracheæ and bronchia; and are thoſe general receptacles of air from which the neighbouring parts of the plant ſecrete what is needed: for, in plants and a certain number of inſects, the functions of the lungs, the ſtomach, and the heart, are generally diffuſed. The ſeveral parts can reſpire, digeſt, and circulate fluids on their own account; and, if they ſhould chance to be ſevered from the whole, can live and grow, and propagate their kind.

The air-veſſels are ſurrounded by thoſe which contain a liquid during the whole time of the growth. They are the largeſt veſſels of the wood, as diſtinguiſhed from the bark; and in the leaves they may ſometimes be ſeen even without the aſſiſtance of glaſſes. Their cavity is formed by certain fibres which wind ſpirally like a cork-ſcrew. In the leaf they generally approach and recede like the filaments of nerves; but they never inoſculate from one end of the plant to the other, except at the extremities; they reſemble the pulmonary tubes of inſects by their general diſperſion over the ſyſtem, and the ſpiral rings of which they are compoſed *; they differ in this, that the pulmonary tubes are frequently obſerved to anaſtomoſe in their larger branches, as the ramifications of a vein or artery do in their ſmaller capillary twigs.

The reſpiratory organs, which are ſimilar either to the gills of fiſhes or the lungs of man, can hardly here claim a deſcription, as their nature and forms are ſo generally known. There is one circumſtance, however, in birds which arreſts our attention: the cells of their bones, and the numerous veſicles of their ſoft parts which communicate with the lungs, have been deſervedly a matter of ſurpriſe to moſt phyſiologiſts. In accounting for their uſe, the ingenious Hunter ſuppoſed that they leſſened the ſpecific gravity and aſſiſted flying; that being the circumſtance which he thought moſt peculiar to birds. Learning afterwards that they were in the oſtrich and not in the bat, he ſuppoſed that they were appendages to the lungs. In amphibious animals, in the ſnake, viper, and many others, he obſerved, that "the lungs are continued down through the whole belly in form of two bags, of which the upper part only can perform the office of reſpiration with any degree of effect, the lower having comparatively but few air-veſſels †." In theſe animals, the uſe of ſuch a conformation of the lungs was to him evident. "It is in conſequence of this ſtructure," ſaid he,

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* See the ſpiral rings in the pulmonary tubes of a bee, Plate XVII. fig. 10. Swammerdam's Book of Nature, or Hiſtory of Inſects.

† The ſame obſervations were long ago made by the immortal Harvey. After obſerving that both the tranſverſe and longitudinal membranous diaphragms of birds contributed to reſpiration, he adds, "Et alia, ut nunc taceam. Avis præ cæteris animalibus non modo facillime reſpirat, ſed vocem etiam in cantu diverſimode modulatur: cum tamen ejus pulmones lateribus et coſtis adeo affixi ſunt, ut parum admodum dilatari, aſſurgere, et contrahi poſſint.

"Quinetiam (quod tamen a nemine hactenus obſervatum memini) earum bronchia ſive aſperæ arteriæ fines in abdomen per-

"that they require to breathe leſs ſrequently than others." From this reaſoning he naturally inferred, that the motion of flying might render the frequency of reſpiration inconvenient; and that a reſervoir for air might therefore become ſingularly uſeful. The bat and the oſtrich, however, are here as formidable objections as before. The bird reſpires frequently when at reſt, and when it flies to our boſom from the hawk; that frequency ſeems to have been increaſed by what is a general and a common cauſe, an increaſed degree of muſcular exertion. Had air-cells been intended merely to prevent the effects of a rapid motion on reſpiration, we might expect to ſee them in greyhounds and a number of quadrupeds, much more readily than in ſome birds whoſe flights are neither rapid nor long.

This great phyſiologiſt was not aware that the circumſtance moſt peculiar to birds was not their act of flying, but their feathers, which contain a large quantity of air, and which require a regular ſupply, whether they ſoar on the wings of the eagle, or remain on the ground attending the oſtrich*.

Both in amphibious animals and birds, the air of the veſicles has paſſed the reſpiratory ſurface of the lungs. In the tracheæ of plants and the pulmonary tubes and veſicles of inſects, it is only proceeding on its way to be reſpired. Would it be worth while to inquire whether vegetable ſubſtances, and thoſe which are called corneous in animals, require a different preparation of air from what is the common preparation of lungs? whether hair grows beſt, or the cuticle thickeſt, over ſoft parts that are cellular and ſpongy †? and whether the animals that bear horns have larger ſinuſes in the frontal bone of their cranium than others? From the general diffuſion of air through the birds, and the ſituation of their veſicles beyond the lungs, it would appear that the pulmonary viſcus in theſe animals does not reſpire or ſecrete air for the whole ſyſtem; and we are certain, that in plants and inſects, moſt parts reſpire the air for themſelves, and that there is no particular part appointed to ſecrete air for the whole.

We here ſpeak of reſpiratory organs, as thoſe which ſecrete an aeriform fluid from water and air; but our language probably had been more accurate had we called them the organs in which an aeriform fluid is abſorbed by their liquid contents, as theſe flow by, either wholly or in part, in their courſe through the ſyſtem. It was long denied that any abſorption of the air took place from the pulmonary ſurface; and ſpeculative reaſoners had attempted to prove that no air could paſs to the blood through the membranes of the lungs, becauſe air had refuſed upon ſome occaſions to paſs through pieces of wet leather that had been expoſed to it for that purpoſe. Borelli, however, endeavoured to ſhow how air in the lungs might mingle with the blood, and how ſome always diſappeared in reſpiration. There are few doubts now entertained on this ſubject. Venous blood incloſed in a bladder by the celebrated Prieſtley diſcovered ſuch an attraction for oxygene, that it abſorbed the aeriform fluid through all the coats of the reſiſting medium, exhibiting an inſtance and beautiful illuſtration of the chemical affinities which take place in this function.

The reader will obſerve, that the two words *reſpiratory organs* are here employed in what may be rather a particular ſenſe. The truth is, there are two kinds of reſpiratory organs, which, though ſometimes included in the general expreſſion, ſhould always be conſidered as perfectly diſtinct. The firſt kind comprehends thoſe in which the water and air are decompoſed; the ſecond, thoſe by which theſe fluids are properly applied to the reſpiring ſurfaces of the former. We obſerve theſe laſt in the fluttering motion of the leaf itſelf, or in that tendril which turns the ſurface of the leaf to the ſun. We ſee them producing theſe oſcillatory motions in the branching gills of the *pulex arboreſcens*. When the breathing ſurface is within the body, we diſcover them again in the tracheæ of plants, whoſe cavity is formed by a ſpiral fibre that is ſeemingly intended for ſome kind of periſtaltic motion. We detect them likewiſe in the pulmonary tubes, in the ſpiral rings, and in the abdominal movements of inſects. We ſee them in fiſhes ſwallowing the water and propelling it onward through the fringes of the gills. In the frog, we note them by the motions of the pouch between the ſternum and the lower jaw. After this animal is divided tranſverſely behind the fore legs, this pouch continues to fill and to empty itſelf downwards by the trachea where the lungs were. When the whole integuments and ſome of the muſcles between the jaw-bone and ſternum are removed, we ſee how the pouch was dilated and

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forantur. Aëremque inſpiratum intra cavitates illarum membranarum recondunt. Quemadmodum piſces et ſerpentes intra amplas veſicas in abdomine poſitas, eundem attrahunt et reſervant, eoque facilius natare exiſtimantur. Et ut ranæ ac bufones cum æſtate vehementius reſpirant, aëris plus ſolito in in veſiculas numeroſiſſimas abſorbent (unde earum tam ingens tumor) quo eundem poſtea in coaxatione liberaliter exſpirent. Ita in pennatis pulmones potius *tranſitus et via ad reſpirationem* videntur quam hujus adequatum organum." *De Generat. Animal.* Exercit. 3.

* "The uſe of this retention (of the air in the veſicles of birds) is not well known to us, at leaſt in reſpect of the upper pouches; ſo in regard of the lower ones. The uſe of this retention has been explained in the deſcription of the OSTRICH: where it was ſhown that there is a probability that the air contained in the lower pouches ſerves to compreſs the viſcera, and make them riſe upwards. Some do think that this retention of air ſerves birds to render them lighter in flying, like as the bladder which is in fiſh helps them to ſwim. And this conjecture would have ſome foundation, if the air contained in the bladders of birds were as light in proportion to the air in which they fly, as the air contained in the bladders of fiſh is in proportion to the water in which they do ſwim. But to ſay ſomething which hath at leaſt a little more probability, waiting till we have a more certain knowledge of the truth and uſe of this retention of air, we conſider that the birds generally riſing very high, and even to the place where the air is a great deal lighter than it is near the earth, might be deprived of the principal advantages of reſpiration, for want of an air whoſe weight might make on the heart and arteries the compreſſion neceſſary to the diſtribution and circulation of the blood—if they had not the faculty of containing a long time a portion of air, which being rarefied by the heat which this retention produceth therein, might, by enlarging itſelf, ſupply the defect of the weight of which the air that they do breathe in the middle region is deſtitute. For, if there be a great many birds which do never riſe very high into the air, whoſe lungs have notwithſtanding theſe bladders in which the air is retained; there are alſo a great many that have wings which they uſe not for flying. And it may be obſerved, that there are found ſome parts in animals which have not any uſe in certain ſpecies, and which are given to the whole genus, by reaſon that they have an important uſe in ſome of the ſpecies. It is thus that in ſeveral kinds of animals the males have teats like the females; that moles have eyes; oſtriches and caſſowars wings; and that land tortoiſes have a particular formation of the veſſels of the heart which agrees only with water tortoiſes, as it is explained in the deſcription of the TORTOISE." *The Anatomical Deſcription of a Caſſowar*, by the Royal Academy of Sciences at Paris. We can hardly anſwer for the juſtneſs of this reaſoning, which maintains that the genus has uſeleſs parts merely in complaiſance to the ſpecies.

† Nails and hair grow after death, and a quantity of air is evolved in putrefaction.

contracted by a broad cartilage connected with the trachea, and attached by muſcles to the inſide of the ſternum and the neighbouring parts. When the pouch is enlarged, the air ruſhes in through the two noſtrils at that time expanded; and when it is contracting, the glottis ſtarts up with an open mouth to the middle of the pouch, and the air is preſſed down through the trachea to the lungs. This amuſing ſight will ſometimes continue for a whole hour. In man and all the warm-blooded quadrupeds, the thorax or cavity where the lungs are placed is dilated and contracted by the diaphragm and muſcles attached to the ribs. In the time of dilatation the glottis opens, as we ſee in birds: the air ruſhes in, ſupports the incumbent weight of the atmoſphere, and enables the thorax to expand wider. The expanding powers having made at laſt their uſual effort, their antagoniſts ſucceed, exert their force, and the air is expelled.

In applying either the water or air to the breathing ſurface, all theſe auxiliary organs are aſſiſted by the circumambient fluid which preſſes equably on all ſides. When a Florentine flaſk is applied to the mouth, and all communication between the larynx and external air entirely cut off, it requires an effort to bring the air of the flaſk into the lungs. The weight of the atmoſphere is therefore aſſiſting in reſpiration; and the air, whether in the lungs or the thorax (ſuppoſing that there be any in the thorax), muſt not be ſo denſe as that which is without. When Verheyen perforated the thorax of a dog, and reſtored the equilibrium betwixt the external and the internal air, the reſpiration of the lungs ceaſed, though for ſome time the alternate admiſſion and expulſion of air was continued through canulas introduced into the wounds.

It cannot ſurely be aſked here, how the preſſure of the atmoſphere ſhould be aſſiſting in raiſing the thorax, and thus ſeemingly counteract itſelf? The heat of the lungs expands the air as ſoon as it enters. The air rapidly abſorbs moiſture; and though not uſually noticed by philoſophers, yet the ſudden expanſion, which is always the conſequence of that abſorption, is a very general phenomenon in nature. By this heat, or by this abſorption, the air would occaſion greater dilatation, were it not for the lungs, which ſeek to collapſe; the cartilages of the ſternum, which ſeek to recoil; and the ſtretched-out muſcles, which either ſpontaneouſly, or directed by the will, endeavour to contract and produce expiration.

Having ſeen how the air will ruſh in on the opening of the glottis, we may alſo conceive how the ſhutting of the glottis will reſiſt the force of internal expanſion, and ſupport a weight laid upon the breaſt. The confined air will expand equally on all ſides, and the preſſure muſt be great before the ſpace which falls to the glottis can exceed its own muſcular force and the weight of the atmoſphere. It is this diffuſed preſſure of fluids that produces ſuch ſtriking wonders in hydraulics; and which explains how the droppings of the ureters ſhould expand the bladder even to a palſy, and overcome the abdominal muſcles.

To account for the action of theſe organs which ſerve as auxiliaries in reſpiration, there have been ſuppoſed an appetite for air which prompts as a ſtimulus; an influence of the will, though we breathe while aſleep; and a natural inſtinct, which indeed may exiſt, but explains nothing. In ſpecifying the ſeveral organs concerned, we have heard of an expanſile power of the lungs, of a certain preſſure of the phrenic nerve, of a muſcular diaphragm, and of the action of oblique intercoſtals. But theſe explanations are from a limited view of the ſubject. The expreſſions uſed may indeed be general; but their meaning is particular, narrow, and confined; and their alluſion is only to man, or perhaps to a few of the warm-blooded quadrupeds: for where are the intercoſtals of the frog? where is the muſcular diaphragm of birds? where the preſſure of their phrenic nerve? and where the expanſile power of their lungs?

It is fortunate for man that theſe aſſiſting reſpiratory organs are in ſome meaſure ſubject to his will. By this ſubjection he produces vocal ſound when he pleaſes, divides it into parts, varies it by tones, forms it into words, and enjoys the diſtinguiſhed and numerous advantages that may be derived from a ſpoken language.

SECT. II. *Digeſtion.*

As reſpiration ſucceeded the placenta in one of its offices by maintaining life, the function of digeſtion ſucceeds it in another by either continuing or ſupporting the growth of the living body. It depends on reſpiration for a portion of heat, and is that function by which the liquid and ſolid food undergoes its firſt preparation in the ſyſtem.

Though gaſeous fluids, including the principles of heat and light, may be proved to nouriſh and compoſe the ſubſtances of all living bodies, yet a part only can enter the ſyſtem in a gaſeous ſtate. This part is changed by the lungs, or by thoſe fluids which they contain. The organs of digeſtion, before they can act on aerial bodies, muſt have them reduced to ſome new form. For the food of vegetables, this form requires to be water, whoſe 100 parts are found to conſiſt of $84\frac{4}{5}$ of oxygene and $15\frac{1}{5}$ of hydrogene. See WATER.

When the gaſes have paſſed through both the watery and vegetable ſtates, they, as juices or ſolids, become the food of a great many animals. Theſe animals produce new changes, and by their preparation the gaſes become the food of others which are called carnivorous; and then the carnivorous and all living bodies, when the vivifying principle has ceaſed within them, and when they are haſtening to a ſtate of diſſolution, are devoured by others who feed on corruption, are partly converted into water and gas, and become in their turn the food of the kinds on which they had fed.

As theſe effects of the digeſting and aſſimilating powers are more ſurpriſing than any chemical proceſs of art, it may not be unpleaſing to take a more particular view of them. It has long been obſerved, that thoſe animals which are not carnivorous feed upon plants; and, ſince the days of Van Helmont and Boyle, it has been ſuſpected that plants live upon water and air. This ſuſpicion has now been confirmed by numerous experiments. Plants have been raiſed from diſtilled water without earth, and, inſtead of requiring a vegetable mould, have ſpread their roots in moſs, in paper, in cotton, in pieces of cloth, in pounded glaſs, and powder of quartz. From theſe facts, the ingenious Chaptal has been led to ſuppoſe that ſoils act but as ſo many ſponges, affording water in different proportions, and in different ways; and that all that the plant wants from the ſoil is a firm ſupport, a permiſſion to extend its roots where it chooſes, and that proportioned ſupply of humidity which will ſecure it againſt the alternatives of being inundated or dried up. To anſwer, however, theſe ſeveral conditions, he allows it to be neceſſary in many caſes "to make a proper mixture of the primitive earths, as no one in particular poſſeſſes them. Siliceous and calcareous earths (he ſays) may be conſidered as hot and drying, the argillaceous as moiſt and cold, and the magneſian as poſſeſſing intermediate properties. Each, in particular, has its faults, which render it unfit for culture. Clay abſorbs water, but does not communicate it; calcareous earth receives and gives it too quickly: but the properties of theſe earths are ſo happily oppoſed that they correct each other by mixture. Accordingly we find, that by adding lime to an argillaceous earth, this laſt is divided, and the drying property of the lime mitigated, at the ſame time that the ſtiffneſs of the clay is diminiſhed. On theſe accounts it is that a ſingle earth cannot conſtitute manure, and that the character of the earth intended to be meliorated ought to be ſtudied before the choice of any addition is decided on. The beſt proportions of a fertile earth for corn are three eighths of clay, two eighths of ſand, and three eighths of the fragments of hard ſtone.

"The advantages of labour conſiſt in dividing the earth, aerating it, deſtroying uſeleſs or noxious plants, and converting them into manure by facilitating their decompoſition."

So far is vegetable mould from communicating any thing new to plants, that it rather owes its formation to them; and if ſea ſalt ſhould at times be requiſite to marine vegetations, it is to be remembered that ſalts, ſulphur, and lime, are all products of organized bodies; that iron * itſelf has been diſcovered in plants and animals; and that even diamonds, quartz, cryſtals, ſpars, gypſum, &c. are found only in thoſe earths that are partly compoſed of an impoveriſhed vegetable reſidue, which provident nature ſeems to have reſerved for the reproduction or reparation of the earthy and metallic ſubſtances of the globe; while the vegetable mould on theſe organic parts that remain is made to ſerve as nouriſhment for the growth of ſucceeding plants†.

If thoſe earths in which plants are reared, and which contain no vegetable mould, ſhould ever be ſenſibly diminiſhed in weight, a circumſtance, we believe, which ſeldom takes place if proper precaution be uſed to prevent it; yet, if it ſhould happen, it ſhould not in that caſe be forgotten that gaſes are the general cements in nature; that they mix intimately with the hardeſt bodies; and that this ſenſible diminution of weight may be owing entirely to ſome diſſolution of the ſolid parts, and the conſequent extrication of the gaſeous fluids ‡.

"Before we had acquired a knowledge of the conſtituent principles of water," reſumes Chaptal, "it was impoſſible to explain or even to conceive the growth of plants by this ſingle aliment. In fact, if the water were an element, or indecompoſable principle, it would afford nothing but water in entering into the nutrition of the plant, and the vegetable would of courſe exhibit that fluid only; but when we conſider water as formed by the combination of the oxygenous and hydrogenous gaſes, it is eaſily underſtood that this compound is reduced to its principles, and that the hydrogenous gas becomes a principle of the vegetable, while the oxygene is thrown off by the vital forces. Accordingly we ſee the vegetable almoſt entirely formed of hydrogene. Oils, reſins, and mucilage, conſiſt of ſcarcely

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* Whether iron exiſts formally in organized bodies, or is the reſult of decompoſition, it derives its origin ultimately from gaſes. Blood gradually decompoſed by putrefaction yielded not only more ſalts and lime, but much more iron, than blood ſuddenly decompoſed by lime. Though the greater part of an animal or vegetable, therefore, be without ſuch ſubſtances as ſalt, lime, iron; yet when decompoſed its parts may recombine, and thus produce them. See *Surgical and Phyſical Eſſays*, by Mr. John Abernethy.

† "Vegetables in their analyſis preſent us with certain metals, ſuch as iron, gold, and manganeſe. The iron forms near one-twelfth of the weight of the aſhes of hard wood, ſuch as oak. It may be extracted by the magnet. We read in the *Journaux de Phyſique* an obſervation, in which it is affirmed that it was found in metallic grains in fruits. Vegetables watered with diſtilled water afford it as well as others.

"Becher and Kunckel aſcertained the preſence of gold in plants. M. Sage was invited to repeat the proceſſes by way of aſcertaining the fact. He found gold in the aſhes of vine twigs, and announced it to the public. After this chemiſt, moſt perſons who have attended to this object have found gold, but in much leſs quantity than M. Sage announced. The moſt accurate analyſes have ſhown no more than two grains, whereas M. Sage had ſpoken of ſeveral ounces in the quintal. The proceſs for extracting gold from the aſhes conſiſts in fuſing them with black flux and minium.

"Scheele obtained manganeſe in the analyſis of vegetable aſhes.

"Lime conſtantly enough forms ſeven-tenths of the fixed reſidue of vegetable incineration. Next to lime, alumine is the moſt abundant earth in vegetables, and next magneſia. Siliceous earth likewiſe exiſts, but leſs abundantly; the leaſt common of all is the barytes." *Chaptal's Elements of Chemiſtry*, part iv. § 3. art. 15.

See Salts, Sulphur, Iron, Lime, in *Elements of Chemiſtry*. See the *Matrix of Diamonds*; ſee *Chaptal*, vol. iii. part 4. § 5. art. 3.

‡ What follows is from the 33d additional note of Dr. Darwin's *Botanic Garden*.

"Dr. Prieſtley obtained air of greater or leſs purity, both vital and azotic, from almoſt all the foſſil ſubſtances he ſubjected to experiment. Four ounce weight of lava from Iceland, heated in an earthen retort, yielded twenty ounce meaſures of air.

4	ounce weight of	Lava	gave	20	ounce meaſures of air.
7	———	Baſaltes	———	104	———
2	———	Toadſtone	———	40	———
1½	———	Granite	———	20	———
1	———	Elvain	———	30	———
7	———	Gypſum	———	230	———
4	———	Blue ſlate	———	230	———
4	———	Clay	———	20	———
4	———	Limeſtone ſpar	———	830	———
5	———	Limeſtone	———	1160	———
3	———	Chalk	———	630	———
3½	———	White iron ore	———	560	———
4	———	Dark iron ore	———	410	———
½	———	Molybdena	———	25	———
¼	———	Stream tin	———	20	———
2	———	Steatites	———	40	———
2	———	Barytes	———	26	———
2	———	Black wad	———	80	———
4	———	Sand ſtone	———	75	———
3	———	Coal	———	700	———

"In this account the fixed air was previouſly extracted from the limeſtones by acids, and the heat applied was much leſs than was neceſſary to extract all the air from the bodies employed."

any thing but this ſubſtance; and we perceive the oxygenous gas eſcape by the pores where the action of light cauſes its diſengagement."

But though water conſtitute the aliment of plants, we muſt not ſuppoſe that it is the aliment of theſe alone: the leech and the tadpole are nouriſhed by water, and many animals have no other food. "Rondelet cites a great number of examples of marine animals which cannot ſubſiſt but by means of water by the very conſtitution of their organs. He affirms, that he kept during three years a fiſh in a veſſel conſtantly maintained full of very pure water. It grew to ſuch a ſize, that at the end of that time the veſſel could no longer contain it. He relates this as a very common fact. We likewiſe obſerve, that the red fiſhes which are kept in glaſs veſſels are nouriſhed, and grow, without any other aſſiſtance than that of water properly renewed."

The ingenious Borelli, who knew that plants and ſeveral animals ſubſiſted wholly by water and air, was likewiſe of opinion that ſome animals lived upon ſand. He could diſcover nothing but ſand in the ſtomachs of many teſtaceous animals that live in the water, and particularly in the ſtomachs of the ſmaller kinds that live buried in the ſand of the ſea. He could not conceive what elſe could be the food of thoſe ſmall fiſhes or worms which penetrate the ſubſtance of the hardeſt rocks, and form excavations that always bear a proportion to their bulk. He had regularly found that the ſtomachs of ſwans which he had examined were full of ſand; and, recollecting the pebbles in the gizzards of fowls, he was led to infer that theſe ſubſtances were ſomehow diſſolved in a gaſtric juice, and ſerved to nouriſh the harder parts, as the ſhells, the feathers, and the bones *. Theſe ſentiments, on a ſlight view, might not be unnatural. From obſerving children of depraved appetites ſwallowing ſand, aſhes, and cinders; from having ſometimes met with ſand in the ſtomachs of wild ducks; from the uſual fæces of the earth-worm; and from the diſſection of ſeveral toads dug up in a garden, in whoſe ſtomachs we could ſee nothing but a quantity of earth, with pieces of coal, ſtone, and of ſlate, that had accidentally happened to be mixed with it †, we long entertained a ſimilar opinion with this celebrated author: but on recollecting that many ſubſtances which enter the ſtomach are not nutritious; conſidering the balls of hair and of feathers which the carnivorous animals return, and that quantity of fæcal matter which is diſcharged by the inteſtines; having frequently experienced that a ſenſe of fulneſs removes hunger, and obſerved perſons as it were by inſtinct preſſing on the empty ſtomach with their hand—we began to ſuſpect that the ſwallowing of ſand, and a number of other indigeſtible ſubſtances, might not be to nouriſh but to prevent ſome cravings of the ſtomach, and that theſe cravings were in part occaſioned by a deficiency of the uſual preſſure which it receives from the neighbouring parts. In this opinion we were more confirmed, by hearing it was cuſtomary among ſome of the tribes of the north of Aſia to repel or mitigate the attacks of hunger by placing a board over the region which is called epigaſtric, and compreſſing it gradually by means of cords as the ſtomach collapſes; and by learning afterwards, on a further inquiry, that a ſimilar practice, and from ſimilar motives, was likewiſe common with ſome individuals in this country; who, to alleviate the ſenſation of hunger, ſtraiten the epigaſtric region with their handkerchief. This practice, however, being often impoſſible with the brute kind, inſtead of bringing the neighbouring parts to preſs on the ſtomach, they are obliged to diſtend the ſtomach, and to bring it to preſs on the neighbouring parts. Of the two ways of producing this preſſure, the laſt is certainly the moſt natural. Senebier has ſuppoſed that diſtenſion of the ſtomach is the cauſe of the ſecretion of the gaſtric liquor; but how well or ill his opinion may be founded, daily experience permits not a doubt, that, in order to ſatisfy the calls of hunger, the ſtomach requires not only to be nouriſhed, but to be filled, or at leaſt to have ſomething like a ſenſe of fulneſs; and this may probably be one reaſon for thoſe balls which are found in the ſtomachs of the chamois, which likewiſe ſwallows ſand, and in the ſtomachs of the cow, the ſheep, the horſe, "when they do paſs away the winter in ſnowy mountains, where they can find no graſs ‡."

From this general view of the food, the natural tranſition is to thoſe organs by which it is prepared. As all plants are fed on nothing groſſer than liquids, we ſee the reaſon why they are all nouriſhed by abſorbents, and why, inſtead of one common alimentary canal, they are furniſhed with a number of capillary veſſels, which by their action aſſiſt the living power in moving the fluids along the trunk, the branches, and the leaves. Theſe fluids are obſerved to move between the different ligneous circles, and the more copiouſly as the wood is younger or the nearer the circles are to the bark. In the circles themſelves, it has been remarked that the ſap-veſſels, from being empty during a great part of the growing ſeaſon, have been called air-veſſels; that they are formed of ſpiral fibres, adapted to ſome periſtaltic motion §: and it is plain, that by this ſtructure they are well fitted to propel their contents, whether water or air, upwards or downwards, backwards or forwards, according to the different poſitions of the plant.

Beſides the particular action of the veſſels, a general concuſſion is received from the movement of the waters or winds, which ſerves as an exerciſe; a general dilatation is occaſioned by both moiſture and heat; and a general contraction by dryneſs and cold, which produce a motion ſomething ſimilar to that of the thorax.

In the ſpringing ſeaſon the ſap aſcends through the empty veſſels before the leaves begin to appear. When the veſſels are filled through their whole extent, the buds ſwell, the leaves ſpread, and the flowers blow; the evaporation from the ſurface is increaſed; the ſap is diminiſhed by the abſorption; the ſucciferous veſſels now ceaſe to bleed ‖; and the roots being unable

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* A ſimilar inference was made by Mr. Burt upon opening the ſtomach of the pangolin of Hindoſtan. See PANGOLIN.

† The third ventricle had a ſtrange body faſtened to its interior membrane. This body was compoſed of a hard membrane, in which there was gravel incloſed. Geſner ſays the chamois is accuſtomed to ſwallow gravel to clear his tongue and throat from the phlegm, which is apt to cover them, and deſtroy the appetite. *Anat. Deſcription of the Chamois or Gemp*, by the French Academy.

‡ Bartholine, quoted by the French Academy, thought that theſe balls were compoſed of the hair which the cows lick from their ſkin, or of the wool which the ſheep eat. But the horſe does not lick himſelf, and many of theſe balls ſeem to be compoſed of ligneous fibres. The balls which are found in the chamois are called by Velſchius *German bezoar*. See *Anat. Deſcription of Chamois or Gemp*, by the French Academy.

§ "The ſuperior part of the inteſtine, which contained about thirteen inches, had a very particular ſtructure; for, inſtead of the ordinary circumvolutions of the inteſtines, the cavity of this was tranſverſely interrupted with ſeveral ſeparations, compoſed of the membranes of the inteſtine folded inwards. Theſe ſeparations were near half an inch diſtant from each other, and turned round like the ſhell of a ſnail, or of a ſtaircaſe with an open newel." *Anat. Deſcription of the Sea-fox*, ibid. Theſe membranous folds running ſpirally, are not uncommon in the alimentary canals of animals.

‖ This happens in a great many plants.

to ſupply the waſte, the rains and the dews enter by the trunk, the branches, the leaves, and the petals of the flowers. When the evacuations are immoderately increaſed by exceſſive heat, or preternaturally obſtructed by the plucking of the leaves, by too much humidity, or other cauſes which prevent perſpiration, the plant ſoon either ſickens or dies. The chyle, which is formed in the ſap veſſels, has generally ſomething of a ſaccharine taſte.

Conſidering the forms of animal food, we may naturally expect in the animal kingdom a greater variety of thoſe organs employed in digeſtion. Moſt animals have indeed, like the vegetable, both inhaling and exhaling veſſels, by which ſome of their fluids are abſorbed, and evacuations regularly carried on. Except, however, in thoſe animals which ſubſiſt by liquids, theſe veſſels are of little importance in receiving food or ejecting what is fæcal from the ſyſtem. In theſe animals the abſorbents terminate in a hollow viſcus, which is called the alimentary canal, where the fluids undergo a preparatory change, and are partly reabſorbed for aſſimilation. In all others the food enters by a proboſcis [*], or by an aperture which is called the *mouth*: this mouth is properly the entrance of the alimentary duct. It is very generally furniſhed with a tongue [†], which is uſually aſſiſting in deglutition; and if the food be of that nature to require cutting, tearing, or grinding, it is likewiſe furniſhed with the proper inſtruments [‡] for theſe operations. When the food is teſtaceous or ſome hard vegetable ſubſtance, and theſe inſtruments not in the mouth, ſomething ſimilar may generally be expected in a more remote part of the canal. The crab and the lobſter have accordingly grinding teeth in their ſtomach, and granivorous fowls have a powerful gizzard lined with a thick corneous ſubſtance. It poſſeſſes the compreſſing force of the jaws; and ſmall pebbles which the animals ſwallow, ſerve it for teeth.

Beſides mere trituration or grinding, the ſolid food will often require to be mixed with ſome additional liquid[§]. In thoſe carnivorous animals which chew, this liquid during the time of maſtication flows into the mouth from certain glands placed in the neighbourhood. In ſome ſpecies of the ape kind a previous dilution takes place in two pouches ſituated on the ſides of the lower jaw. In granivorous birds this dilution is very uſually performed in a ſac [‖], which is a dilatation of the canal; and the food being macerated there by the glands or exhaling veſſels, gradually paſſes down [¶], as is needed, to be triturated and further prepared in the ſtomach. In the ruminating kind the dilution is performed in a ſimilar manner: but theſe having no muſcular ſtomach fitted for grinding, inſtead of deſcending the food is brought up again into the mouth, and is then after the proper maſtication ſent to the ſtomach. If the food require no maſtication, it is ſent directly that way at firſt: a circumſtance which ſhows a curious diſcernment with reſpect to foods, and proves that their alimentary canal is ſubject to the action of voluntary muſcles as far as the ſtomach. Some of thoſe birds which have a diluting ſac or ingluvies ſeem likewiſe to ruminate. This in the parrot was obſerved by the gentlemen of the French academy. It has ſince been obſerved in rooks, macaws, cockatoos, and others: and Mr. Hunter, to whom phyſiology is ſo much indebted, diſcovered, that the male and the female pigeon ſecrete in their ingluvies a certain liquor for feeding their young; and that moſt kinds of what have been thought ruminating birds do very often in expreſſing their fondneſs regurgitate their food. Yet both this and another ſpecies of regurgitation, which is very common with thoſe animals that ſwallow indigeſtible ſubſtances with their food, ſhould be carefully diſtinguiſhed from rumination.

To the ruminating kinds the diluting ſac is by no means peculiar. The porpoiſe has one, though it does not ruminate; and many of thoſe animals which have none, as the rat, the hog, and the horſe, have a part of the ſtomach covered with a cuticle, and which muſt therefore principally ſerve as a reſervoir. The gullets of ſeveral fiſhes and ſerpents are ſacs of this kind. It frequently happens that a part of their prey is projecting from the mouth, while another part fills up the gullet and gradually deſcends, to be reduced in the ſolvent below. So very dilatable are the ſtomachs and gullets of ſome animals, that ſerpents have been often ſeen to ſwallow whole animals which, prior to the gorging, were larger than themſelves; and many polypes, and even ſome of the louſe kind, will, by ſwallowing food, more than double their own bulk.

Applying *ſtomach* as a general word to the different ventricles of the canal, we may here obſerve, that every ſpecies of animals which ruminate have two ſtomachs, or at leaſt two diviſions in one; that ſome have three, as the gazella; and ſome four, as the cow, the dromedary, and the ſheep: but it muſt not be ſuppoſed that the number of ſtomachs is any proof of a ruminating power. It was ſaid already that the porpoiſe has two; the porcupine has three diviſions in one; and the ſingular caſſowar, although it be found to have four ſtomachs, does not ruminate; nor, although granivorous, is any one of the four a gizzard.

Somewhat different from theſe expanſions which we have been mentioning as exiſting in the firſt part of the alimentary canal, is a ſort of pouch [⸸] which hangs from the neck and the lower mandible of ſeveral birds, and which, like the two pouches of apes, may be uſed either to macerate the food or to carry proviſions from a diſtance to their young. The pelican, a native of warm countries, employs this pouch ſometimes to carry a quantity of water; and another native of the ſame countries, we mean the dromedary, was obſerved to have at the top of the ſecond of the four ventricles a number of ſquare holes, which being the orifices of as many cavities between the membranes which compoſe the ventricle, reminded the gentlemen of the French academy of thoſe large reſervoirs of water which Pliny mentions to be in camels; and for which, according to his ſtory, their guides have opened them ſometimes in caſes of extreme thirſt.

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[*] Every perſon may have an opportunity of ſeeing a proboſcis in a number of thoſe winged inſects which extract juices from plants. It is very eaſily diſcernible in the butterfly. In this inſect it is a fine moveable tube, poſſeſſing a great variety of action. It ſerves for a hand, a mouth, and a gullet; and when not extended in ſearch of food, it is coiled up in circular folds. The elephant has both a mouth and proboſcis, and this proboſcis is one of the moſt ſingular of living organs.

[†] The crocodile has no tongue; the oſtrich, the ſeal, and ſome others, have forked tongues; the cormorant has a double tongue; ſome, like the eagle, have a cartilaginous tongue; ſome, like the porcupine, have it toothed. We have found a bone in the tongue of a gooſe; the tongue of the cameleon is a hollow trunk like a proboſcis; the tongue of the frog is forked and long—it is rolled up in the mouth, and originates from the fore part of the lower jaw. In ſome the tongue is the organ of taſte; in others, the inſtrument for ſeizing their prey. In diſtinguiſhing foods, moſt animals rely chiefly on ſmell.

[‡] Theſe inſtruments are corneous, bony, or calcareous; they are teeth or bills; their ſituation is the tongue, the jaws, the palate, or the ſtomach. Many teeth ſeem intended only for attack or defence, for ſeizing, killing, or retaining the prey. This is remarkable in the fangs of ſerpents, and in the large tuſks of the elephant, the barbirouſſa, and ſome other animals, where they have ſome reſemblance to horns, and project from the mouth. The philodotus and ant-eater have no teeth; the larvæ of inſects have generally two, which are placed externally, and cut like a forceps.

[§] There are many perſons whoſe tongues and mouths are naturally dry, and when they ſwallow a piece of bread muſt call for water or ſome other moiſtener. This complaint is even ſometimes general in a family, and is propagated like an hereditary evil through its different branches. Cockatoos and parrots have likewiſe dry mouths.

[‖] The buſtard has no ſac of this kind; but the œſophagus is remarkable for the largeneſs of its glands.

[¶] In the oſtrich the œſophagus paſſes down and returns, and the crop opens from below upwards into the gizzard.

[⸸] A pouch of this kind is obſerved in our common rook.

We come now to one of the principal agents in digeſtion. Independent of the fluids which mingle with the food in the mouth, the gullet, or macerating ſacs, there is one denominated the *gaſtric juice*, and which, either by itſelf or along with others from the aliments or ſyſtem, acts in ſome meaſure as a ſolvent. It is ſecreted from large glands at the entrance of the gizzard, from veſſels or glands in the coats of the ſtomach, and perhaps moſt plentifully near the pylorus: it powerfully reſiſts the putrefactive fermentation; it coagulates milk and the white of an egg; it diſſolves food even when incloſed in metallic tubes; and when life ceaſes, it acts frequently on the very ſtomach from which it was ſecreted. Its taſte, its colour, and its ſolvent powers, are different in different claſſes of animals. It ſeems to be modified according to the age, the health, the habit, and the different aliments on which they live. The ſick and the child are incapable of digeſting the food that is proper for a healthy man. The hawk kind, after loathing bread and throwing it up without any change, can be gradually brought to take it for food; and Gaſſendi has mentioned a certain lamb, which, being fed on bread, cheeſe, and on fleſh, refuſed afterwards to taſte graſs. But what is moſt ſurpriſing in the gaſtric juice is, that it ſpares all living bodies, as thoſe worms which exiſt in the ſtomach, and the ſtomach itſelf while it is alive; and it differs otherwiſe from a chemical ſolvent, in that it has an aſſimilating power, and reduces all ſubſtances, whether animal or vegetable, on which it acts, to a certain fluid of determinate properties, which is called *chyle*.

Beſides the gaſtric, the food again, after paſſing through the ſtomach, is mingled with a greeniſh ſaponaceous liquor, which is called *bile*, and which flows either immediately from the liver or from a veſicle into which it had regurgitated as into a blind gut: at the ſame time nearly it is mingled with another reſembling the ſaliva from the pancreas or ſweet-bread; a gland or glands whoſe place is ſupplied in a great many fiſhes by a number of vermicular appendages to the ſtomach.

In ſhort, from one extremity of the alimentary canal to the other, fluids are perpetually flowing into its cavity from glands, veſſels, or organic pores; and the membranes conſtantly ſecreting a mucus to protect themſelves from the acrimony of their contents. This acrimony muſt often be conſiderable near to that end of the canal where the fæces are diſcharged; for, as the firſt part of the canal has generally one or more dilatations which are called *ſtomachs*, and ſecretes at leaſt one fluid which is ſtrongly antiſeptic, ſo the laſt part has generally appendages which are called *cœca*, where the food always remains for ſome time, and where, from the quantity of animal matter that happens to be mixed with it, it becomes putreſcent. The office of the cœca is ſometimes ſupplied by the largeneſs and convolutions of the colon*; to which gut the ileum cannot, when it enters laterally, ſo eaſily communicate its periſtaltic motion. As the ſtomachs were the receptacles of the food when it entered, the cœca are receptacles of the fæcal matter before it be diſcharged. They are of various forms and capacities; they are often larger than the ſtomach itſelf; are often compoſed of proportionally thin and tranſparent membranes; and from their contents have often a colour ſomewhat reſembling that of the gall bladder. Their number is different in different animals. Some have but one. The birds which have them have generally two; the buſtard has three; and Swammerdam has diſſected inſects which had four. As ſome ſtomachs have a number of folds which hang pendulous within their cavity, and increaſe their ſurface, ſo have often the cœca as well as ſome portions of the canal. The cœcum of both the rabbit and the hare is curiouſly formed. It is large and beautiful: it is rolled up like a cornu ammonis; it has the like outward appearance; and a fold running ſpirally is obſerved within. The animals which live on vegetable food have uſually the greateſt length of the canal, and the greateſt number of ſtomachs and of cœca: yet the caſſowar, which has no gizzard, has no cœcum; and the polype, which is ſaid to be all ſtomach, is, properly ſpeaking, rather all cœcum.

To ſee more fully the proceſs of digeſtion, we muſt not overlook that general and organic action which takes place through the whole alimentary canal. The power of maſtication exerted in the mouth is obvious to all. But the force of ſome ſtomachs has till very lately been known to few; we allude here to that of the muſcular or gizzard kind: for Abbé Spallanzani has divided ſtomachs into three ſorts; the muſcular, the membranous, and intermediate. The immortal Borelli, who was probably the firſt that tried the force of the muſcular ſtomachs by throwing into them nuts of filberds, hollow ſpheres of glaſs, hollow cubes of lead, ſmall pyramids of wood, and ſeveral other very hard ſubſtances, ſuppoſed that the power exerted by the ſtomach of the Indian cock † was equal to 1350 pounds weight. The force of an intermediate ſtomach cannot be ſo great, and that of a membranous one muſt be ſtill leſs. Each ſeems to have more of the ſolvent as it has leſs of the muſcular power. The moſt membranous are aſſiſted by the action of the neighbouring parts, and expel their contents as readily as the ſtrongeſt. The muſcular ſort is either wholly or principally confined to certain kinds of birds and of fiſhes, as nature has meant that the grain or the ſhells which they uſe as food ſhould be firſt triturated before it be ſubjected to the gaſtric juice. This comminution takes place in their ſtomach, becauſe it is plain that, had bones or muſcles, fully equal to all theſe effects, been placed in the head, the form of the animal muſt have been altered, or that equilibrium which it preſerves in thoſe fluid elements through which it moves been completely overturned.

As to the movements of the alimentary canal, the direction of hairs found in the ſtomachs, and the balls of hair which are thrown up, would appear to indicate a circular motion. The inteſtinal part has a motion ſimilar to that of a worm, and is called the *vermicular* or *periſtaltic*. Here every portion retains its own motion, although it be ſeparated from the reſt by ligatures. The ſtomach of the polype, the gullets of the ruminating kinds, and the cœca, have this motion in different directions at different times; and that obſerved in the alimentary canal of a louſe is, when viewed through a microſcope in the time of action, amazingly rapid; the ſtimulating cauſes employed are the food, the different liquors with which it is mixed, the air, the nerves where they exiſt, and a portion of heat. Some degree of heat is neceſſary to every proceſs of digeſtion both in the animal and vegetable kingdom: what that degree is depends on the nature of the living body; and is various according to its age, its health, its employments, and habits. The ingenious Hunter has mentioned the digeſtive and generative heats; and thoſe gardeners who are verſant in the operations of hot-houſes, have on their thermometers the ſwelling, flowering, and the ripening heats, with a great many others, for the ſeveral plants which they mean to raiſe.

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* The bear, whoſe inteſtines are 40 feet long, has nothing reſembling a colon or a cœcum.

† The original is *gallus Indicus*, which in the writings of Longalius, Geſner, and Aldrovandus, means a bird different from the *coq d'Inde* or Turkey cock. Johnſton has called it *gallus Perſicus*. See *The Anatomical Deſcription of two Indian Cocks* by the French Academy. *Gallina Indica* is Ainſworth's Latin for the Guinea hen. See *Borelli de Motu Animal.* Prop. 189, 190, 191.

Among the other cauſes of digeſtion ſome authors have ranked fermentation: and it muſt be allowed, that ſomething ſimilar to the putrefactive fermentation takes place in the cœca and the lower extremity of the inteſtine, and that the vinous and acetous fermentations but too frequently occur in our ſtomach when that viſcus is morbidly affected[*].

Much of the hiſtory of living bodies relates to the different degrees of heat, the varieties of ſoil, and the kinds of food concerned in digeſtion. The plants grow where the ſoil and the heat are congenial to their nature; and thoſe which admit of the greateſt variety with reſpect to ſoil, and the largeſt range on the ſcale of heat, are the fartheſt diſperſed over the globe. As every ſoil has uſually ſome regular ſupply of moiſture, the plants that can live upon that ſupply extend their roots under the ſurface where their liquid food is the leaſt expoſed to evaporation, and meeting there with the conſtant nouriſhment which they require, they remain in that ſituation for life[†]. If their trunks be ſo feeble as to need a ſupport, they creep on the ground, they climb the face of a neighbouring rock, or cling to the body of ſome of the ſtatelier children of the foreſt. Their range for food is extremely limited: it is chiefly confined to the ſmall ſpace which happens to be occupied by their roots and branches; yet if any uncommon exertion be neceſſary, the branches will bend, and the leaves turn to drink of the water that is paſſing by. If the roots be laid bare, they will again plunge into the earth; if a ſtone or a ditch be thrown in the way, they will move round or will dip downwards, and ſpread into the ſoil on the other ſide: if there they arrive at one that is unfriendly, they will not enter; but if a favourite earth ſhould be near, though not in their direction, they will twiſt about, advance as they grow, and at laſt meet it. In all theſe caſes the prop, the water, and ſoil, muſt be neceſſary; they muſt alſo be within a very ſmall diſtance, otherwiſe the plants cannot perceive them, or will fail in their languid attempts to approach them.

It may be conſidered as a general fact, that wherever food is liberally ſupplied for a whole lifetime in one place, the creatures which uſe it have ſeldom much locomotive power, or much inclination to exerciſe it in a long continued and progreſſive line. The curious inſect is therefore obſerved to depoſit its offſpring in thoſe places where the proſpect of genial warmth and of plenty ſeems to preclude the future neceſſity of wandering or reſearch; and when this offſpring is about to paſs into a new ſtate, and the organs foretel that a change or perhaps a variety of food will ſoon be required, the appearance either of wings or of legs does likewiſe foreſhow that the power of locomotion is to be increaſed. Even nobler animals in their fœtal ſtate, where they live upon one ſpecies of food, and where that is afforded in regular plenty, do ſpread out their roots, adhere to their ſoil, and become as ſtationary as the plant itſelf: and even when that ſupply is withdrawn, and they are expelled; yet if the ſtate into which they emerge be helpleſs and feeble; if their organs of digeſtion have a weak ſolvent or maſticating power, particularly adapted to ſome eaſily aſſimilated food; and if that food be preſented either by their parent or nature without their exertion, their power of locomotion is not great, nor is it exerciſed in wandering afar. It is when the organs of digeſtion are ſtrong, and the appetite inclines to variety of aliment, that they are diſpoſed and feel themſelves able to wander in ſearch of it; and that then they may be ready to move at intervals from place to place, when the enemy comes or the ſpirit prompts them, nature has directed them to ſolid food, and has given them a large alimentary canal with ſtomachs, with convolutions, and cœca, where they may lay up proviſions for a journey: but, afraid to entruſt them with too much freedom, leſt in their excurſions they might wander from the places where ſubſiſtence is found, there are two appetites, hunger and thirſt, which never fail in a ſtate of health to remind them of their duty.

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[*] "It may be admitted as an axiom (ſays Mr. Hunter), that two proceſſes cannot go on at the ſame time in the ſame part of any ſubſtance; therefore neither vegetable nor animal ſubſtances can undergo their ſpontaneous changes while digeſtion is going on in them; a proceſs ſuperior in power to that of fermentation. But if the digeſtive power is not perfect, then the vinous and acetous fermentation will take place in the vegetable, and the putrefactive in the food of thoſe animals which live wholly on fleſh. The gaſtric juice therefore preſerves vegetables from running into fermentation, and animal ſubſtances from putrefaction; not from any antiſeptic quality in the juice, but, by making them go through another proceſs, prevents the ſpontaneous change from taking place.

"In moſt ſtomachs there is an acid, even although the animal has lived upon meat for many weeks: this, however, is not always the caſe; therefore we muſt ſuppoſe it is only formed occaſionally. Whether the ſtomach has a power of immediately ſecreting this acid, or firſt ſecretes a ſugar which afterwards becomes acid, is not eaſily aſcertained: but we ſhould be inclined to ſuppoſe from analogy the laſt to be the caſe; for animals in health ſeem to have the power of ſecreting ſugar, as I find in the milk, and ſometimes in the urine, from diſeaſe. The acid prevails ſometimes to ſo great a degree as to become a diſeaſe, attended with very diſagreeable ſymptoms; the ſtomach converting all ſubſtances which have a tendency to become acid into that form: the ſugar of vegetables, and even ſometimes vinous ſpirits, turning directly into acid.

"To aſcertain whether there is an acid naturally in the ſtomach, it will be proper to examine the contents before the birth, when the digeſtive organs are perfect, and when no acid can have been produced by diſeaſe or any thing that has been ſwallowed. In the ſlink calf, near the full time, there is acid found in the ſtomach, although the contents have the ſame coagulating powers with thoſe of animals who have ſucked.

"Spallanzani gives the opinion of authors reſpecting digeſtion; and ſo anxious is he to combat the idea of its being fermentation, that he will hardly allow that fermentation ever takes place in the ſtomach. That fermentation can go on in the ſtomach, there is no doubt. It is often found that milk, vegetables of all kinds, wine, and whatever has ſugar in its compoſition, become much ſooner ſour in ſome ſtomachs than they would if left to undergo a ſpontaneous change out of the body; and even ſpirits in certain ſtomachs almoſt immediately degenerate into a very ſtrong acid. All oily ſubſtances, particularly butter, very ſoon become rancid after being taken into the ſtomach; and this rancidity is the effect of the firſt proceſs of the fermentation of oil. Mr. Sieffert has been able to reſtore rancid oils to their original ſweetneſs, by adding to them their due quantity of fixed air; the loſs of which I conſider as the firſt proceſs in this fermentation, ſimilar to what happens in the fermentation of animal and vegetable ſubſtances." *Obſervations on Digeſtion, by Mr. Hunter.*

[†] Many of the fat plants live chiefly by the abſorption of moiſture from the air; and many ſea-plants float through the ocean; and having plenty of food wherever they go, they ſend out no roots in order to ſearch for it.

This variety of food, and the manner in which it is affected by climate, are the cauſe of the many and ſingular migrations from ſpot to ſpot, from country to country, and from ſea to ſea: they are the cauſe of a ſtate of torpor in the hedge-hog and the bear, and they partly explain the provident foreſight of the ant and of the bee. Animals of great locomotive power, in order to provide for themſelves and their offspring, remove to a diſtant country or climate when they ſee the ſigns of approaching famine. Thoſe of leſs locomotive power, and who are incapable of migrating far, as if warned by heaven, lay up a ſtore for the ſcarcity to come; or, ſhould their food be of that kind as not to be eaſily preſerved for a ſeaſon, they receive no ſecret warning to hoard it at the time when it fails, their ſyſtem becomes ſuſceptible of torpor, and they are enabled to ſleep through the ſtorm of trouble and of want. The ſource of this want is in moſt inſtances to be traced to the nature of the plant and inſect. The plant which has little heat of its own depends on, the ſun, or ſome other agent, for one of the great cauſes of digeſtion. When this agent refuſes the neceſſary heat, the plant muſt decline; its leaves, its juices, and its fruits muſt fail. The inſect tribe, which had no other food, or which like the plant could not maintain their vivifying warmth, muſt likewiſe ſubmit to the ſame fate. The various animals which live on either the one or the other, according to their ſeveral diſpoſitions and characters, retire to their ſtores, to their dens of torpor, or migrate to a country to which they are led by unſeen guides to ſhare in its abundance. Of theſe laſt the [*] rail and the ſwallow are the only two which are ſometimes arreſted, and which, with the bear, the hedge-hog, and the toad, are obliged to remain in the dwellings of torpor till the genial ſeaſon of warmth and of plenty.

Sect. III. *Abſorption.*

When the food has undergone the firſt preparation, which is called *digeſtion*, and the chyle [†] is formed in the alimentary canal or ſap-veſſels, it is thence taken up by means of abſorption for the uſe of the ſyſtem. From the veſſels it paſſes into the whole cellular tiſſue, compoſed of veſicles, and cloſely interwoven with all the vaſcular part of the plant. From the veſicles or utricles of the cellular tiſſue it enters the vaſa propria and glands, which contain and prepare the fluids and ſecretions peculiar to the ſpecies.

In the animal economy it was always ſuppoſed that the chyle was abſorbed by the ramifications of the red veins ſpreading on the gut, till the year 1622, when Aſellius an Italian diſcovered the lacteals [‡] running on the meſentery of a living dog, and printed his account of them in 1627. As he had not traced their courſe very far, he naturally thought that they went to the liver, which was then imagined to be the organ of ſanguification. This opinion, with reſpect to the place where they entered the veins, continued to be general till 1651, when Pecquet in France publiſhed his account of the thoracic duct [§]. With great candour this author acknowledged, that he had been led to make the diſcovery by obſerving a whitiſh fluid mixed with the blood in the right auricle of the heart of a dog, which kind of animal it had been cuſtomary to diſſect alive ſince the time of Aſelius. "This practice of opening living animals furniſhed likewiſe occaſions (ſays Dr. Hunter) of diſcovering the lymphatics. This good fortune fell to the lot of Rudbec firſt, a young Swediſh anatomiſt, and then to Thomas Bartholine [‖] a Daniſh anatomiſt, who was the firſt who appeared in print upon the lymphatics. His book came out in 1653, that is, two years after that of Pecquet; and then it was evident that they had been ſeen before by Dr. Highmore and others, who had miſtaken them for lacteals; but (adds Dr. Hunter) none of the anatomiſts of thoſe times could make out the origin of the lymphatics, and none of the phyſiologiſts could give a ſatisfactory account of their uſe[¶]." He had not known that Gliſſon, who wrote in 1654, has aſcribed to theſe veſſels the office of carrying the lubricating lymph from the ſeveral cavities back into the blood; and that Frederic Hoffman has expreſſed the doctrine of their being abſorbents very explicitly.

It was on the 19th of June 1664 that Swammerdam diſcovered the valves of theſe veſſels; and Ruyſch, who had ſeen them, perhaps very nearly about that time, firſt gave an account of them in a ſmall treatiſe which he publiſhed at the Hague in 1665.

The beſt mode of demonſtrating the lymphatics we probably owe to the celebrated Nuck, who, as a ſpecimen of that complete Syſtem of Lymphography which he meant to publiſh [‡], printed in 1691 his Adenography, or Deſcription of the Glands. In this treatiſe he not only tells us how he brought them into view, but in his plates repreſents many of them as filled with his new mercurial injections; a happy invention, which per-

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[*] All the birds on the lakes of Siberia are ſaid by Profeſſor Gmelin to retreat ſouthward on the commencement of froſt, except the rail, which ſleeps buried in the ſnow. Account of Siberia quoted by Dr. Darwin in his *Loves of the Plants*.

[†] The chyle of different living bodies has not yet been analyſed; in man it is generally a whitiſh fluid reſembling milk, and yielding water, oil, ſugar, and a coagulable lymph.

[‡] We learn from Galen, that the lacteals in kids had long before been ſeen by Eraſiſtratus, who called them *arteries*.

[§] This duct had been ſeen before by Euſtachius. See *Euſtach. de Vena ſine pari.*

[‖] The diſcoveries of Rudbec and Bartholine were made in the years 1651 and 1652, about which time Jolyffe an Engliſhman ſaw alſo the lymphatics.

[¶] Drs. Hunter and Monro claim the merit of having found out the true uſe of the lymphatics. The former ſays that he taught it in his lectures ſo early as 1746, and appeals to his pupils for the truth of the aſſertion. The latter ſeems to have made the diſcovery in 1753; and in 1755 publiſhed an account of it in a theſis *De Teſtibus in variis Animalibus*. Before the printing of this theſis, Dr. Black told him that the ſame opinions concerning the valvular lymphatics had been long entertained by Dr. Hunter. In 1756 Dr. Monro attended Dr. Hunter's lectures in London; heard the whole doctrine of the lymphatics very fully explained; and in 1757 reprinted his opinion at Berlin without taking notice of Dr. Hunter's, who charges him with plagiariſm; and the charge is retorted by Dr. Monro.

[‡] Lymphographiæ, quod offertur ſpecimen, ubi lectori non ingratum percepero ad alias tranſiturus tum partes, non minus quam hæ, lymphaticis ductibus ſuperbientes. *Præfatio ad Adenographiam.*

Nuck had traced lymphatics on the exterior parts of the head and neck, on the membrane of the lungs, on the ſpaces between the ribs, in the loins, on the diaphragm, on the heart, the ſpleen, on the liver, the gall bladder, on the ſtomach, on the meſentery, on the tunica albuginea of the teſtes, in the feet, and in the hands. Ita (continues he), ut multiplici experientia et variis partium præparationibus eo uſque pervenerim ut *integrum lymphaticorum ſyſtema* a capite ad calcem mihi compoſuerim; cujus delineationem haps was ſuggeſted by remarking the extreme ſubtility of mercury when employed in the cure of venereal infection.

A method by which he inflated theſe veſſels led him to ſuppoſe that they took their origin from veins or arteries, either immediately or through the intervention of ſome follicles [*]. The celebrity of his name procured credit to this miſtake; and notwithſtanding the ſounder opinion of Gliſſon, of Hoffman, and ſome others, the old notion that the veins performed the office of abſorbents came ſo far down as the great names of Haller and of Meckel. The arguments, however, by which it was ſupported are ſhown now, and particularly by thoſe of the Hunterian ſchool, to have been injections that were not ſkilful, obſervations that were not accurate, and concluſions that were not logical; while the boaſted aſſertion that birds and fiſhes were without lacteals and without lymphatics, has been diſproved by the fortunate diſcoveries of Mr. Hewſon and Dr. Monro. Excepting, therefore, in the penis and placenta, and in thoſe animals whoſe veins may be injected from the gravid uterus, the lymphatics ſeem to perform the whole buſineſs of abſorption. They contain a fluid that is coagulable like the lymph of the blood, and are called valvular to diſtinguiſh them from the arteries that do not admit the red globules. They derive their origin from the cellular membrane, from the different cavities, and from the ſurface. Some authors ſay that they have ſeen them in the brain [†], and theſe Maſcagni has ventured even to deſcribe in prints. That ſome indeed may exiſt in the brain, has not been denied: but to believe that they have been found, and to truſt aſſertions which are not countenanced by the obſervations of ſkilful anatomiſts, requires a faith which for our part we do not pretend to. Both they and the lacteals derive their name from the colour of the fluids which they contain. They both empty themſelves into the veins; but moſt of the lymphatics in the human ſubject, and all the lacteals, firſt unite in the thoracic duct, which near the heart leads into the courſe of the circulation.

SECT. IV. *Circulation.*

AFTER part of the food is converted into chyle, and this chyle abſorbed by the lacteals, and brought into the courſe of the circulation, it remains to be diſtributed to all the different parts of the ſyſtem. On this account Hippocrates ſpeaks of the uſual and conſtant motion of the blood, of the veins and arteries as the fountains of human nature, as the rivers that water the whole body, and which if they be dried up man dies. He ſays that the blood-veſſels are for this reaſon every where diſperſed through the whole body; that they give ſpirits, moiſture, and motion; that they all ſpring from one; and that this one has no beginning and no end, for where there is a circle there is no beginning [‡]. In ſuch language was the prince of phyſicians accuſtomed to expreſs his vague ideas of a circulation; for, ſo far was he from having acquired accurate conceptions on this ſubject, that, when he ſaw the motions of the heart, he believed that the auricles were two bellowſes to draw in air, and to ventilate the blood.

When after his time anatomy came to be more ſtudied, the notions of the ancients reſpecting the blood were better defined; and, however chimerical they may ſeem to us, they were partly derived from diſſection and experiment. On opening dead bodies, they found that the arteries were almoſt empty [§], and that very nearly the whole of the blood was collected in the veins, and in the right auricle and ventricle of the heart. They therefore concluded that the right ventricle was a ſort of laboratory; that it attracted the blood from the cavæ; by ſome operation rendered it fit for the purpoſe of nutrition, and then returned it by the way that it came. From the almoſt empty ſtate of the arteries, they were led to ſuppoſe that the right ventricle prepared air, and that this air was conveyed by the arteries to temper the heat of the ſeveral parts to which the branches of the veins were diſtributed.

To this laſt notion entertained by Eraſiſtratus, Galen added an important diſcovery. By certain experiments, he proved

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libenter tecum communicabo, ubi partium nonnullarum hactenus nondum ſatis examinatarum, Lymphographiam abſolverimus. *Anton. Nuck de Inventis novis Epiſtola Anatomica ad D. D. B. G. Med. Doct.*

[*] Quidam nervos conſtituunt vaſorum lymphaticorum principia; alii glandulas minores; alii membranas: nec deficiunt qui a tendinoſa muſculorum parte eadem deducunt. Sed miſſis aliorum ſententiis, dicam modo; varia me hanc circa ſpeculationem molitum fuiſſe, variis experimentis (irrito licet ordinario conatu) varia tentaſſe, caſuque tandem nonnulla detexiſſe quæ lucem, hic adferre poſſunt.

Ante triennium, mundando lieni vitulino intentus, omnique ſanguine, aquæ tepidæ ope, jam eloto, copioſum in arteriam ſplenicam infudi aerem, et, ſpiritu fortius adacto, non tantum plurimas exiguas in ſuperficie lienis vidi elevari veſiculas, ſed ex iiſdem veſiculis vaſa prodire lymphatica, flatu etiam turgida et lienem perreptantia vidi, et quo diutius arteria fuit inflata, eo majorem notavi vaſorum numerum, ita ut, hac arte per inflictum vaſis lymphaticis vulnus aër immiſſus, membrana linealis fere tota lymphaticis ductibus obſeſſa fuerit viſa.

Ab eo tempore conjicere cœpi vaſorum lymphaticorum principia ab arteriarum ſurculis emanare, idque aliquando intermedia veſicula, aliquando deficiente veſicula, immediate ab ipſa arteria venave. *Adenographia curioſa*, cap. 4.

[†] Sed rogare videris, utrum in cerebro etiam vaſa occurrant lymphatica? Quamvis ex recentioribus, nonnulli in eorum deſcriptione ſatis liberales, eadem concedant et facile admittant: Verum, quod paſſim obſervo, ſyſtemata in proprio cerebro formant et viſcera ex ſuo placito componunt: ad experimenta enim provocati nihil egregii præſtare valent. Nunquam hac in parte, ut ingenue loquar, hactenus ſcopum attingere potui. Interim non negandum ceníeo aliquando cerebri lymphatica in una aut altera parte fuiſſe viſa; et non ita pridem, anatomicus quidam mihi amiciſſimus, inter alia inventa, hæc nobiſcum, communicat. "Vidi, inquit, lymphaticum in cerebro bovino, quod examine tuo (ut originem ſcias et inſertionem) erit digniſſimum. Non longe a glandula pineali, a qua ramos forte habet, incumbit plexui choroideo, ad infundibuli latera ſeſe extendens." Ante biennium ductum lymphaticum ex pini glandula eodem modo ut aliis glandulis, exeuntem vidi. Ita ut quidem certiſſimum, et cerebrum ſuos habere rivulos aquoſos, ſed nondum diſtincte, in lucem protractos. *Epiſt. Anat.*

[‡] *Hippocrat. de Venis.* "Plato, in his Timæus, ſpeaks of the heart as a watch-tower completely fortified, as the knot of the veins, and the fountain from whence the blood ariſes, and briſkly circulates through all the members. The blood he calls the paſture of the fleſh; and adds, that for the ſake of nouriſhing the remoteſt parts, the gods have opened the body into a number of rivulets like a garden well ſtocked with plenty of canals, that the veins might by this means receive their ſupply of moiſture from the heart as the common ſource, and convey it through all the ſluices of the body." The reſt of the paſſage cited by Longinus is as full of nonſenſe as it well can hold: and indeed Longinus ſeems chiefly to have admired it for ſomething which had ſtruck him as divine and unparalleled in its tropes, as making the head a citadel, the neck an iſthmus, the vertebræ hinges, and the fleſh a rampart. See *Longinus on the Sublime*, § 32.

[§] Eraſiſtratus opened dead bodies at Alexandria.

that the arteries contained blood as well as the veins. But this diſcovery was the occaſion of ſome embarraſſment. How was the blood to get from the right to the left ventricle? To ſolve the difficulty in which his new diſcovery had involved him, he ſuppoſed that the branches of the veins and arteries anaſtomoſed[*]; that when the blood was carried to the lungs by the pulmonary vein, it was partly prevented by the valves from returning; that therefore during the contraction of the thorax it paſſed through the ſmall inoſculating branches to the pulmonary vein, and was thence conveyed along with the air to the left ventricle to flow in the aorta[†]. This opinion, ſo agreeable to fact, unfortunately afterwards gave place to another that was the reſult of mere ſpeculation. This notion was, that the left ventricle received air by the pulmonary vein, and that all its blood was derived through pores in the ſeptum of the heart.

The paſſage through the ſeptum being once ſuggeſted, and happening to be more eaſily conceived than one through the lungs, it was generally ſuppoſed the only one for a number of centuries; and ſupported likewiſe, as it was thought, by Galen's authority, it was deemed blaſphemy in the ſchools of medicine to talk of another. In 1543, however, Veſalius having publiſhed his immortal work upon the ſtructure of the human body, and given his reaſons in the ſixth book why he ventured to diſſent from Galen, he particularly ſhowed how it was impoſſible that the blood could paſs through the ſeptum of the heart. His reaſoning rouſed the attention of anatomiſts; and every one grew eager to diſcover the real paſſage which the blood muſt take in going from the right to the left ventricle. The diſcovery of this fell firſt to the lot of Michael Servede, a Spaniſh phyſician, who publiſhed his opinion, and revived the old doctrine of Galen, in 1553[‡]. But his opinion did not ſpread at the time; the book in which it made its appearance contained hereſy, and was therefore deſtroyed by public authority. Fortunately, however, the ſame diſcovery was again made by Realdus Columbus, profeſſor of anatomy firſt at Padua and afterwards at Rome, who printed his account of it in 1559. Many others who were engaged in the ſame reſearch were equally ſucceſsful, and Andreas Cæſalpinus even ſingularly lucky. It appears by his Peripatetic Queſtions printed at Venice in 1571, and reprinted there with his Medical Queſtions in 1593, that he knew not only the leſſer circulation, but had obſerved that there were times when the blood flowed from the branches of the veins towards their trunks, and that veins ſwelled between their ligature and the extremities, and not between the ligature and the heart. From theſe obſervations, he neceſſarily inferred that the veins and arteries anaſtomoſed; and having alſo contemplated the nature of all the valves which were then known, and had been known ſince the days of Galen, he ventured to aſſert that the blood could not return by the arteries to the left ventricle. One ſhould imagine that from ſuch concluſions he muſt have diſcovered the true circulation; but he did not. Being a zealous peripatetic, he thought himſelf bound to maintain with Ariſtotle that the blood flowed, like the tides of Euripus, backwards and forwards in the ſame channel; and therefore ſuppoſed that it flowed from the arteries into the veins in the time of ſleep, and from the veins back into the arteries in the time of waking. The greater circulation, ſo far as we can learn, was not even dreamed of by this writer. A farther ſtep was yet to be made towards its diſcovery; and this was reſerved for another profeſſor of the Paduan ſchool.

In 1574, Hieronymus Fabricius ab Aquapendente, while he was ſeeking for a cauſe to explain the varicoſe ſwellings of ſome veins which had ariſen from friction and ligature, he to his great joy and aſtoniſhment diſcovered their valves in one of his diſſections: and here again the true theory of circulation ſeemed almoſt unavoidable. Yet whoever reads the ſmall treatiſe *De Venarum Oſtiolis*, firſt printed by Fabricius in 1603, will ſoon perceive that he was as far from entertaining a juſt notion of the circulation as his predeceſſors. Notwithſtanding all that he ſaw, he ſtill was of opinion that the blood flowed from the heart to the extremities even in the veins. He thought that the valves were intended by nature only to check and moderate its force. He calls them an inſtance of admirable wiſdom, and miſtakes his own awkward conjecture for one of the deſigns of infinite intelligence. In another reſpect, it muſt be confeſſed that he bore no inconſiderable ſhare in promoting the diſcovery of the circulation[§]. By writing on the valves, the formation of the fœtus, and the chick in ovo, he directed the attention of his pupil Harvey to thoſe ſubjects where it was likely that the motion of the blood would frequently occur.

Harvey was born at Folkſtone in Kent, in 1578, completed his ſtudies at the univerſity of Cambridge, went to Padua, and was there admitted to the degree of doctor, with unuſual marks of approbation, in 1602. He examined the valves with more accuracy than his maſter Fabricius; and explained their uſe in a treatiſe which he publiſhed ſome time after. It is uncertain when he firſt conceived his celebrated doctrine of the circulation; but about 1616 he taught it in his lectures, and printed it in 1628. He was the firſt author who ſpoke conſiſtently of the motion of the blood, and who, unbiaſſed by the doctrine of the ancients, drew rational concluſions from his experiments and obſervations. His books preſent us with many indications of a great mind, acute diſcernment, unwearied application, original remark, bold inquiry, and a clear, forcible, and manly reaſoning[||]; and every one who conſiders the ſurpriſe which

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[*] In toto eſt mutua anaſtomoſis atque oſculorum apertio arteriis ſimul cum venis. *De Uſu*, pars 6. cap. 10.

[†] It was the opinion of Galen, that the motion of the lungs and the pulſe of the arteries was to cool the blood, and to expel the fuliginous vapour. That he had juſt ideas of the leſſer circulation through the lungs, and of the true nature of the valves, is evident from the paſſages cited by Harvey, *De Motu Cordis*, Exercitat. 1. cap. 7.

[‡] The words in which he mentions this diſcovery are theſe: "Non per parietem cordis, uti vulgo creditur, ſed magno artificio a dextro cordis ventriculo, longo per pulmones ductu agitatur ſanguis ſubtilis." Being born at Villa Nuova, in the kingdom of Arragon, he ſometimes called himſelf Michael Villanovanus, or ſimply Villanovanus. In the title of all his books he takes the name of *Reves*, which is formed from Servede, by throwing out the *de* and tranſpoſing the five letters that remain. The book in which his diſcovery was mentioned was printed clandeſtinely, and entitled *Chriſtianity Reſtored*. Being firſt impriſoned at Vienne in Dauphiny, and afterwards allured to Geneva by the treachery of his correſpondent and confident John Calvin, he was, by a ſervant of that reformer's, accuſed of blaſphemy, and condemned to the flames in 1553.

[§] Almoſt the whole merit of his diſcovery is due to the Paduan ſchool, of which Cæſalpinus as well as Columbus was once a profeſſor.

[||] Dr. Hunter ſays, that "none of his writings ſhow him to have been a man of uncommon abilities. It were eaſy to quote (he ſays) many paſſages which bring him nearly to a level with the reſt of mankind. He lived almoſt 30 years after Aſellius publiſhed the Lacteals, yet to the laſt ſeemed moſt inclined to think that no ſuch veſſels exiſted. Thirty hours at any time ſhould have been ſufficient to remove all his doubts; but this ſubject taken up in ſelf-defence (continues the Doctor) grows unpleaſant." Dr. Hunter was here thinking of his own diſcovery when brought in compariſon with that of Harvey's. When this compariſon his doctrine occaſioned among the anatomiſts of thoſe days, the ſtrong oppoſition that it met with from ſome, and thoſe numerous and powerful prejudices which it had to encounter from the ſanction of time and of great names, muſt allow it was new, and that the author has from its importance a title to rank in the firſt claſs of eminent diſcoverers ancient or modern.

His diſcovery ſhowed, that in moſt animals the blood circulates in arteries and veins, and through the medium of one, two, or of more hearts: that in arteries it moves from the trunk to the branches; and that, meeting there with the branches of veins, it returns in a languid ſtream to the heart; that the heart communicates a new impulſe; that it drives it on to the trunk of the arteries; and that the arteries, by the thickneſs of their coats, exerting a force, do puſh it onwards again into the veins.

In every part of this circulating courſe, there are valves ſituated where it is neceſſary; they are meant to prevent the return of the blood; they are at the beginnings of the great arteries, and are found in different places of the veins where their feeble action requires to be aſſiſted.

The veins, before they enter the heart, generally expand into a thin muſcular ſac, which is called the *auricle*. It receives the blood while the heart is contracting; and, when the heart admits of dilatation, contracts itſelf, and throws the blood into the ventricle.

We have here called the ventricle a heart: though what is uſually meant by the heart be a ventricle and auricle; or ſometimes a ventricle and two auricles, where the veins approach in different directions, and, without bending to meet one another, expand at two different places. Two hearts are ſometimes united, ſo as in appearance to form but one.

From our having mentioned more than one heart, it will be ſuppoſed that the modes of circulation are various. In ſome animals the heart throws its blood to the remoteſt parts of the ſyſtem*; in other animals it throws its blood only into the reſpiratory organs: from theſe organs it is collected by the branches of veins; and theſe branches, uniting in a trunk, convey it to an artery, which renews the impulſe, and acts as a heart. In a third ſet of animals, the blood from the reſpiratory organs is carried by the veins to another heart; and this ſecond heart, united in the ſame capſule with the firſt, diſtributes the blood by the channel of its arteries to the ſeveral parts. In the human fœtus, and the fœtus of thoſe animals which have two hearts, a part of the blood, without taking the paſſage through the lungs, proceeds directly from auricle to auricle. In amphibious animals, the auricular paſſage continues open during their life, and is employed, when the breathing ceaſes, under the water. In many inſects, a number of hearts, or expanſions which anſwer the purpoſe of hearts, are placed at intervals on the circulating courſe; and each renews the impulſe of the former where the momentum of the blood fails. In the *Sepia Loligo* the two ſeparate parts of the gills are each ſupplied by a heart of its own: the blood from both is collected into one; which, by two arteries opening at two different parts, ſend it at once to the oppoſite extremities. In numbers of animals, the heart, like the ſtomach, is in the extremity oppoſite to the head.

After the diſcovery of the circulation, the moſt intereſting object with anatomiſts was to demonſtrate it in a clear, ſatiſfactory, and eaſy manner. Harvey, to ſhow it with every advantage that he could think of, was obliged to open animals alive: but whether the animals were dead or alive, the larger branches of the veins and arteries were only to be ſeen, and even theſe but in certain caſes, when they happened occaſionally to be full of blood. That admirable method, which is now obſerved in demonſtrating the courſe of the circulation, we owe to the great anatomiſts of Holland who flouriſhed in the laſt century. About 1664, Regnier de Graaf invented the ſyringe, which is now uſed; and, accompanied with a print, publiſhed an account of it in 1669. His injection was uſually a thin fluid of a blue, green or ſome other colour; this injection tranſfuſed through the veſſels, allowed them to collapſe by its general diffuſion, and broke out through the firſt opening that happened in its way. A fluid which hardened after being injected, and which preſerved the veſſels diſtended, was a happier contrivance. This at firſt was either melted tallow or wax, of a colour ſuiting the taſte of the anatomiſt. So early as the year 1667, the celebrated Swammerdam injected the veſſels running on the uterus with ceraceous matter; and, jealous leſt another ſhould claim the merit of ſuch an invention, he tranſmitted preparations, accompanied with plates, and with a full account of his method, to the Royal Society of London in 1672. Soon after, his friend Ruyſch acquired ſuch ſkill in the art of injecting, that he has not been ſurpaſſed by any ſince his time. He diſcovered veſſels in many parts where they were not ſuppoſed to have had an exiſtence; and, contrary to the opinion of the great Malpighi, he ſhowed that even many of the glands were entirely vaſcular; and that what had been ſuppoſed excretory ducts, deriving their origin from ſome follicle, were but terminations of arteries continued: yet even Ruyſch could not exhibit in all caſes the courſe of the veſſels ſo well as we do now. Another diſcovery was yet to be made for demonſtrating their ſmall capillary branches running through a part. This was reſerved for the very ingenious Dr. Nicholls of London; who invented the method of corroding the fleſhy parts with a menſtruum, and leaving the wax, as it was moulded by the veſſels, entire.

From theſe reſearches, which evince circulation to be a function ſo general among animals, ſome are diſpoſed to think it takes place in all living bodies. But notwithſtanding the faſhionable language of circulating fluids, of veins, arteries, and even of valves, in the vegetable ſtructure; yet nothing performing the office of a heart, and nothing that ſeems to conduct fluids in a circular courſe, has been found in plants. In the vegetable kingdom, the chyle is diſtributed to all the parts from the numerous veſſels which convey the ſap; and theſe veſſels, being fitted by their ſtructure to carry the ſap either downwards or upwards, from the branches to the roots, or from the roots to the branches, is the reaſon why plants inverted in the ground will ſend forth roots from the place of their branches, and ſend forth branches from the place of their roots. Even a ſimilar diſtribution of the chyle takes place in ſome animals. In the human tænia, in the faſciola hepatica of ſheep, and in moſt polypes, the chyle, without a circulating ſyſtem, is conveyed directly to the different parts from the alimentary canal. The taſte for circulation may at laſt ſubſide. Till the buſineſs of abſorption from the inteſtines was, of late, fully ſecured to the lacteals, we were wont to have alſo learned diſſertations upon a circular motion of the bile. The jaunt which it took was not very cleanly; but it was ſocial: it went with the fæces down the inteſtines, and returned with the blood in the meſeraic veins.

Beſides the circulation, another circumſtance reſpecting the

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was leſs immediately in view, he ſays that "Dr. Harvey, as appears by his writings, was certainly a firſt-rate genius for ſagacity and application; and his name is deſervedly immortal on account of the many obſervations and improvements he made in anatomy and phyſiology." *Dr. Hunter's Firſt Introductory Lecture.*

* We never exclude the action of the arteries.

blood, which ſometimes has engaged the thoughts of phyſiologiſts, is the colour which it has in moſt animals. The late Mr. Hewſon was of opinion, that the lymphatics, with the ſpleen * and the thymus, contributed greatly to the formation of the red globules. He was ſeemingly led to entertain this opinion from that attention to the lymphatics which made him aſcribe much to their power, and from ſeeing red particles in the abſorbents which riſe from the ſplenic and the thymic gland. His reaſoning, however, though very ingenious, is not concluſive. The celebrated Nuck, who had often obſerved a reddiſh fluid in the lymphatics, aſſures us, without any hypotheſis, that ſuch an appearance was always preternatural; and was either occaſioned by a ſcarcity of lymph, or by ſome irregular and too much accelerated motion of the blood †.

It is well known that the blood receives its vermilion colour in paſſing through the lungs; that animals with lungs have the blood redder than thoſe which are ſeemingly without that organ; and that the colour, as well as the heat, is in proportion to the extent and perfection of the lungs. It has alſo been obſerved, that oxygenous gas is abſorbed in reſpiration; and been proved by experiment, that the red globules of the blood, and the red only, contain iron. It thence would appear, that the colour is owing to iron calcined by the pure air, and reduced to the ſtate of a red oxyd. From this manner of conceiving the phenomena, ſays Chaptal, we may perceive why animal ſubſtances are ſo advantageous in aſſiſting and facilitating the red dye ‡.

A great variety of experiments have ſhown how much the colour and conſiſtence of the blood is altered by the mere action of the veſſels; and this diſcovery has enabled us to conjecture, with more certainty than we did formerly, why in infants and phlegmatic perſons the blood is paler, in the choleric more yellow, and, in the ſanguine, of vermilion red. It explains likewiſe, in ſome meaſure, why the blood varies in the ſame individual, not only with regard to the ſtate of health, but likewiſe at the ſame inſtant; and why the blood which circulates through the veins has not the ſame intenſity of colour, nor the ſame conſiſtence, as that of the arteries; and why the blood which flows through the organs of the breaſt differs from that which paſſes languidly through the viſcera of the lower belly. This power of the veſſels over the blood will bring us alſo to the true cauſe why the veſſels vary in the denſity of their coats and in their diameters; why they are ſometimes convoluted in a gland; why they ſometimes depoſit their contents in a follicle; why they are ſometimes of a ſpiral form; why the branches ſtrike off at various angles; why they are variouſly anaſtomoſed; why they ſometimes carry the blood with diſpatch, and ſometimes ſlowly, through a thouſand windings. By thoſe means their action is varied, and the blood prepared in numerous ways to anſwer the ends of nutrition and ſecretion.

Sect. V. *Nutrition.*

Nutrition is the function which aſſimilates the food in the ſeveral parts, and which finiſhes the proceſs already begun in the ſtomach, in the lungs, and the vaſcular ſyſtems. In perfect animals ſome of the ſtages of this proceſs are diſtinctly marked. The chyle, which has ſome reſemblance to milk, is the work of the alimentary canal: it undergoes ſome new changes by the action of the lacteals, and of their glands when they exiſt. In the courſe of circulation it paſſes along the reſpiratory organs, and is mixed with oxygen or ſome other gas: by this mixture, the conſequent heat, and the action of the veſſels, it is turned into blood. The blood, when examined, ſpontaneouſly ſeparates into three parts; an albuminous part or a ſerum, a coagulable lymph §, and red globules. The two firſt are analogous to the white parts of an egg, by which the chick in ovo is nouriſhed; the globules have ſome reſemblance to the yolk, which ſerves afterwards as food to the chick in the more advanced period of life. The three parts contain each a variety of principles which are originally compoſed of gaſes: theſe principles, conveyed through veſſels of various forms, of various diagonals, and with various degrees of motion and of heat, and all along varying as they paſs, arrive at laſt on the confines of the parts which are wrapt up in a cellular tiſſue or ſome other membrane. The tiſſue or membrane gives a new change; the parts nouriſhed perform the office of ſecreting organs; and as the action of the veſſels is varied according to the place to which they are tending and the parts which they enter, we partly ſee the manner in which bone, muſcle, cartilage, and nerve, are all ſecreted from a common maſs.

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* Before we can expect to arrive at a proper knowledge of the ſpleen, we have firſt to examine its form, its proportion, its ſituation, its numbers, and its different circumſtances in different animals; and as yet this has been done only in a few caſes. The gentlemen of the French Academy found, that in the demoiſelle it was like the liver, in the buſtard like the kidney of a quadruped, in the chamois round and flat, in the lynx narrow and long, in ſome animals proportionally large, in others proportionally ſmall; that in the gazella it was joined immediately to the ſtomach, without a vas breve; that in the caſtor, again, it was attached to the left ſide of the ſtomach by eight veins and arteries, and as many vaſa brevia; that in the otter it was faſtened to the epiploon, in the Canada ſtag to the great ventricle; and they found that in the porcupine and ſea-fox it was double. Since their time Dr. Monro has obſerved two large ſpleens, one attached to the ſmall and the other to the large curvature of the ſtomach of the ſqualus ſquatina or angel-fiſh, whoſe blood contains few red particles; and the ſame eminent phyſiologiſt found in a ſturgeon no fewer than ſeven, one of the ſize of a dried horſe-bean,. and the reſt about the bulk of a dried garden-pea.

† Interim non diffiteor vaſa illa lymphatica lympham ſubinde vehere rubicundo colore tinctam, loturæ carnis ad inſtar ſe habentem. Hoc autem nunquam contingit in ſtatu naturali, verum poſt nimium et irregularem ſanguinis motum. Vel in quibus humidum (ob defectum alimenti) deficit, qua occaſione plerique humores vitiantur, et colore preternaturali tinguntur. Quid mirum itaque hiſce in caſibus et lympham reddi ſanguineam? *Adenographia*, cap. 5.

‡ *Chaptal's Chemiſtry on the Properties of the Blood.* The phyſiologiſts of laſt century accounted for the red colour in another way. Rubedo ſanguinis (ſays Verheyen) pro magna parte procedere videtur ab alimentorum particulis ſalinis ac ſulphureis ſeu oleoſis exaltatis. Cujus non leve indicium eſt, quod lixivium ex cineribus vulgari modo paratum notabiliter rubeat, in quo, præter aquam, vix aliud quam ſal et ſulphur reperibile eſt:—et lac (quod ſulphure abundare probat butyri inflammabilitas), ſi coquatur cum ſale lixivioſo, colorem plane ſanguineum contrahat; quod ſimiliter decoctum ex aqua, ſulphure vulgari, et ſale tartari ad confectionem lactis ſulphuris paratum rubeſcat; quod cereviſia et quædam alia diuturniori coctione ruborem contrahentia, iiſdem principiis ſcateant, &c.

Ad intenſiorem ſanguinis rubedinem multum quoque contribuunt particulæ nitroſæ, quæ beneficio reſpirationis ex aëre in ſanguinis maſſam jugiter tranſmittuntur: ſiquidem color ille coccineus magiſque ſplendens quo paſſim ſanguis arterioſus a venoſo diſtinguitur, in pulmonibus jugiter alitur ac renovatur.

Rubedinem autem hoc modo facile excitari poſſe amplius confirmatur ex eo, quod vitrum, etiam centum librarum capax per unicam unciam ſpiritus nitri rarefacti, omnino repletum appareat materia rubeſcente. *Verheyen de Sanguificatione.*—Verheyen uſes the word ſulphur for any inflammable ſubſtance.

§ Senac was the firſt who diſcovered this lymph.

In worms and polypes, the function of nutrition is after digeſtion carried on almoſt entirely by the cellular tiſſue; and in plants by a tiſſue cellular and veſicular. In all living bodies the cellular tiſſue, beſides giving a form to the parts, and beſides preventing friction and coheſion, certainly performs ſome important office. Many have thought it the organ of nutrition; and it ſurely is one of the organs employed in aſſiſting to aſſimilate the nutritious fluid. But it ſhould be remembered, that all the parts of the living body are aſſimilating organs; that each part aſſimilates for itſelf; and that the ſtomach, the reſpiratory organs, the veſſels, and nerves where they exiſt, are aſſiſtant to the whole, and to one another.

It is ſingular how any ſhould have imagined that the nerves are peculiarly the organs of nutrition, or that growth ſhould be owing to the addition of ſome organic and vivifying particles pre-exiſting in the food. Theſe phyſiologiſts have not demonſtrated the exiſtence of nerves in all living bodies; and theſe organic and vivifying particles have as yet been diſcovered but in their fancy. Dr. Monro has condeſcended to prove, that the limb of a frog can live and be nouriſhed, and its wounds heal, without any nerves: and Mr Hunter has given many inſtances of a living and nutritious power in the blood.

In plants and animals, the aſſimilating power has always certain limits preſcribed to it: its influence is very generally confined to the ſort of food congenial to the ſpecies; and its ſtrength is varied according to circumſtances, as the age, the habits, and the ſtate of health. Thoſe which are young aſſimilate faſter than thoſe which are old; and one ſpecies, which may partly be owing to the nature of their food, will aſſimilate much faſter than another. Certain worms that feed on animal and vegetable ſubſtances will, in 24 hours after their eſcape from the egg, become not only double their former ſize, but will weigh, according to Redi, from 155 to 210 times more than before. Moſt oils are of very difficult aſſimilation; and thoſe which are eſſential will often reſiſt the long continued and the varied action of the living organs; will mingle with the parts, and, undecompounded, communicate their flavour.

An aſſimilating power is not peculiar to living bodies; it is obſerved in ferments and contagion, and is ſo obvious with reſpect to flame which is neither living nor organized, that whole nations who have ſeen it feeding on inflammable ſubſtances, have been diſpoſed to think it was animated, to call it the principle of life itſelf, and to pay it a kind of religious homage as the proper emblem of that Being by whom the whole univerſe is upheld.

In living bodies nutrition is only a ſpecies of ſecretion.

SECT. VI. *Secretion*

Is a function in which a part is ſeparated from the whole, and generally with ſome change of its qualities. In the caſe of nutrition it was obſerved, that all parts ſecrete for themſelves; and that ſome few, as the lungs, the ſtomach, the veſſels, and the nerves, officiate beſides for the general uſe of the whole ſyſtem. If all the ingeſta were to remain and to be aſſimilated, the body would go on continually increaſing. But living bodies are conſtantly in a ſtate of waſte and repair. In moſt animals part of the ingeſta is carried off by evacuation, without having entered the mouths of the abſorbents; part, which enters the abſorbents and veins, is thrown off by exhaling arteries or the urinary paſſage: and experiments with madder prove that the lymphatics, beſides originating from all the cavities and carrying back the lubricating fluids, do enter the ſubſtance of the hardeſt bones, and convey particles that had been aſſimilated back into the blood.

This office has not been generally aſcribed to the abſorbents; nor has it been very generally ſuppoſed that the blood receives the excrementitious matters of the ſyſtem, and that one intention of the circulation was either to return them for re-aſſimilation, or to diſcharge them by exhaling veſſels or by the kidneys. Decayed parts, however, are diſcovered in the fæces evacuated by the inteſtines, in the clouds, the ſediment, and colour of the urine, and by the ſmell of the perſpirable matter. The two laſt, on certain occaſions, and for ſome time, have often ſupplied the place of one another; and all the three, the fæces, the urine, and perſpirable matter, we have reaſon to believe, are remarkably diſtinguiſhed by two kinds of odour; the one peculiar to the whole ſpecies, the other peculiar to the individual. By the perſpirable matter which adheres to the ground, and of which the odour is diffuſed by moiſture, the dog not only diſtinguiſhes a man from any other animal, but is able to trace his maſter through a crowd.

The natural evacuations of plants, and of ſome few animals which feed by abſorbents, are all by perſpiration or exhaling veſſels. The urine in quadrupeds is before emiſſion collected in a veſicle, and thence carried off by the genital organ. In birds, and in a number of fiſhes, the ureters empty themſelves into the rectum and their contents are evacuated with the fæces.

Beſides being uſed to denote the function, the word ſecretion is ſometimes employed for the matters ſecreted. In this ſenſe there are various ſecretions. Beſides the fæces, the urine, and the ſweat, and the vapour from the lungs, which are excrementitious, there are ſecretions which anſwer uſeful purpoſes in the ſyſtem. Of theſe the moſt important and general are the bile, the ſaliva, the gaſtric juice, and the pancreatic, which aſſiſt in digeſtion; the lymph and the fat, which lubricate the parts; the mucus, which protects them from acrid ſubſtances; the nervous fluid, which forms a very conſpicuous link between body and mind; the ſeminal fluid, employed in generation to propagate the ſpecies; and the lacteal, intended for ſome while to ſupport the young after they emerge from the fœtal ſtate.

The ſaliva is a fluid that mixes with the food in the time of maſtication. In man it is ſecreted from the parotid, the ſublingual, and ſubmaxillary glands *; it is watery and ſomewhat viſcid; it is found to retard and moderate fermentation: it has ſometimes a tendency to form calculi like the urine. By theſe concretions it incruſts the teeth and ſometimes obſtructs the ſalivary ducts. It is the ſeat of the rabies canina.

Upon firſt examination the gaſtric liquor ſeems to poſſeſs a ſolvent power upon animal and vegetable ſubſtances, without

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* Theſe glands are very rarely met with in birds. It is mentioned as a ſingular circumſtance, in the demoiſelle of Numidia, that, "in the lower beak, on both ſides of the tongue, under the inward tunicle of the mouth, there were found two glandulous bodies, whence proceeded ſeveral lympheducts which opened into the mouth, and there diſcharged, being ſqueezed, a white and viſcous humour. There were two of them towards the upper part a great deal bigger than the others. The tongue was fleſhy at top and cartilaginous underneath, as in hens.

"The tunicle of the palate was rough, with a great number of little nipples and of hard and membranous points. It like-any great preference of affinity. The reaſon is, it varies according to the nature of the aliment; " it is ſometimes acid, ſometimes inſipid. Brugnatelli has found (ſays Chaptal) in the gaſtric juice of carnivorous birds and ſome others a diſengaged acid, a reſin, and an animal ſubſtance, united with a ſmall quantity of common ſalt. The gaſtric juice of ruminating animals contains ammoniac, an extractive animal ſubſtance, and common ſalt. In our time the phoſphoric acid has been found diſengaged in the gaſtric juice" of the graminivorous kinds.

" The bile ſecreted by the liver is glutinous or imperfectly fluid like oil, of a very bitter taſte, a green colour inclining to yellow, and froths by agitation like the ſolution of ſoap. Its conſtituent principles are water, a ſpiritus rector, a coagulable lymph, a reſinous oil, and ſoda. The reſinous part differs from vegetable reſins, becauſe theſe do not form a ſoap with fixed alkalis, becauſe they are more acrid and inflammable, and becauſe the animal reſin melts at the temperature of 40 degrees, and acquires a fluidity ſimilar to that of fat. From fat it differs in not being ſoluble in cold alcohol, in which reſpect it approaches to ſpermaceti, which alcohol cannot diſſolve without heat.

Bile, like other ſoaps, removes ſpots of oil from thoſe ſubſtances to which they are adherent; when its paſſages are obſtructed, the motion of the inteſtines becomes languid. It is neither alkaline nor highly putreſcent. In putrefaction it yields ſomething of a muſky odour; the foſſil alkali precipitates from it a green ſediment; and with diſtilled vinegar it produces a mixture neither acrid nor ſweet. Like ſaliva and urine, it has a tendency to form concretions which are called *biliary calculi* or *gall-ſtones*. They are ſometimes found of an irregular texture, of a brown, black, yellowiſh, or greeniſh colour. They ſometimes conſiſt of tranſparent cryſtalline laminæ, like mica or talc, and are ſometimes radiated from the centre to the circumference. They are always inflammable, of a more ſolid conſiſtence than the generality of animal oils, and reſemble ſpermaceti both in their ſolidity and cryſtallization; they are ſoluble in ardent ſpirit when aſſiſted by a moderate heat: the warm ſolution, when filtered, depoſits by cooling a number of laminated white brilliant cryſtals, ſuch as Poulletier de la Salle found in the bile, and which have been compared to the ſalt of benzoin, the concrete acid of borax, and to ſpermaceti. Many of their characters indicate that they are a ſubſtance of the ſame nature with the laſt mentioned. Fourcroy found that the ſubſtance of which theſe cryſtals are compoſed exiſts not only in the cryſtalliſed gall-ſtones or bile; he obſerved it to a very conſiderable degree in a human liver which had been expoſed to the air for ſeveral years, and had loſt its volatile parts by putrefaction. He detected it alſo in a ſaponaceous form in bodies which had been many years buried under ground; and lately Dr. Pearſon of London has artificially converted the muſcular fibre into a ſubſtance of a ſimilar kind, highly inflammable, and reſembling ſpermaceti *.

The pancreatic juice reſembles the ſaliva, and was examined in the laſt century, with a good deal of care, by De Graaf and Swammerdam. It has often been obſerved forming ſtony concretions †.

The lymph conſiſts chiefly of water; but, like the ſerous part of the blood, contains a ſubſtance which is coagulable by heat, by acids, and by ſpirit of wine. It is found in the cellular membrane, in the ventricles of the brain, in the pericardium, on the ſurface of the pleura, in the abdomen, in the burſæ mucoſæ, and in the joints under the name of *ſynovia*, where it has more than an ordinary degree of viſcidity, and of the lubricating quality. Sometimes, when it ſtagnates in the ſheaths of the tendons and burſæ mucoſæ, it acquires a thickneſs, and forms indolent tranſparent tumours, which become at laſt gelatinous. It is ſecreted chiefly by arteries.

Animal fat is a ſubſtance of a nature ſimilar to thoſe oils which are called *fat* in the vegetable kingdom. Its colour is uſually white, ſometimes yellow, and its taſte inſipid. Its conſiſtence is various in different animals. In cetaceous animals and fiſhes it is nearly fluid: in carnivorous animals more fluid than in the frugivorous: in birds, finer, ſweeter, and more unctuous, and generally leſs ſolid than in quadrupeds. In the ſame animal it is more ſolid near the kidneys and under the ſkin than in the vicinity of the moveable viſcera. As the animal grows old it becomes yellower and more ſolid; and in moſt animals is more copious in winter than in ſummer. In man and ſome other animals, it is collected in particular follicles of the cellular membrane, accumulated in great quantities in the groin, in the axilla, in the epipiploon around the kidneys and around the blood-veſſels: it is likewiſe ſecreted on the ſurface of the ſkin, which it protects from acrid ſubſtances, and where it ſometimes concretes, often from a want of cleanlineſs, in the form of ſmall worms. In cetaceous animals and fiſhes it is generally diſpoſed in certain reſervoirs, ſuch as the cavity of the cranium and the vertebræ; in ſome it is chiefly confined to the liver; in ſerpents, inſects and worms, to the viſcera of the lower belly, where it is diſpoſed in ſmall lumps, and only a ſmall quantity found on the muſcles and under the ſkin; in frogs it is collected in certain bags which diverge, as it were, from a common trunk, and ſeem like appendages to the ovaria and teſtes. In many places it ſeems to be ſecreted by organic pores, and under the ſurface of the ſkin by glands. It is accumulated from a diminution of perſpiration, from the nature of the aliments, from morbid affection, and from idioſyncraſy. It is of the ſame nature as the fixed oil of plants; and Lorry has found a very ſtriking analogy between it and the bile.

It is a bad conductor of heat, and preſerves the warmth of thoſe regions where it is ſituated. It is more adheſive and leſs apt to evaporate than water, and is therefore a better lubricating fluid. When reabſorbed, it counteracts the ſaline impregnation if too copious; and its nutritive power is as three to one when compared to that of the muſcular fibre. Theſe proper

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wiſe included a glandulous body, which ſhot forth two great ductuſes opening into the mouth. There was diſcovered a great quantity of other little glands at the ſides of the larynx, which had alſo ſome lympheducts." *Anat. Deſcript. of the Demoiſ. of Num. by the French Academy.*

* The means which he uſes is digeſtion in water; and the proceſs ſuppoſes a previous acquaintance with what is common and what peculiar to the fibre and the fat. He maintains that the fibre is entirely compoſed of carbone, oxygene, hydrogene, and azote. In a high temperature theſe are decompoſed, or at leaſt ſeparated, without producing fat. But when the fibre is kept in water in a low temperature, the carbone unites with the hydrogene of the water, and forms a fat reſembling ſpermaceti, and highly inflammable. Part of the oxygene, too, uniting with azote, forms the nitric acid; and part of the azote uniting with the hydrogene conſtitutes ammonia; ſo that three ſubſtances are thus formed.

† De Graaf was of opinion, that calculi might be formed in all glands. He had ſeen them above twenty times in the pineal gland, that was long thought the reſidence of the ſoul.—He ſays, too, they occur more frequently in the pineal gland of Frenchmen than of Dutchmen; and very pleaſantly aſſigns this reaſon, that the volatile ſpirit of a Frenchman requires more ballaſt than that of a Hollander. *De Succo Pancreatico*, cap. 7.

ties may partly ſerve to explain its uſes around the ſeveral branches of the blood-veſſels in thoſe parts which require warmth, and in thoſe which are anywiſe expoſed to motion. They will likewiſe account for its being more copious in winter than in ſummer *; and for its being found in great quantities in the marmot, the dormouſe, in the bear, and thoſe animals in general which are conſtrained to a long abſtinence. It forms ſometimes ſteatomatous tumours, and contains the ſebacic acid, which acts readily on lead, copper, and iron.

The vegetable fat is contained chiefly in the fruit; and is known by the names of *fat oil*, *ſweet oil*, and *oil by expreſſion*. It freezes in different degrees of heat, and varies according to the nature of the plant by which it is afforded.

The mucus is more viſcid than the lymph, and is not coagulable by fire or alcohol. It is mild, not diſpoſed to corruption, nor ſoluble in water. This ſecretion is performed by glands. Theſe glands, in the pulmonary phthiſis, ſecrete often a mucus that reſembles pus, and occaſions a ſuſpicion of ulcers where there are none. Mucus is found in the noſe, through the whole length of the alimentary canal from the mouth to the anus, in the aſpera arteria, in the bronchia, in the kidneys, ureters, bladder, and moſt of all in the urethra. It forms hard ſtony concretions ſometimes in the lungs.

The ſeminal fluid has been ſeldom the ſubject of chemical analyſis. It is heavier than water, ſoluble in urine, deliqueſces in air and with heat; it hardens with the fixed alkali, and is not coagulable by alcohol. It contains a number of animalculæ; and in the ſyſtem in which it is ſecreted, it affects the paſſions, the manners, and the voice, the taſte of the muſcles, the ſecretion of fat, and the growth of the hair. In many fiſhes this fluid is contained in a ſort of bags. In moſt animals it is ſecreted by glands, which are called *teſtes*, and is accumulated in the vaſa deferentia, or where they exiſt in the ſeminal veſicles. Of theſe veſicles Swammerdam obſerved long ago, that in the ſcorpion they were probably "adapted by nature to ſecrete a ſeminal matter different from that ſupplied by the teſticles; they are largely (he ſays) ſupplied with glandules to anſwer that purpoſe, and conſiſt of a conſiderably thick and ſpongy ſubſtance." Mr. Hunter ſince has endeavoured to ſhow that they ſecrete a particular fluid in all animals.

So little are we acquainted with the nervous fluid, that ſome have doubted of its exiſtence. The diſcovery, however, of Galvani, and the numerous experiments that have ſince been making on animal electricity, leave us not without all hope that ſomething yet may be known of its properties, that will greatly illuſtrate ſeveral phenomena in the animal economy.

The lacteal ſecretion is generally confined to one ſex, and is peculiar to the claſs of mammalia, though ſomething ſimilar may perhaps be ſecreted in the crops of pigeons.

It would be impoſſible here to enumerate or to tell the uſes of all the different kinds of ſecretions in living bodies. We cannot enumerate all that we know without running into tedious detail. The eſſential oils, the camphor, the gums, the balſams, the reſins, and many others, are various ſecretions of the vegetable kingdom. Each ſpecies of plant and animal has generally ſome peculiar ſecretion; and this ſecretion in the individual has often ſome diſtinguiſhing quality, diſcoverable by taſte, by colour, or by ſmell. Theſe different ſecretions have likewiſe each their particular uſes. We know the intention of the oily juice with which the bird dreſſes its feathers, of the glutinous fluid of the fiſh, of the viſcid mucilage of the ſnail; we ſee the purpoſe for which the viper ſometimes employs its virulent humour, and for which the cuttle-fiſh ejects its ink: but yet we know only in part.

The difference among the various ſecretions of the ſame ſyſtem ſeem principally owing to a difference of ſtimulants, and to ſome difference in the action, the form and the irritable power of the ſecretory organ. Paſſions of the mind very often affect the ſecretions; and it frequently happens that paſſion and medicine affect one ſecretory organ and not another. It is therefore probable that the organs of ſecretion, and the ſmalleſt fibre is an organ of this kind—we ſay, it is probable that the organs of ſecretion, like the eye, the ear, and all the different organs of ſenſe, are each affected in ſome meaſure by peculiar ſtimulants; as the ſtomach by hunger, the fauces by thirſt, and the genital organs by venereal orgaſmus.

Fermentative mixture, and ſome original impregnation of the organs, have alſo been brought to explain the ſeveral phenomena of ſecretion. We conclude with obſerving, that however much the various fluids of living bodies may differ in appearance, chemical analyſis has generally reduced them to a water, a gluten, a ſaline impregnation, and an oil.

Sect. VII. *Integumation.*

All living bodies are furniſhed with one, two, or with more integuments, which are prepared by ſecretory organs, and which are a defence againſt thoſe injuries to which their ſituation is commonly expoſed. Of theſe integuments, ſome prevent the diſſipation of the fluids, ſome again reſiſt acrid and corroſive ſubſtances, ſome are indigeſtible in the ſtomach, and ſome are ſeemingly incorruptible in the earth. By theſe properties they preſerve ſeeds and the ova of inſects for a number of years, waiting the change of ſoil or of ſeaſon. They protect both from the action of weak membranous ſtomachs, and make thoſe animals who chooſe to ſwallow them contribute likewiſe to their propagation. The gelatinous ſubſtance ejected by birds, and called the *tremella-noſtoc* or *ſtarfall*, we have lately found, by numerous experiments, to be a ſubſtance of this kind. It is nothing elſe than the oviducts of frogs, which, as the embryo in form of an egg moves along their winding canal, are intended by nature to ſecrete that tranſparent and viſcid glaire which conſtitutes the albuminous part of the ovum, and feeds and protects the embryo in water †.

Some integuments are chiefly uſeful by their ſtrength and hardneſs. The ſhells of the beetle are an excellent defence for the membranous wings which the creature is ſeen to pack up in folds when it inclines to creep into the earth. The ſhell of the ſnail lodges the inteſtines ‡ when the animal comes forth to ſearch for its food, and it furniſhes a ſafe retreat for the body when any danger is threatened from without. Some animals, confined to their ſhells, can open and cloſe them by a muſcular power; and ſome ſhells, like the ſcales obſerved on fiſhes and inſects, are diſpoſed into plates, ſo as to be no hindrance to motion. Several inſects which ſpend a part of their time in the water always compoſe a ſhell for themſelves where it is needful. The uſual materials are ſand, ſtraws, or mud, which they cement by a viſcid ſecretion. The ſhells of moſt inſects are corneous. Swammerdam found that cretaceous ſhells are compoſed of layers of indurated membranes, and that they are ſometimes covered with a cuticle.

Some integuments are covered with feathers, ſome with hair or a thick down. Beſides many other obvious uſes of theſe coverings, they ſerve in general to repel inſects; and, being but bad conductors of heat, maintain a genial and neceſſary warmth.

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* The efficient cauſe may be diminiſhed by perſpiration.

† We have often inflated the oviducts of frogs, and dried them; and afterwards putting ſmall pieces of them into water, have ſeen them ſwoln in a few hours to a large ſize, and forming the tremella-noſtoc or ſtarfall.

‡ This ſnail is found in our gardens, and carries its ſhell, including the inteſtines, upon its back.

When the integuments are covered with prickles, they repel attacks by the ſtrength of their points, or by the venom which they infuſe, as the ſtings of nettles and the downs of ſome inſects and plants.

When they are moiſtened with a viſcid ſecretion, they preſerve the neceſſary ſoftneſs of the parts, prevent evaporation, reſiſt acrimony, enable plants to deſtroy their enemies, and aſſiſt the ſnail in performing its motions.

Both plants and animals, but particularly the former, are often protected by an odorous effluvia from their integuments. This effluvia is the finer part of their volatile oil, always inflammable, and ſo ſubtile, that the continual emiſſion of it from wood or flowers does not ſenſibly diminiſh their weight. To this fragrance it is owing, that the deadly nightſhade, the henbane, hounds tongue, and many others, are ſeen on almoſt every high road untouched by animals. The mancinelle-tree of the Weſt Indies emits ſo very dangerous vapours, that the natives poiſon their arrows with its juices, and thoſe have died who have ventured to ſleep under its ſhade. The lobelia longiflora of America produces a ſuffocating oppreſſion in the breaſt of thoſe who reſpire in its vicinity. The return of a periodical diſorder has been attributed to the exhalation of the rhus toxicodendron. Every one knows, ſays Chaptal, the effects of muſk and oriental ſaffron on certain perſons. Ingenhouſz mentions a young lady whoſe death was occaſioned by the ſmell of lilies; and Triller reports an inſtance of another who died in conſequence of the ſmell of violets. The ſelection of graſſes by different animals ſeems to be owing to the manner in which the volatile aroma affects their ſenſes. But of all the vegetable exhalations known, thoſe emitted by the bohun-upas, or poiſon- tree of Java, are the moſt remarkable. For many miles round no animal can breathe the air, no plant dares to peep from the ſoil, the fiſhes die in the poiſoned ſtream, and the birds that venture athwart the atmoſphere with deſpairing ſhrieks ſink down lifeleſs. Such often is the uſe of the fragrant oils in the vegetable economy. The ſhrubs and trees that are covered with thorns are in general a grateful food to animals. They generouſly avow their manner of attack, and ſcorn the dark aſſaſſination by poiſons.

The various colours of the integuments, as well as the aroma, is a ſpecies of defence. "Caterpillars which feed on leaves (ſays Darwin) are generally green; and earth-worms the colour of the earth which they inhabit. Butterflies which frequent flowers are coloured like them. Small birds which frequent hedges have greeniſh backs like the leaves, and light-coloured bellies like the ſky, and are hence leſs viſible to the hawk who paſſes under them or over them. Thoſe birds which are much amongſt flowers, as the goldfinch, are furniſhed with vivid colours. The lark, partridge, hare, are the colour of dry vegetables, or earth on which they reſt; and frogs vary their colour with the mud of the ſtreams which they frequent *, and thoſe which live on trees are green. Fiſh which are generally ſuſpended in the water, and ſwallows which are generally ſuſpended in the air, have their backs the colour of the diſtant ground, and their bellies of the ſky." The ſphinx-convolvuli, or unicorn-moth, reſembles in colour the flower on which it reſts; and among plants, the nectary and petals of the ophrys, and of ſome kinds of the delphinium, reſemble both in form and colour the inſects which plunder them, and thus ſometimes eſcape from their enemies by having the appearance of being pre-occupied. From colour being thus employed as a defence, many animals vary their colours with the ſeaſons and circumſtances; and thoſe which are of different colours in ſummer according to the places which they inhabit, do all in winter aſſume in common the colour of the ſnow.

But a change of colour is not the only change of the integuments. As the outmoſt are often inſenſible to ſtimulants, and for obvious reaſons poſſeſs little of the vital principle; in all caſes where they cannot be enlarged to admit an additional increaſe of growth, or where they are not furniſhed with neceſſary organs to repair thoſe injuries which they may ſuffer from diſeaſe or accident, the body is endowed by nature with a power to throw them off, and to produce others in their ſtead †. For this reaſon, we ſee the tree caſting annually its exterior bark, the lobſter his ſhell, the bird his feathers, the quadruped his hair, and ſometimes his horns, the ſerpent his ſkin, and man himſelf renewing the ſcales of the epidermis. Theſe changes uſually take place once a-year, twice frequently with reſpect to ſerpents, and oftener in toads, who have been obſerved to devour the ſkin which they throw off. All the integuments of ova and ſeeds, being wholly the production of parental organs, neither are nor can be repaired.

SECT. VIII. *Irritability*

Is that property of the living fibre by which it acts in conſequence of ſtimulants. Being one of the great cauſes of motion in living bodies, no property has excited more wonder, been the cauſe of more error, or exhibits ſuch a number of ſtriking phenomena to the ſenſes. Theſe effects, however, have ariſen rather from the nature of the ſtimulants than from any thing myſterious in irritability. Many of the ſtimulants by which this property in bodies is diſplayed are often inviſible, unknown, or unthought of; and men being conſcious that a number of their motions proceed from a ſtimulant that is under the direction of a mental power, they readily conclude from a ſort of analogy, that every motion in plant and inſect that ſeems to anſwer a uſeful purpoſe, and is cauſed by ſome inviſible ſtimulant, is the conſequence of mind directing from within. They further ſuppoſe that irritability is in all caſes the conſequence of nerves, which are thoſe organs which nature has employed in the animal kingdom to convey ſtimuli between body and mind. Theſe ſingular concluſions have led to others that are leſs admiſſible even than themſelves. It has been imagined that creatures the moſt ſtupid poſſeſs within them a principle of mind that is incapable of further improvement, but which, notwithſtanding, is in many reſpects ſuperior to reaſon, and a ſurer guide in whatever relates to ſelf-preſervation or that of the ſpecies: it enables the animal to predict without foreſight, and to act rationally without intelligence. This wondrous principle has been called inſtinct: and in order to account for ſome of the ſingular phenomena of vegetables, a ſhare of it has graciouſly been allowed to plants; which having become favourites of late, have been alſo preſented with the privilege of ſenſation, permitted to fall in love, and to marry, and on ſome occaſions to exerciſe the faculty of volition.

At theſe conceſſions the metaphyſician will naturally ſmile. He knows how many impoſe on themſelves by the mere ſound of their own words, as if by calling the ſnow black they were to diſcover a new property; which curious diſcovery would turn out at laſt to be only a groſs ignorance of language, and the fooliſh miſapplication of a ſyllable. He who has ſtudied the philoſophy of mind, and been accuſtomed to view objects through another medium than the magic colourings of paſſion and of fancy, readily perceives a ſomething of abſurdity in aſcribing ſuch wiſdom to plants and inſects. With reſpect to animals, theſe gentlemen do not recollect that voluntary actions are of two kinds, as they proceed from deſign or propenſity; that in performing one of theſe kinds the mind itſelf has an object in view, and is properly the ſource whence they originate; but that in the other the mind is merely a ſecondary agent, is acting under the influence of ſtimulants, is often not aware of the conſequences, or, although aware, is often ſo infatuated as not to regard them, however fatal. It is generally well known to the naturaliſt, that not a few of theſe propenſities ariſe from the form and ſtructure of the body, from the manner in which the optic nerve is affected by colours, the olfactory by ſmells, the guſtatory by taſtes, and the auditory by ſounds; from the different ways in which the fauces are affected by thirſt, the ſtomach by hunger, and the genital parts by venereal orgaſmus.

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* The ſame is the caſe with many fiſhes that live in lakes.

† Several ſmall animals in changing their integuments change likewiſe the interior coat of the alimentary canal, which they void with the fæces.

Beſides theſe and other propenſities which operate as ſtimulants in the ſyſtem itſelf, the naturaliſt has found that light, heat, and moiſture, in various degrees from abſolute darkneſs, coldneſs, and dryneſs, act as ſtimulants upon living bodies: he has experienced that electricity is a general agent, that ſeveral plants emit flaſhes *, and that ſome animals even give ſhocks reſembling the electric. He has made it probable that it produces all the wonders of cryſtallization; and that the cauſe of chemical affinity, and of all the phenomena diſplayed by the magnet, if not ſimply a modification, is at leaſt akin to it. In the male parts of plant and animal, he has ſeen both the fluid and the pollen that give the ſtimulus in generation, and are accompanied with ſo extraordinary changes in the ſyſtem. He has found that much of the vegetable economy, and even the function of generation itſelf, as the development of the fecundating powder, and its application to the female organ, is partly carried on by wind, heat, and other ſuch agents. He has reaſon to conjecture that many general agents in nature are yet unknown. By the help of chemiſtry, he has found out lately a conſiderable number which are called gaſes, which are of the very higheſt importance in both the animal and vegetable economy, and which, like the aromas of plants, or the cauſes of contagion, produce their effects without being viſible. It is only, too, of a late date that the celebrated profeſſor Galvani of Bologna has excited ſo much curioſity through Europe, by the diſcovery of a certain ſtimulus that reſides in the nerves, that paſſes along electric conductors, and which by a certain application of metals occaſions a vivid flaſh in the eye, convulſes the body of a living frog, and rouſes the detached limbs into action. The change of colour in the integuments according to different ſeaſons and circumſtances, though it anſwer a rational and uſeful purpoſe, proceeds from a cauſe that does not ſeem to be very well known. Even many agents which are not inviſible, nor yet unknown, exert their influence in a ſecret manner, ſo as not to be obvious to the ſenſes. It is generally known that many ſingular movements of plants are owing to heat, many to light, and ſeveral to moiſture. The barley-corn is often obſerved to creep on the ground by means of its awn, which dilates or contracts according to the different degrees of moiſture. The wild oat, employed as an hygrometer, moves through the barn, travels through the fields, nor ceaſes to be changing its ſituation till its beard fall off, or till it meet with a ſoil where it conveniently may ſtrike root. Upon a ſimilar principle of motion, the ingenious Edgeworth conſtructed an automaton which moved through a room which it inhabited. It is eaſily conceived how theſe ſingular effects, ariſing from cauſes that are unknown, inviſible, or unthought of, ſhould give birth to the notions of witchcraft and of inſtinct, and impreſs the fancy with an idea of ſomething reſembling ſenſation and volition in the vegetable kingdom. Theſe agents, whether inviſible, unknown, or unthought of, directed by regular and uniform laws under the great Author of nature, produce effects that indicate preſcience, wiſdom, and deſign, and, cauſing a tranſient or permanent propenſity in the mental part, frequently control by reſiſtleſs ſway the finite minds that reſide in matter. Theſe minds, in a living body, have generally been found accompanied with ſome ſyſtem of nerves; and theſe nerves happening with equal facility and promptneſs to convey ſtimuli from the mind to the body and the body to the mind, the great difficulty has been to determine with reſpect to others when the action proceeds ſolely from deſign, ſolely from propenſity, or from deſign and propenſity together. The uniform conduct of the brute creation would ſeem to imply that their mind has little of inventive power; that it generally acts from the impulſe of propenſity; and that its manners are varied, not in conſequence of a change of ſentiments, but from the induction of new habits, and the application of new ſtimulants.

It has been obſerved, that in all animals the vigour of mind has ſome relation to the quantity of brain, and to the perfection of its organization; and that the acuteneſs of the different ſenſes is generally proportioned to the quantity of nerve beſtowed on their organs †. Man has a greater proportion of brain than any other animal; but many an animal has a much greater proportion of nerve beſtowed on different organs of ſenſe. Many animals have therefore acuter ſenſes than man; but man has a greater vigour of mind than any other animal on this globe.

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* "In Sweden (ſays the author of the *Loves of the Plants*) a very curious phenomenon has been obſerved on certain flowers by M. Haggeren, lecturer on natural philoſophy. One evening he perceived a faint flaſh of light dart from a marigold: ſurpriſed at ſuch an uncommon appearance, he reſolved to examine it with attention; and to be aſſured that it was no deception of the eye, he placed a man near him with orders to make a ſignal at the moment when he obſerved the light. They both ſaw it conſtantly at the ſame moment; the light was moſt brilliant on marigolds of an orange or flame-colour, but ſcarcely viſible on pale ones; the flaſh was frequently ſeen on the ſame flower two or three times in quick ſucceſſion, but more commonly at intervals of ſeveral minutes; and when ſeveral flowers in the ſame place emitted their light together, it could be obſerved at a conſiderable diſtance. This phenomenon was remarked in the months of July and Auguſt at ſunſet, and for half an hour after when the atmoſphere was clear; but after a rainy day, or when the atmoſphere was loaded with vapours, nothing of it was ſeen. The following flowers emitted flaſhes more or leſs vivid in this order: The marigold, garden naſturtion, orange lily, African marigold; ſometimes it was alſo obſerved on the ſunflowers; but bright, yellow, or flame colour ſeemed in general neceſſary for the production of this light, for it was never ſeen on the flowers of any other colour. The flowers were carefully examined with a microſcope, without any inſects or phoſphoric worms being found. M. Haggeren, after having obſerved the flaſh from the orange lily, the anthers of which are a conſiderable ſpace diſtant from the petals, found that the light proceeded from the petals only; whence he concludes, that this electric light is cauſed by the pollen, which in flying off is ſcattered upon the petals." (*Obſerv. Phyſiques par M. Rozier*, vol. xxxiii. p. 111.)—Addition to the note on *Tropæolum*, *the Loves of the Plants*. The author of this beautiful poem ſuppoſes, that the time of the twilight is ſometimes extended by different bodies emitting the light which they had abſorbed during the day.

† The acuteneſs of the ſenſes depends upon the readineſs with which their organs are affected by ſtimuli. This readineſs de-

The brain of quadrupeds is ſomewhat ſimilar to that of man, but proportionally ſmaller, and not perhaps ſo well organized. Willis has obſerved, that among animals the ſtructure of the cerebrum is more variable than that of the cerebellum; that the former generally furniſhes nerves to the voluntary muſcles, and the latter with the medulla oblongata to the involuntary. He has likewiſe remarked, that the round prominences, commonly called the nates and teſtes, are large in the quadrupeds which are active and vigorous, and in ſome meaſure able to procure their own ſubſiſtence at birth; that the tuber annulare is large in the quadrupeds that are diſtinguiſhed for their ſagacity; that wherever the tuber annulare is ſmall, the prominences are large, and wherever it is large the prominences are ſmall. From theſe obſervations he has concluded that the tuber annulare is the ſeat of genius, and the round prominences the ſeat of what has been called inſtinct *.

The brain of birds is ſeemingly the reverſe of the human brain; the cortical ſubſtance is the interior, and the ventricles are ſituated in the white part on the outſide. In the brain of the bird there are no circumvolutions like the inteſtines, no fornix, corpus callosum, nor corpora ſtriata.

The brain of fiſhes is in many reſpects ſimilar in its ſtructure to the brain of birds. It is very ſmall in proportion to their body, and is generally ſurrounded with an oily matter. In one genus of fiſhes, the gadus, Dr. Monro found ſpheroidal bodies between the dura and pia mater, and covering the greater part of the nerves like a coat of mail. The two ſenſes, ſeeing and hearing, in many fiſhes are often acute. By laying one ear on the water, and ſtriking the ſurface at ſome diſtance, this element is found to be a better conductor of ſound than even the air.

The reptile tribes have very little brain, and like the fiſhes have no ganglions upon their nerves.

Moſt inſects have no brain at all, but a nervous cord that is full of ganglions, that runs from one extremity to the other, and is denominated the ſpinal marrow. This knotty cord, however, is not marrow; the inſect has nothing reſembling a ſpine; and the ſituation of the cord in the animal is often not along the back but the breaſt. In the ſilk-worm, and moſt other inſects, this cord is in contact with the alimentary canal; and the firſt ganglion, which is ſometimes called the brain, though not in the head, divides, in order to give a paſſage to the ſtomach, and again unites in a ſecond ganglion. Swammerdam found in a ſpecies of ſnail a brain with two lobes, in contact with the ſtomach, moveable by muſcles, and without a fixed place in the body.

The polypes exhibit no appearance of brain or of nerve, as in other animals. Their ſkin, however, is obſerved to be full of a number of ſmall granulary bodies, which are connected by a glareous matter that reſembles a thread. Like rows of bead-ſtrings, they extend from one extremity to the other, and along the arms. Trembley learned from a number of experiments that they received their colour from the food, and therefore ſuppoſed them to be veſicles or glands. If not like the tuberous nerves of the inſects, they at leaſt are not very different in appearance from the nerves of the gadus that are covered with a number of ſpheroidal bodies like a coat of mail.

Some things would inſinuate that a nervous ſyſtem does not ſeem to be neceſſarily connected with mind. The ſtimuli of nerves may be brought into action by other cauſes beſides mind. Even many nerves are not ſubjected to the influence of mind; and the mind often by its own inattention may loſe the power which it originally poſſeſſed over nerves. Many perſons can move the muſcles of the ear, and others may have loſt that power through neglect. After Fontana had obſerved that the heart was a voluntary muſcle in a wheel polype, he learned to retard and accelerate the motions of his own at pleaſure. If ſome nerves, from a ſort of preſcription, thus ceaſe to be obedient to the power of mind, others by frequent ſervice and habit become ſo obedient as to convey their ſtimuli to the muſcles almoſt without the conſciouſneſs of mind. The motions excited by the ſtimuli of nerves are in many caſes exceedingly rapid. Theſe may be ſeen in the wings of moſt inſects, but are moſt noticed in dancers, tumblers, and apes, and all thoſe animals that are exhibited for feats of agility.

The motions which we ſee excited in the body by the ſtimuli of nerves have often been ſo vigorous and prompt, as to have torn the muſcle from the bone, and to have broken the bone itſelf. They often affect the organs of ſecretion, have often unhinged the fabric of the ſyſtem, occaſioned death, and accounted for the miracles that have been aſcribed to the power of fancy. The prompt motions of what have been named ſenſitive plants ſeem owing to a different ſpecies of ſtimulants acting on extremely irritable fibres †.

In the animal kingdom, all muſcles in the time of action are obſerved to diſcharge a quantity of their blood; and thoſe muſcles which are naturally white are the moſt irritable. In all living bodies, the irritable power will ceaſe to obey the action of a ſtimulant, if either long or violently applied. After exerciſe, therefore, the irritable fibre requires reſt, after heat cold, after waking ſleep, before it again becomes ſubmiſſive to the action of the ſtimulant that overwhelmed it. This is the reaſon that in plants and animals there are certain exertions and functions of the ſyſtem that can only be continued at intervals and ſeaſons. The natural ſtimuli of involuntary muſcles continue to act, and the muſcles continue to obey through life.

The organs of ſenſe were formed to mark the difference of ſtimulants; yet living bodies are affected by light without having eyes, by ſounds without having ears, by odorous effluvia without having ſmell, and by ſapid bodies without having taſte. It is eaſily conceived how theſe objects, by their inherent properties or motion, may produce a confuſed ſort of excitement in every highly irritable fibre. But the organs of ſenſe are peculiarly fitted to receive accurate and diſtinct impreſſions from each of theſe objects; and theſe different impreſſions ſeem not to ariſe from any difference in the kind of nerves

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pends on irritability. It is not neceſſarily connected with mind, nor ſhould it ever be confounded with perception, which in claſſical language ſignifies a property of the mental principle.

* Few perhaps who have diſſected different animals, and who, beſides a number of ſtructures, have ſeen a variety of tubercles and lobes exiſting in the brain, will be raſh in aſcribing to any one of them one particular office. The pineal gland was for ſome time thought the ſeat of the ſoul. It was afterwards found to be often filled with ſtony concretions; and the celebrated Nuck, inſtead of aſſigning to it any prerogative, contented himſelf with writing its epitaph.

† In many inſtances the prompt motions of animals ſeem more owing to the irritability of their fibres than to what has been called the ſenſibility of their nerves. The poet was miſtaken when he ſuppoſed that the mangled inſect would feel as ſenſibly as a mangled giant. When the gad-fly fixes fairly on the hand, you may cut off its wings, its legs, its antennæ, and a part of the lower diviſion of its body, without diſturbing its gratification, or apparently occaſioning to it much trouble.

by which they are received. All the difference that has been obſerved ariſes from the ſtructure of the organ itſelf, and from the manner in which the nerve is diſtributed through it. Other parts of the animal body, as the ſtomach, the fauces, and genital organs, are thus affected by particular ſtimulants; and many animals, and even vegetables, may be affected in various manners, and by various ſtimulants, of which neither our feelings nor our ſenſes can give intimation of any thing analogous.

With reſpect to the ſeveral organs of ſenſe, ſome animals have many eyes without any motion, and ſome animals have few eyes with varieties of motion. The entrance to the ear in ſome animals is from the mouth, as happens in the frog; and the bones of the ear are without the cranium, as in ſome fiſhes. The ſenſe of ſmelling is found in the noſe: this ſenſe is aſtoniſhing in dogs; and even ſheep, in diſtinguiſhing their lambs, truſt to it more than to ſeeing or hearing. The ſenſe of taſte is far from being general; and the ſenſe of touch can hardly be ſaid to reſide peculiarly in any one organ.

Sect. IX. *Motion.*

Irritability is one of the great ſources of motion in all living bodies; and this power is brought into action immediately by nerves or ſome other ſtimulants. Locomotion here is principally conſidered; for although the kinds of internal motion employed in ſecretion and the other functions be as remarkable, in the eye of the philoſopher, they have not ſo generally attracted the attention. Moſt animals are capable by nature of changing the place which their body occupies; for this reaſon, the irritable fibres, being formed into bundles, which are called *muſcles*, are in moſt animals attached to bones, cartilages, or hard integuments, which they move as levers: theſe levers, with their muſcles attached, are in moſt caſes formed into wings, fins, and legs of various kinds, and are employed in performing the motions of flying, ſwimming, walking, leaping, and creeping. So very neceſſary, in the opinion of ſome of the ancients, was one or other of theſe inſtruments to progreſſive motion, that the movement of the ſerpent was often aſcribed to a preternatural cauſe, was ſuppoſed to reſemble the *inceſſus deorum*, and procured to the animal one of the higheſt and moſt honourable ranks among the emblematic kinds of divinities. Even Moſes himſelf, who was unwilling to allow it the character of an agathodæmon or good genius, was yet ſo puzzled at its being able to move without feet, that he pronounces it a tool of the devil; and ſays that it was deprived of its feet by a curſe from heaven for ſeducing mankind into idolatry. Notwithſtanding, however, the ſurpriſe that has been occaſioned by its ſingular movement, the motion of ſnails, though not ſo rapid, is in many reſpects as extraordinary: they adhere by a certain viſcid ſecretion; on dry ground this ſecretion forms a pavement over which they glide; and they proceed by the action of muſcles, without bone, cartilage or ſhell to which theſe muſcles can be attached.

No animal walks without legs or flies without wings*; but there are many that ſwim without fins, and that leap and creep without any legs. The rapidity of movement is not proportioned to the number of inſtruments that are employed: if the ſpout-fiſh be obſerved to move ſlowly with one leg, the ſea-urchin moves ſtill ſlower with many thouſands; the oyſter moves by ſquirting out water; the ſcallop by the jerk of its ſhell, and when in the water it riſes to the ſurface and ſails before the wind.

Many animals are formed by nature to fly, walk, leap and ſwim: the fate of thoſe is rather uncommon whoſe muſcles or feet are by nature attached to their integuments; the lobſter is obliged to throw off its ſhell, and the caterpillar all its feet with the ſkin, and in that ſituation to remain ſtationary till it receive new inſtruments of motion.

Whoever has read the celebrated work *De Motu Animalium*, needs not to be told that, beſides the organs which are here mentioned, the form, the ſtructure, and even the ſpecific gravity of the body, as depending on the nature of the bones and muſcles, or as varied by air, veſicles, and bubbles, with a great variety of other circumſtances, are neceſſary to explain the different phenomena of locomotion.

As to vegetable motions, they evidently depend on external agents. The motion of the wild oat has been mentioned; the wings of ſeeds only fit them to be carried by the wind, their ſpecific gravity to float in the water, and their legs or tentacula to adhere to bodies that are in motion: the ſingular motions which have been aſcribed to ſleeping, to waking, to ſenſation, and volition, in the vegetable kingdom, ſeem only the conſequence of light, heat, moiſture, and ſuch ſtimulants, acting inviſibly or with ſecret influence: the opening and cloſing of the meteoric flowers are always correſpondent to the ſtates of the atmoſphere; and the opening and cloſing of the equinoctial and tropic flowers, to the light, the length, or ſhortneſs of the day.

The principal intentions of locomotion are, to get food, to ſhun danger, to promote intercourſe, and diſperſe the ſpecies.

Sect. X. *Habit.*

Habit here deviates a little from its uſual meaning. We employ it to ſignify that principle in living bodies by which they accommodate themſelves to circumſtances, aſſume as it were a different nature, and in many reſpects undergo a ſpecies of transformation.

So very much do ſome individuals of the vegetable tribe accommodate themſelves to different ſituations, to ſoil, to climate, and the ſtate of cultivation, that thoſe naturaliſts who have not been accuſtomed to nice and accurate diſcriminations have frequently miſtaken the variations of the ſame plant for ſo many ſpecies. Theſe variations may be daily ſeen by examining the plant as it grows on the mountains, in the valleys, in the garden, or in the fields; or by bringing it from a rude uncultivated ſtate, when it ſometimes lays aſide its formidable prickles, and changes the colour and ſtructure of its flowers.

In the plant and animal, the delicacy and vigour of the conſtitution are oftener the effects of habit and circumſtance than original conformation. We have mentioned already the varying colour of the integuments, and the purpoſe which it ſerves in changing with the ſeaſons. We may here add, that animals covered with a down or hair have it thick or thin, long or ſhort, according to the different exigencies of climate.

Thoſe changes produced on their body are accompanied with others which are the cauſes of new taſtes, of new propenſities, and new manners. At the Cape of Good Hope the oſtrich inclines to ſit on her eggs day and night like any other bird; but in Senegal, where the heat is greater, ſhe is ſomehow diſpoſed to leave them to the ſun during the day. In thoſe countries where proviſions can be found during the greateſt part of the year, the bee gradually loſes the propenſity of laying up ſtores for the ſeaſon of winter; and in "thoſe countries infeſted with monkeys, many birds (ſays an amuſing and inſtructive writer) which in other climates build in buſhes and the clefts of trees, ſuſpend their neſts upon ſlender twigs, and by this ingenious device elude the rapacity of their enemies." Man, from imitation, is expoſed to a great number of habits peculiar to himſelf; and phyſical cauſes have ingeniouſly been aſſigned for the variety of his features and complexion.

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* The fins of the flying fiſh enable it rather to ſpring than fly.

Few experiments have yet been inſtituted with a view to ſhow how far this accommodating principle in nature may be extended in the different ſpecies of plants and animals. It is known, however, that the lamb and the dove can be made carnivorous; and that the hawk, laying aſide his ferocity, can be brought by art to live upon grain.

Of all the effects of this ſingular principle, the moſt wonderful are thoſe which are ſeen to take place with reſpect to generation. The fact is far from being new to the naturaliſt, that certain animals, oviparous at one ſeaſon, are viviparous at another. This indicates much of accommodating power, though far inferior to what has been ſince witneſſed and diſplayed: for, who from all this could ſuſpect, that any animal which uſually propagates by an intercourſe of ſexes, could in any circumſtance accommodate ſo far as to multiply its ſpecies another way? Bonnet of Geneva, however, has diſcovered, that the puceron or vine-fretter, which generally propagates by an intercourſe of ſexes, is not only oviparous at one period and viviparous at another, but, in all caſes where the union of the ſexes is not to be obtained, can eaſily accompliſh all the purpoſes of generation without it. Similar experiments have likewiſe proved, that many plants can bring to maturity a productive ſeed, though the male parts of the flower be deſtroyed before they can in the uſual way have any impregnating effect on the female. In this caſe, the concluſions drawn have been ſomewhat new. From theſe experiments it has been inferred, that the ſexual ſyſtem is ill-founded, and that moſt of the learned naturaliſts of Europe are on this ſubject labouring at preſent under a miſtake. This reaſoning, however, is not ſatisfactory: for why, it might be aſked, in the vegetable kingdom more than in the animal, ſhould the mode of generation be neceſſarily uniform? Though ſome plants may, like ſome animals, propagate without ſexual diſtinctions, the concluſion is not logical that theſe diſtinctions are uſeleſs in all; and though ſome few may, in particular inſtances, propagate without that impregnation to which they were accuſtomed, will any one demonſtrate, that accommodating nature does not here as in the puceron adopt a new method to accompliſh her deſigns?

In all living bodies, it frequently happens that ſeveral characteriſtic diſtinctions, as the colour, the features, and a number of diſeaſes that are originally the effects of circumſtance, do at laſt become ſo fixed in the ſyſtem, that they are afterwards tranſmitted to poſterity through ſome generations *. With regard to animals theſe facts are well known; and as to vegetables, it has been obſerved by a pupil of Linnæus, that the apple-trees which are ſent from Britain to New England bloſſom at firſt too early for the climate, and bear no fruit; and that it is only after ſome years that they conform to their ſituation: and this circumſtance, by the way, explains why roots and ſeeds germinate ſooner when brought from ſouthern than when they are brought from northern latitudes. The very permanency of theſe effects has often been the cauſe of much confuſion and error in philoſophy: for the naturaliſt, miſtaking the laſting though temporary qualities of habit for the real and eſſential qualities of ſpecies, has not unfrequently drawn concluſions from his experiments that have been contradicted by ſimilar experiments in other circumſtances. This is one of the obvious reaſons why experiments exhibit ſo many inconſiſtencies and contradictions, and why we are amuſed with ſuch a multitude of viſionary theories about the properties of living bodies.

From not attending to the numerous circumſtances that induce habits, and to that general accommodating principle in living bodies, many medical preſcriptions are found to be not only uſeleſs but miſchievous; and many parents, by ſtudying the health and comfort of their children, bring on habits that prove the ſources of perpetual ſickneſs, or the certain preſages of an early death.

The accommodating principle is one of the conſequences of irritability. Its various effects ariſe from the actions of different ſtimulants on the irritable fibre; and the after-duration of theſe effects, from the modifications of the irritable fibre, become habitual from the frequently repeated action of the ſtimulants.

The deſign of this accommodating principle is to fit both the plant and the animal for a more extenſive and a more varied range of exiſtence.

Sect. XI. *Transformation.*

More remarkably ſtriking than any of thoſe changes to which the plant and animal are expoſed, from the variations of habit or the change of integuments, are thoſe alterations which they undergo from metamorphoſis or tranſformation. It has indeed been aſſerted, that theſe alterations conſiſt in throwing off certain temporary coverings or envelopes: but there is here a want of preciſion in the ideas, and conſequently a want of accuracy in the expreſſion. The ſame perſons who make this aſſertion inform us, that caterpillars change their ſkin, and many of them even ſeveral times, previous to the period of their transformation. Transformation, therefore, and a change of integuments, by their own conceſſions, are different things. The truth is, transformation frequently takes place independent of any change of integuments; and there is often a change of the integuments without transformation or any appearance of a new form: but a new form or change of appearance is always implied in metamorphoſis or transformation. This new form is ſometimes occaſioned by a change of ſhape, conſiſtency, and colour; as when the lobes of a ſeed are converted into ſeminal leaves. It is ſometimes occaſioned by a change of proportions among the parts: the proportions of a fœtus, every one ſees, are different from thoſe of a full grown man; and the painter, merely by obſerving the proportions, repreſents a child, a dwarf, and a giant, on the ſame ſcale. It is ſometimes occaſioned by the addition of new organs; as when the emmet receives wings, and the plume of the ſeed is fed by new roots ſtriking into the ground; or it is occaſioned by a change of both the form and the organs, and their mode of operation, as happens remarkably in ſome inſects: for, though all living bodies, plants and animals without exception, undergo partial or general transformations, yet theſe changes are chiefly obſervable among inſects. Many inſects appear to conſiſt of two diſtinct animal bodies one within the other: the exterior, a creature of an ugly form, reſiding in the water or under the earth, breathing by gills or ſometimes by tracheæ projecting from the tail, poſſeſſing a voracious and grovelling appetite, and having a ſyſtem of ſanguiferous veſſels that circulates the blood towards the head. When all its parts decay and fall off, the creature incloſed ſucceeds in its ſtead: this often is an animal of a different form, generally lives in a different element, feeds on a different ſpecies of food, has different inſtruments of motion, different organs of ſenſe, different organs of reſpiration, and differently ſituated; and, being endowed with the parts of generation, inclines to gratify the ſexual propenſity, and produces an embryo which becomes like the firſt, and from which afterwards in proceſs of time a creature is evolved ſimilar to itſelf.

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* Might not theſe facts reaſonably claim the attention of thoſe who mean to form matrimonial connections? How many might eaſily entail on their poſterity hale conſtitutions, regular features, beautiful forms, ſound minds, and tempers at once uniform and cheerful, who yet, from their ſordid deſire of wealth or their fond admiration of high rank, bequeath to them only ſcorbutic habits, deformed perſons, diſagreeable features, mean underſtandings, and forbidding tempers! Excepting the more extraordinary properties of body and mind, there are few that may not in ſome meaſure be tranſmitted to poſterity: but nature ſeems unwilling that what is very eminent ſhould ever be extended to a genus or a ſpecies; and therefore the ſons of Cicero and Cromwell are only two of a thouſand inſtances that might ſerve to prove, that neither extenſive nor eccentric geniuſes can be made hereditary: in the ſecond generation they often degenerate into minds that are weak, fatuous, or deranged; or into minds that are chiefly remarkable by their oddities and whims.

If the embryo or egg be depoſited on a leaf, the leaf frequently is obſerved to bend, to wrap it in folds intended for the purpoſe, and to protect it from injuries and danger. If depoſited in the body of an animal or plant, they accommodate themſelves to its wants and neceſſities, and furniſh a tumour which ſerves it for a nidus, and beſides, like an uterus, ſupplies it with nouriſhment; and if depoſited in the body of an inſect, the creature provides for the future deſtination of its young charge with all the tender care of a parent, and then dies.

Theſe circumſtances, added to the great variety of forms which inſects aſſume, render it ſometimes difficult to know who is the parent. We cannot, for inſtance, pronounce with certainty who is the true parent of the gordius, known by the name of the *ſeta equina*, or hair eel. A ſet of experiments, which we once began with a view to throw ſome light on the ſubject, were interrupted unfortunately by an accident, and we have not ſince had leiſure to reſume them. We learned only, from a number of obſervations, that certain black beetles about the end of the ſummer months have the ſtrongeſt propenſity to run into the water, where they ſoon die; and that one or two, and ſometimes three or more, of thoſe eels gradually drop from the beetle by the anus. Whether other inſects provide for the gordius in this manner we have not yet been able to determine.

The tranſmutations of ſome animals are moſt obſervable in the uterus and egg. Some early transformations of the chick may be ſeen in the plate belonging to this article; and anatomy has often witneſſed the change which happens at birth with reſpect to circulation, reſpiration, digeſtion, and the other functions.

If the reader wiſh to be much acquainted with the manners and transformations of inſects, he will derive information and pleaſure from conſulting the plates and memoirs of Reaumur. If he wiſh to know their intimate ſtructure, the laborious Swammerdam can introduce him to a new and amuſing ſpecies of anatomy. This laſt author had before Reaumur defined and deſcribed the kinds of tranſmutations among inſects and ſome other animals. He has ſhown ſimilar tranſmutations in plants; and in plate 46 of his Book of Nature, has compared the frog and the clove July-flower under their ſix different forms.

In all living bodies poſſeſſed of mind, the changes of form, as well as the change of habit and of age, are uſually accompanied with new propenſities, appetites, and paſſions. It may therefore be inferred, that we ought not to look for the cauſe of temper in either the brain or the nervous ſyſtem; or to imagine, that the propenſities, appetites, and paſſions, are properties of mind: they ſeem only affections happening to mind in conſequence of ſtimuli and organic ſtructure.

Microſcopic obſervations having demonſtrated, that all the forms of the plant and animal exiſted previouſly in the ſeed or embryo, transformation muſt be owing entirely to the evolution of the different parts by means of nutrition.

What nature intends by transformation, we pretend not to ſay; but by means of transformation different elements are peopled, the different ſeaſons variouſly adorned, and animated nature wonderfully diverſified without a multiplication of beings.

Sect. XII. *Generation.*

Many of the cauſes which contribute to the formation of a living body have hitherto eluded human reſearch; may in all probability never be diſcovered; and perhaps are beyond human comprehenſion. Some philoſophers, conſidering the extreme diviſibility of matter, and learning from the microſcope that transformation is but the development of certain parts that previouſly exiſted, have thence imagined that generation is ſomewhat analogous; that all regularly organiſed bodies received their form at the beginning; that the firſt of every genus and ſpecies contained by involution the numerous millions of ſucceeding generations; and that the union of the two ſexes gives only a ſtimulus, and brings into view forms that had exiſted ſince the world began.

This hypotheſis has attempted to explain a thing that is unknown, by what muſt for ever remain incomprehenſible to the human mind in its preſent ſtate. It appeals abſurdly from obſervation to conjecture; and ſuppoſes that bodies which are originally brought into view, which are daily augmented, frequently repaired, and ſometimes renewed by organic action, do nevertheleſs in their firſt formation require an effort ſuperior to what omnipotent power is able to perform by ſecondary agents.

Had the ſupporters of this hypotheſis conſidered that many herbaceous plants produce new flowers when the firſt ſet are untimely cut off, that lobſters and many a ſpecies of inſect renew their limbs, and that certain polypes can raiſe ſo perfect vegetable forms as to puzzle the naturaliſt whether or not he ſhould claſs them under plants; they would not ſurely have preſcribed ſuch bounds to omniſcient wiſdom and almighty power, or declared with ſuch confidence what the Author of Nature, to ſpeak with the vulgar, muſt neceſſarily perform by his own hands, or what he may intruſt to ſecondary cauſes regulated by his laws.

Theſe philoſophers will find it difficult to account in a very ſatisfactory manner for monſtrous productions, and for thoſe changes of ſtructure and of form which for a while continue hereditary from the influence of habit. They object to others, that all the parts of a living body are mutually dependent on one another, and that they muſt neceſſarily have been coeval or exiſted at once. But though every attempt that has yet been made to aſcertain which of the vital organs are prior and which poſterior in a living body has proved unſucceſsful, it has not been demonſtrated that either themſelves or their functions are coeval. It may, on the contrary, be plainly demonſtrated from obſervation, that the lungs and the ſtomach do not begin to perform their functions ſo early as the heart and the vaſcular ſyſtem; that the heart and its ſyſtem perform their functions, even with ſome conſiderable changes, immediately after birth; that the vegetable tribes are without nerves; and that brain and nerves in the animal kingdom perform more and more of their functions as the ſyſtem approaches towards maturity. It has even been ſhown that bones will unite, and the limbs of an animal continue to be nouriſhed without nerves; that there is a principle of life in the blood; that the heart will act under other ſtimuli beſides that of nerves; and that ſound logic does by no means require us to ſuppoſe that the firſt actions of the fœtal heart, or the punctum ſaliens, are owing to the influence of ſtimuli from the brain, or that the brain muſt have exiſted when the heart firſt moved.

Although the minuteneſs and tranſparency of the parts may prevent us from ſeeing the firſt gradual formation of the embryo, yet every obſervation corroborates the opinion that it is

PHYSIOLOGY.

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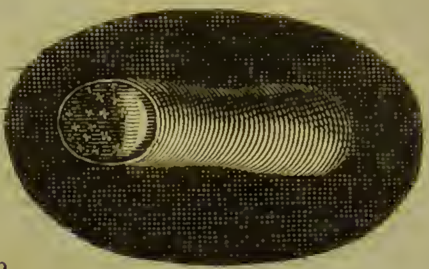

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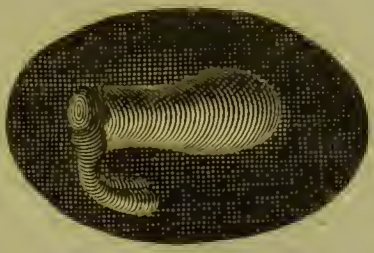

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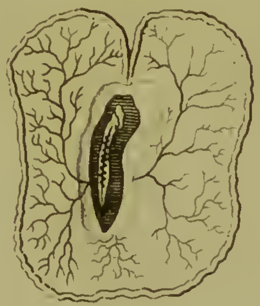

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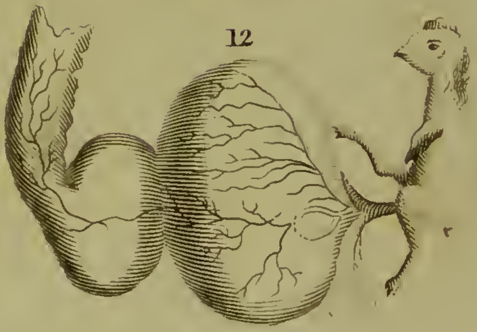

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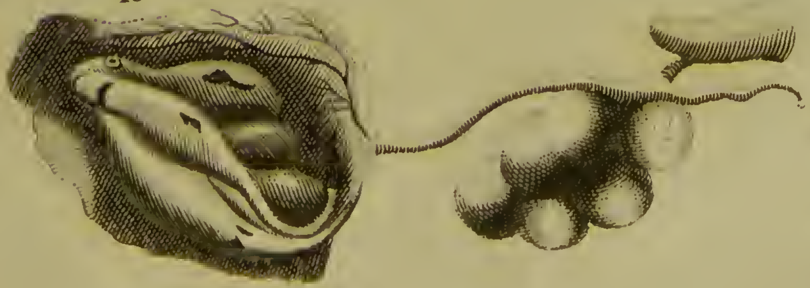

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formed by ſecondary cauſes, and through the medium of organic powers.

It has been aſked, whether or not is the embryo formed by the joint operation of the two ſexes? or is it formed entirely by the one, and brought into action by a ſtimulus from the other? The former of theſe queſtions ſuppoſes that each of the ſexes has a ſeminal fluid; that ſome mixture takes place in the uterus, and produces an embryo, in the ſame manner that a neutral ſalt aſſumes a certain and determinate form. The notion implies ſome general and confuſed idea of chemical combination; but does not beſpeak a very clear head, profound reflection, or much acquaintance with the nature and properties of living bodies.

For a long time paſt the moſt rational phyſiologiſts have generally agreed that the embryo is formed gradually and ſlowly in one or other of the two ſexes, not by chemical combination and mixture, but a ſyſtem of organs, directed by laws and prompted by ſtimuli, with many of which we are yet unacquainted. From the great Hippocrates downwards to Aquapendens and Harvey, the credit of furniſhing the fœtal embryo was almoſt univerſally given to the females of thoſe animals which are named oviparous. Among the viviparous, appearances were ſuch, that the female was left to conteſt it with the male. At laſt the eclat of Leeuwenhoek's diſcoveries ſeemed to put an end to all doubts entertained upon the ſubject. He very plainly ſaw, through his microſcope, that very great profuſion of particles that move to and fro with amazing rapidity in the male ſemen. Upon this he embraced the doctrine of Hamme, who had ſeen them before, and ſuppoſed from their motions that theſe particles were not only animalcules, but the principles or rudiments of that animal in whom they were formed, and that they were depoſited in the uterus of the female only to be nouriſhed and augmented in ſize.

What raiſed ſuſpicions againſt this theory were the numerous animalcules diſcoverable by the microſcope in other fluids, and that vaſt profuſion of young embryos in thoſe caſes where never more than one or two arrive at maturity. It was an objection to it, that ſome females had been impregnated where the hymen remained unbroken, and where the vulva had been ſhut ſo cloſely as to leave only a paſſage for the urine. The male ſemen in theſe inſtances could have reached only the mouth of the uterus. It was another, that in all birds which have no intrant penis the male ſemen is never ſent farther than the mouth of the vulva, and that a ſingle act of the male impregnates the whole eggs of the ovarium. A third objection is the pollen of flowers, which is not applied immediately to the ſeed, but often to a diſtant part of the veſſel in which it is contained. A fourth may be taken from frogs and fiſhes, and all thoſe animals whoſe eggs are impregnated after emiſſion. And laſtly, Haller had obſerved the pullet completely formed in thoſe eggs that were not fecundated.

Suppoſing animalcules in every kind of prolific ſemen, yet it frequently happens that this ſemen undergoes a change before it can be applied to the embryo. The ſemen of the frog is diſſolved in water; and that which is injected diſappearing ſuddenly after coition, would ſeem to intimate, that in thoſe animals which have been examined it had met with a ſolvent ſomewhere in the uterus, and produced its effect after the change. It is now, we believe, pretty generally known, that the embryo does not commence its exiſtence in the cavity of the uterus. De Graaf obſerved it on its paſſage down the Fallopian tube; he ſaw the place where it firſt began in the teſticle of the female; and caſes have occurred where it has miſſed the Fallopian tube, where it has fallen into the abdomen, where the placenta has been formed, and the fœtus has grown among the viſcera of the lower belly.

From theſe facts it has been concluded, notwithſtanding ſome feeble objections, that the female teſticles are real ovaries containing eggs; that theſe eggs are brought into action by the ſtimulating power of the male ſemen, which is ſometimes thrown into the cavity of the uterus, ſometimes applied only to its mouth, and ſometimes ſprinkled over the egg after emiſſion. The principal difference, therefore, that occurs between oviparous and viviparous animals, conſidered as ſuch, appears to be this: the former are accuſtomed to eject their embryo before it eſcapes from the membranes of the egg; the latter retain it long in the uterus until it acquires a conſiderable ſize, until the membranes can hold it no longer, and then eject it when the membranes are burſt. A plant is oviparous when it yields ſeed; viviparous when it produces a gem, a bud, a bulb, or an eyed root. The membranes of the ſeed being removed, an incipient embryo is ſeen through the microſcope.

Some animals, according to the ſeaſon, eject the embryo incloſed in its membranes, or retain it in the uterus till the membranes are broken. Theſe are the animals which are ſaid to be oviparous at one period and viviparous at another. The ſpider-flies retain their young till they are as large as the natural ſize of their own bodies, and have undergone all their transformations within the expanſile membranes of the egg, and an uterus as expanſile as the ſtomach of a ſerpent.

In moſt caſes generation requires a temporary union of two ſexes: but it has been ſaid, that in Senegal there is a ſpecies of ſhell-fiſh among whom this operation is the joint work of three individuals. In our own country, too, three frogs are frequently obſerved adhering together, though the labours of the third have generally been thought more officious than neceſſary. In ſome animals the ſexual union is almoſt inſtantaneous. It conſtitutes nearly the buſineſs of life in the laſt ſtage of the ephemeron; and the male both of the frog and toad often continues on the back of the female not for hours and for days only but for ſome weeks. Upon examination it has been found, that with his fore-feet he aſſiſts the female to protrude her eggs through the windings of the oviduct; and when they at laſt arrive at the anus, a ſpecies of the toad has been obſerved to draw them out with his hind legs. Theſe animals were probably the firſt of the maſculine gender who practiſed this art. But due honour has not been aſcribed to the diſcoverers. In former days, the generous and grateful ſpirit of the ancients made them ready to acknowledge their obligations to different animals for the arts of bleeding, clyſtering, and purging; but ſuch is the degeneracy of modern times, that many write only to claim the diſcoveries of others. On this account we ought not to wonder that many accoucheurs, in publiſhing encomiums on their own merit, have invidiouſly concealed the ſuperior pretenſions of the obſtetrical toad.

Among all living bodies the two ſexes are generally ſimilar; and the male ſex generally diſtinguiſhed by ſuperior ſtrength, beauty, and courage. The law, however, does not hold univerſally. The females of ſome carnivorous animals, who are left by the male to provide for their offspring, are larger, ſtronger, and more ferocious than he. Among ſome inſects the male and female have no ſimilarity even in form. The male of the glow-worm is a beetle, which flies in the dark, and is attracted not by the form, but the brilliancy of his miſtreſs*. The female gall inſect is a large maſs like a vegetable excreſcence, without locomotion; the male a ſmall fly full of activity. The one is as unlike to the other as a Harpy to a Venus, and as diſproportioned in point of bulk as a horſe to an elephant.

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* Such glowing beauty allures enemies as well as lovers. "In Jamaica, in ſome ſeaſons of the year, (ſays Dr. Darwin,) the fire flies are ſeen in the evenings in great abundance. When they ſettle on the ground, the bull-frog greedily devours them; which ſeems to have given origin to a curious, though cruel, method of deſtroying theſe animals: If red hot pieces of charcoal be thrown towards them in the duſk of the evening, they leap at them, and, haſtily ſwallowing them, are burnt to death." *Bo-*

In many animals the diſtinctions of ſex are concealed in the body. When any of their parts are placed externally, or protruded occaſionally, the male parts are uſually prominent, and the female hollow, in order to receive them. In the acari, however, in many flies, and a few hornets, the caſe is reverſed; the female parts ſuffer erection, and the male parts are open and hollow for their reception.

The external ſituation of theſe parts is very much varied in different animals. In many worms it is near to the head. It is often upon the ſide of the ſnail; near to the breaſt in the female of the dragon-fly. It is at the extremity of the antennæ in the male ſpider. The vulva enters from the rectum in birds. Its common ſituation in moſt animals is well known. The male penis, where there is one, is ſometimes found to enter the vulva, ſometimes not: it is ſometimes imperforated, ſometimes forked, ſometimes double, ſometimes fleſhy, ſometimes bony, ſometimes ſtraight, ſometimes winding ſpirally like a ſcrew, ſometimes with a knob and ſometimes with a point at its extremity, according to the kinds and varieties of animals.

Few individuals have more than one ſex. Many ſnails, however, are androgynous, and have two. In copulation they perform the office of two ſexes, and are mutually impregnated. This circumſtance has often led the ſenſualiſt to wiſh that he were a ſnail. With equal reaſon the epicure might wiſh to be one of thoſe worms that imbibe by abſorbents, and ſuck in nouriſhment by a thouſand mouths. The organs employed may be more in number, the continuance of their function may be much longer, and yet the gratification may be leſs. The diſcreet beauty can afford a million of pleaſures to her lover which no ſnail or ſenſualiſt enjoys, and which proſtitution can never yield.

The male and female parts of the vegetable are ſometimes both on the ſame flower, ſometimes on ſeparate flowers, and ſometimes even on different plants of the ſame ſpecies. Beſides the flower, another organ of generation is found in vegetables. This is the corona, from which the buds and branches proceed. It is a ſubſtance between the pith and the ligneous circles, and from which the diametral inſertments diverge.

The corona is moſt conſpicuous at the time when it ſends forth ſhoots. The flower comes forth only at the time when the ſeed is to be formed; and the teſticles and ovaries of thoſe animals which procreate only at ſtated periods are diminiſhed in ſize, and ſometimes diſappear till the genial ſeaſon. Even ſome females, when they ceaſe to be prolific, as the pheaſant, for inſtance, aſſume many marks of the other ſex, as if their former ſex had been aſſumed only for a while, and to anſwer ſome temporary purpoſe.

In all animals the incipient embryos are perhaps neuters, and the ſex determined according to the predominancy of the male or female ſtimulus on the parts. It would not a little confirm this opinion, were the obſervation to be well founded, that certain bulls are very apt to beget males and others females, and that certain cows which have females always when they are young bring forth males when they grow old. The different proportions of males and females in different climates might alſo ſerve to illuſtrate this doctrine. It is no objection to it that the order of male and female births in the ſame family is often irregular. The proportional force of the two ſtimuli will naturally be different at different times. It may depend on the quantity or quality of the fluid ſecreted, upon the difference of ardour in the parties, on the fancy, the paſſions, the particular ſtate of the ſyſtem at the time, and a thouſand circumſtances, beſides the age, and the uſual or general habit of the body. We mean only to infer at preſent, that wherever a male or female is produced, the ſtimulus of that particular ſex, whatever was the cauſe, had during the time of coition and conception acquired the aſcendency over the parts that were to become ſexual in the embryo. We cannot ſo readily anſwer the queſtion, Why the offspring ſhould poſſeſs the form and diſpoſitions of one parent, and the ſex of the other? In this caſe, the different ſtimuli may have acted differently on different parts; in the caſe of hermaphrodites, which are very common in the horſe, the aſs, the cow, and the ſheep, the two parents ſeem to divide the form, the ſex, and the diſpoſitions, equally between them.

The particular cauſe which excites the orgaſmus in the female organs is not aſcertained. That viſcous fluid which young laſcivious females eject when fond of the male, is chiefly a ſecretion from the glands of the vagina, the mouth of the uterus, and the neighbouring parts. In ſome reſpects it appears to be ſimilar to thoſe periodical diſcharges of females which frequently aſſume the erect poſture; and theſe diſcharges being uſually diſcontinued during the times of pregnancy and ſuckling, we muſt ſuppoſe that it is a portion of that fluid which nature has prepared for the uſe of the fœtus. Theſe diſcharges are always a proof that the female has arrived at the age of puberty; that her ovary is now performing its office; and that ſhe is diſpoſed to propagate her kind. Whatever be the cauſe of the female orgaſmus, it is often ſo ſtrong as to counteract the natural effects of the ſeminal fluid, and prevent impregnation. For this reaſon, few young and laſcivious females conceive immediately after their marriage; and after coition, therefore, in cattle, it is ſometimes a practice to beat the female, to plunge her in water, to weary her with running, and to uſe other means to prevent the return of the ſexual deſire.

In man, and ſome of the nobler animals, the influence of fancy over the organs of generation is unqueſtionably great; but the extent and mode of its agency is not defined. Thoſe who allow it ſo much power in impreſſing marks, and altering the form and colour of the fœtus, ſupport their opinion rather by the number than the ſtrength of their arguments. Many of the ſtories which they adduce as a ſort of proofs are evidently fabulous, and have brought the truth of the whole into queſtion. The reports, however, of the French commiſſioners who were appointed to examine the nature of animal magnetiſm, ought to deter the candid inquirer from drawing very haſty concluſions. The queries of Fienus, in his ſmall work entitled *De Viribus Imaginationis Tractatus*, concerning the powers of this mental faculty are important and curious, and might be of uſe in directing our reſearches; but they ought to be anſwered by accurate experiments, and not by acute metaphyſical reaſoning and hiſtorical anecdotes that are ill authenticated.

To prevent a confuſion of genera and ſpecies, animals are generally reſtricted by propenſity to their own kind; and the ſeminal fluids, beſides, being various in various animals, they cannot indiſcriminately act as a ſtimulus on all female organs of generation. The changes of form induced by habit, which is owing itſelf to the influence of ſtimuli, will partly explain the manner in which the progeny is made to reſemble the male. As the irritability of different parts is of different kinds, the ſtimulus will have a different effect on different organs; and in theſe caſes, where either genera or ſpecies are mixed, the parts which are moſt and leaſt affected by the ſtimulus of the male will be obvious in the ſhape and form of the offſpring.

We have hitherto ſpoken of generation as being performed by

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tanic Garden.—From this fact the romantic moraliſt and ſpiritualizer might derive ſome hints for amuſing declamation; and in their diſſuaſives might plauſibly demonſtrate, that in moſt caſes beauty is fatal to the object beloved, to the lover, and deſtroyer.

the temporary intercourſe of two ſexes; but the puceron is an inſtance where ſexual diſtinctions are not always neceſſary. Even where they exiſt they are daily diſpenſed with in the vegetable kingdom. Plants grow from the gem, the bulb, the leaf, or the root. They propagate by ſlips, by ſuckers, and by layers; and ſome of them, as the houſe-leek and ſome graſſes, multiply by ſpontaneous ſeparation. In many animals the diſtinctions of ſex are totally unknown. It has been obſerved, that infuſory animalcules multiply their ſpecies by continual diviſions and ſubdiviſions of their own body; that ſome polypes, by ſpontaneous ſeparation, ſplit tranſverſely, ſome longitudinally, and that ſome ſend off ſhoots. When experiments have been made upon theſe animals, it has been diſcovered that the numerous and artificial diviſions of their body or their head produce entire animals. Trembley learned that they might be engrafted upon one another, and produce monſters as wild and extravagant as poet or fabuliſt has ever dreamed of.

It was noticed already, that the alimentary canal of ſome animals diſtributed nouriſhment through the whole body without the intervention of circulating veſſels, and that the vital organs of vegetables were generally diffuſed through the whole ſyſtem. The caſe is the ſame in polypes as in plants. Every part is a miniature of the whole. It is found to have ſimilar organs of digeſtion, of reſpiration, of circulation, and of generation. In perfect animals all the parts are more dependent on one another; the vital organs have diſtinct ſituations, and their powers are concentrated in diſtinct places. The arm of a man has no heart; it has no lungs; it has no ſtomach, and no organs of generation; but the branch of a tree has as complete a ſyſtem of organs as the trunk itſelf, and is as independent of that body from which it grew as the graft is independent of the ſtock.

The ſeveral parts of perfect animals all contribute to make one whole; the ſeveral parts of a plant or polype, when united together, form only a congeries of living bodies. Theſe facts contribute to explain the principal phenomena in this mode of propagation.

Sect. XIII. *Sleep.*

Sleep is rather an affection of mind than a property of body, and is therefore more naturally a ſubject of metaphyſics than of phyſiology. This affection is often induced by fatigue and exerciſe; and ſeveral perſons, when they are weary and no longer able to move their limbs, ſay they are exhauſted. Though the word *exhauſted*, in this expreſſion, has ſeldom any preciſe meaning, it ſeems, however, to have been the means of ſuggeſting a theory with regard to ſleep. This theory ſuppoſes that ſleep is occaſioned by the exhauſtion of irritability in the living ſyſtem; but it ſeems to be founded on very limited and partial obſervations, or rather has been formed, like a great many others, prior to any obſervations at all, and afterwards tortured to account for facts which it does not comprehend. It does not account for the periodical returns of ſleep, for the almoſt unremitting drowſineſs of infants, and for that liſtleſs lethargic inaction ſo often attendant on old age. When no exhauſtion of irritability can well be ſuppoſed to have taken place, the propenſity to ſleep on many occaſions becomes irreſiſtible, from the effects of monotonous ſpeaking, from ſtillneſs, darkneſs, or from the ſameneſs of ſcenery around us; and when one ſtimulus, after long application, can rouſe no more (a plain proof that the irritable principle is by no means exhauſted), another ſtimulus that is leſs powerful in ordinary caſes is accompanied with excitement.

Of theſe phenomena, we frankly confeſs that we can aſſign no phyſical cauſe that is ſatisfactory. It is eaſy, however, to ſee the intention which nature has in view by inducing ſleep. It has long been obſerved, that in all living bodies there is a continual waſte and repair, or, to ſpeak with more preciſion and accuracy, one proceſs of aſſimilation and another of diſſolution conſtantly taking place in all the different parts of the ſyſtem. It is alſo true that this aſſimilation, when the body is healthy, predominates in youth; that diſſolution prevails in old age; and that the two are nearly on a par during the vigour and meridian of life. Another fact which admits of demonſtration is, that a gentle and moderate exertion of mind and body will promote both. And laſtly, it is certain that immoderate exertion in either reſpect, or any exertion that is not ſuited to our ſtrength, habits, or period of life, prevents aſſimilation, haſtens diſſolution; and that the means which nature employs to reſtore the balance is uſually by inducing a ſtate of ſleep.

When the balance is reſtored, and all the parts are again repaired for diſcharging their office, man awakes; but his waking period is of ſhort duration, if appetite or paſſion do not engage him in ſome purſuit, if his mind be not occupied with ſome object, or if no ſtimuli be applied from without. This period ſeems chiefly intended for collecting food, and for being employed in thoſe exertions which promote reſpiration, digeſtion, abſorption, circulation, and ſecretion; while ſleep, after the food is collected, aſſiſts nutrition, and promotes aſſimilation throughout the ſyſtem. If what is the natural food of the ſpecies cannot be collected by the plant or animal in a ſhort time, the period of ſleep is proportionally reſtricted. If the food received be difficultly aſſimilated, the period of ſleep is proportionally extended. If the food be not prepared for aſſimilation, the ſleep is diſturbed. If it be difficultly prepared by the organs, the active exertions are more vigorous; if eaſily prepared, they are more feeble. If it be collected during the day, the ſleep is in the night; if collected in the night, the ſleep takes place during the day; and all living bodies are directed by nature to ſelect that time and ſpecies of food which is moſt ſuited to their nature, their habits, their circumſtances, and age.

To favour nutrition, not only the body, but even the mind, muſt be allowed to indulge in reſt. The child ſleeps, and his mental faculties are under reſtraint, that thoſe functions employed in nutrition may not be diſturbed. The mental faculties are ſtill feeble in a more advanced period of life; and the moderate exertions of mind and body which are natural to youth are chiefly ſuch as favour the preparatory organs of the ſyſtem, and promote growth: but the active and vigorous exertions of manhood, conſidered with reſpect to mind or to body, ſoon cauſe diſſolution to preponderate in the ſcale, and old age becomes liſtleſs, inactive, and drowſy, and the mind returns to childhood or dotage, becauſe living bodies are known to accommodate themſelves to circumſtances, and becauſe the prevailing diſſolution is retarded by the frequent returns of reſt and of ſleep, which favour ſo much the aſſimilating powers, counteract *re-abſorption*, and oppoſe decay.

During ſleep the irritable principle is more languid, and all the ſenſes are more obtuſe. The mind then is withdrawn to its reſt, and does not attend to ſtimuli from without. The ſame happens when the mind is abſorbed in profound thought: but profound thought is hurtful to the ſyſtem. The mind then is engaged in purſuits peculiarly its own, and is leſs attentive to the calls of nature. In the time of ſleep it withdraws ſeemingly not ſo much for its own ſake as that of the body, which then being freed from the interruption of voluntary motions, all thoſe organs which act ſpontaneouſly can more eaſily diſcharge their functions.

For the beſt of reaſons, the mind is not allowed to judge for itſelf when it is proper to eat, to drink, to ſleep, to wake, and to propagate the ſpecies. Theſe and the like are offices too important to be wholly intruſted with a being of ſo very limited intelligence. In all theſe caſes, it is therefore directed by certain propenſities reſulting from the body in conſequence of ſtimuli or organic ſtructure. Being often amuſed with thoughts and ideas on thoſe objects which are purely intellectual, as the notes of memory, the forms of fancy, and its own operations in the way of reaſoning; being inveſted with ſome little power in rouſing, calming, and regulating the paſſions, the deſires, and appetites; and having the command of all the voluntary movements of the body; it ſometimes neglects its charge of the ſyſtem, deſtroys it ſometimes by exceſſive indulgence, and ſometimes employs it in accompliſhing ends peculiarly its own. One ſhould imagine that the mental principle in the lower animals ſhould occaſion but little diſturbance to the ſyſtem; yet it has been obſerved that geeſe fatten ſooner in the dark than they do in light, where the mind is entertained with varieties of objects: and this circumſtance will partly explain why man does not fatten ſo regularly as the brute, and why caſtration, which prevents ſo much anxiety and paſſion and exhauſting efforts, aſſiſts growth and the organs of nutrition. The venereal ſtimulus, for this reaſon, is not ſtrongly felt at a very early period of youth, nor is very troubleſome in old age. In the former caſe it would prevent the growth of the ſyſtem; in the latter it would haſten its diſſolution.

The natural returns of waking and ſleeping may be altered by the preſence or abſence of ſtimuli, and are curiouſly affected by the influence of habit. Although the commencement of one of theſe periods happen to be changed, the commencement of the other will continue as before. If a perſon be accuſtomed to ſleep preciſely at nine in the evening, and to riſe again at ſix in the morning, though his ſleep in the evening may now and then be kept off till twelve, he will waken at ſix; and though continued by darkneſs, quietneſs, or ſuch-like cauſes, till the day be advanced, it will recommence in the evening at nine. The ſtate of phyſiology is ſuch at preſent that we cannot aſſign any preciſe phyſical cauſe for the natural kinds of ſleeping and waking, or for their regular periods of return. As for the cauſes which occaſion morbid ſleeping and waking, we refer our readers to books on pathology.

Plants too have been ſaid to ſleep. At the approach of night, many of them are obſerved to change their appearances very conſiderably, and ſometimes even to ſuch a degree as ſcarcely to be known for what they were before. Theſe changes happen principally to the leaves and the flowers. During the night, many leaves, according to the nature and genus of the plant, are ſeen to riſe up, to hang down, or to fold themſelves in various ways for the protection of the flowers, the buds, the fruits, or young ſtems; and many flowers, to eſcape a ſuperabundance of moiſture, to hang down their mouths towards the earth, or wrap themſelves up in their calyxes. It was mentioned already, that theſe phenomena are owing to ſtimuli acting from without: we may add here, that moſt of the motions are performed at the joints where the leaves and petals articulate with the ſtem. A period of reſt is as neceſſary to plants as ſleep is to animals. The irritable principle cannot act long under the influence of the ſame ſtimulant, except at intervals; and the rapid growth obſervable in plants during the night, is a ſtrong proof that the organs employed in aſſimilation had been diſturbed in diſcharging their functions during the day, when expoſed to the actions of heat and light and of other ſtimulants.

Sect. XIV. *Death.*

DEATH is the ceſſation and total abſence of the living principle in organized bodies. It is ſometimes imitated by ſleep and ſwoons; and a ſtate of torpor in many inſtances can hardly be diſtinguiſhed from it. Several moſſes and a few animals, as the ears of blighted wheat, the ſeta equina, the wheel polype, and ſome ſnails as we learn from the Philoſophical Tranſactions, may be ſafely preſerved as dried preparations, not for months only but for years; and after irritability and ſenſation have been totally ſuſpended, will return to life upon the proper application of moiſture. A wheel polype was put by Fontana upon a bit of glaſs, and expoſed during the whole ſummer to the noonday ſun; another was expoſed in a ſimilar manner for a year and a half; and, after they were like a piece of hardened glue, were reſtored to the uſe of all their functions by a few drops of water *. Wherever there is death, there muſt therefore be likewiſe a partial or general decompoſition of one or more of the vital organs. This decompoſition takes place naturally in ſome living bodies after a few hours, in ſome after a few days; the life of others is extended to weeks; ſome are vigorous for months or a ſeaſon. Man has often ſeen more than fourſcore; and the hardy oak ſurvives the ſhock of two or three centuries. Theſe obſervations conſpire to ſhow that there is a certain period of exiſtence allotted by nature to every ſpecies of living bodies. In the individual this period is ſometimes abridged, and may be ſometimes extended by circumſtances; but yet there is a bound which it cannot paſs, when the vital organs muſt be decompoſed, and the ſyſtem return to moulder with the duſt. The time of incubation and the time of geſtation are pretty much defined in every ſpecies, becauſe the circumſtances of the individual in theſe caſes are generally ſimilar; but, after emerging from the fœtal ſtate, the individuals are partly entruſted to their own organs and the chances of life, which are much varied; and hence we account for the difference of their age.

Life in general ſeems to be proportioned to the ſpace occupied by that ſeries of functions which the ſpecies is evidently deſtined to perform: and here ſometimes the accommodating principle is ſingularly remarkable. As the period of decay is never ſeen to commence in the ſpecies till that of propagation be nearly elapſed, and as propagation in the lower tribes of plants and of animals is often the immediate harbinger of death; ſo many animals which have not propagated, indulged the propenſity, nor become uneaſy from the languor of deſire, continue vigorous longer than ordinary, as if it were waiting for an opportunity to multiply their kind. And in the vegetable kingdom, where no individual is ever the victim of deſire or paſſion, annuals, if prevented from flowering and feeding in their proper ſeaſon, will live double, and ſometimes triple, the uſual time, till theſe functions be ſomehow performed, and then die. But when all the organs are fully evolved and have diſcharged, or have continued for the uſual time capable of diſcharging, thoſe offices for which they were intended; diſſolution commences, the aſſimilating organs begin gradually to loſe their tone, and the re-abſorbents carry off more from the different parts than what they receive in the way of nutrition: the irritable fibre then becomes rigid; the membranes and cartilages begin to oſſify; the bones grow harder; the ſmaller veſſels collapſe and diſappear; the parts no longer are obedient, as before, to the action of ſtimulants; and death enſues.

Some, in order to account for this event, imagine that the body receives at firſt a certain portion of irritability, and continues to live till that be exhauſted: but this theory explains nothing; and without pretending to a great deal of foreſight, we will venture to predict, that for all the irritability which it has, it will not be diſtinguiſhed for its longevity.

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* Father Gumillo a Jeſuit, and the Indians of Peru, ſays Dr. Fowler, are quoted by Fontana, on the authority of Bouguer, as ſpeaking of a large and venomous ſnake, which being dead, and dried in the open air or in the ſmoke of a chimney, has the property of coming again to life on its being expoſed for ſome days to the ſun in ſtagnant and corrupted water. But, adds the Doctor, it would almoſt require the credulity of an Indian to credit the teſtimony of the Jeſuit. *Experiments and Obſervations relative to Animal Electricity, by Richard Fowler.* With regard to this report, we ſhall only obſerve, that the ſnake would not readily return to life after it was dead: but if the Jeſuit meant only that it recovered after it was dried, and its ſeveral functions had been ſuſpended, we muſt ſay, that if his report be not ſufficiently authenticated, neither has it been ſufficiently diſproved.

With regard to the periods by which the life, the functions, and diſeaſes of living bodies are ſo frequently regulated, and which periods may ſometimes be varied but not evaded, the moſt prudent language that, perhaps, can be adopted in the preſent ſtate of phyſiological ſcience is this of the Divine, That the God who formed us hath numbered our days, determined our times, and preſcribed the limits of our exiſtence.

The following Table may be conſidered as in ſome reſpect a ſummary View of the foregoing Sections, and as a Supplement to the Table of D'Azyr.

1. Respiration.
Some living bodies have reſpiratory organs *

Diffuſed through the ſyſtem.
Confined to one place.
Situated externally.
Situated internally.
In the courſe of circulation.
Not in the courſe of circulation.
Within or without the courſe of circulation at pleaſure.
Without tracheæ †.
With tracheæ ramified through the ſyſtem where the reſpiratory organs are generally diffuſed.
——— not ramified through the ſyſtem where the reſpiratory organs are confined.
——— formed by rings.
——— by ſegments of rings on one ſide, and a membrane on the other.
——— by continuous rings running ſpirally like a ſcrew.
——— admitting air by one entrance.
——— by ſeveral entrances.
——— wholly concealed in the body.
——— partly projecting from the body.
——— opening at the head.
——— at the oppoſite extremity.
——— upon one ſide.
——— upon both ſides.

2. Digestion.
Some living bodies have an alimentary canal

Without teeth.
With teeth in the mouth.
——— in the ſtomach.
—— ſtones or artificial teeth in the ſtomach.
—— glands in the mouth for ſecreting a liquor to be mixed with the food.
—— pouches in the mouth where the food is kept and moiſtened.
—— a ſac or bag where the food is kept and moiſtened.
—— a membranous ſtomach.
—— a muſcular ſtomach.
—— an intermediate ſtomach.
Without a cœcum or blind gut.
With a cœcum.
—— two cœca.
—— three cœca.
—— four cœca.
These parts, as well as ruminating ſtomachs and their œſophagus, have anti-periſtaltic motions.
—— one entrance or mouth.
—— many entrances by abſorbents.

Digestion.

Plants have many alimentary canals ‡.
Some polypes have alimentary canals that branch through the body.
The alimentary canals of plants, of ſome polypes, and worms, diſtribute the fluids without the aid of a circulating ſyſtem.

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* The gentlemen of the French Academy, who have been attentive to mark the number of lobes in the lungs and livers of different animals, have ſufficiently demonſtrated, by the facts which they relate, that many of thoſe phyſiological concluſions which have been drawn from the number of lobes in theſe two viſcera, are juſt as deluſive as many of thoſe which have been drawn from the number of lobes and the different tubercles found in the brain.

† Where the reſpiratory organs are ſituated externally.

‡ The ſubterraneous bulbs, the ſwoln fleſhy parts of the roots, and certain cups and veſicles which contain water, ſerve often as reſervoirs of food to the plant, although for various reaſons we have not ventured to call them ſtomachs. *Stomach* would be a vague and unmeaning word, were it applied even to all thoſe reſervoirs of water or ſecreted fluids which we find in fiſhes, and by which ſome of theſe animals are preſerved alive on the dry ſhore till the tide return.

3. Absorption. Performed
By veſſels beginning from the alimentary canal.
———————— from the cavities.
———————— from the ſurface.
— veins in the penis and placenta.
— reabſorbents originating from all the parts of the ſyſtem.

4. Circulation. Some living bodies have
No circulating ſyſtem.
A circulating ſyſtem with one heart.
———————— a heart for diſtributing the blood through the reſpiratory organs, and an artery for diſtributing it through the ſyſtem.
———————— one heart for the reſpiratory organs, and one for the ſyſtem, both in one capſule.
———————— two hearts for the reſpiratory organs, and one for the ſyſtem.
———————— a pulmonary heart, or a heart for the reſpiratory organs in the courſe of circulation.
———————— a pulmonary heart within or without the courſe of circulation at pleaſure.
———————— a heart ſituated in the breaſt.
———————————— near to the head.
———————————— in the oppoſite extremity.

5. Nutrition. The food is prepared
By the alimentary canal.
— the lacteals.
— the reſpiratory organs.
— the circulating ſyſtem.
— the cellular membrane.
— glands.
And by the ſeveral parts in which it becomes finally aſſimilated.

6. Secretion. Performed
By veſſels.
— exhaling veſſels.
— excretory organs.
— organic pores.
— glands.
And by all the parts of which the ſyſtem is compoſed.

7. Integumation*. Some living bodies have integuments
Which are ſcaly.
———— ſhelly.
———— membranous.
———— corneous.
———— cretaceous.
———— ligneous.
———— covered with down.
———————— hair.
———————— prickles.
———————— feathers.
———————— a viſcid matter.
—— change their colour.
———— their covering.
—— are changed themſelves.

8. Irritability. The irritable principle effected
By ſtimulants inviſible.
— ———— unknown.
— ———— unthought of.
— the nervous influence.
— light.
— heat.
— moiſture.
— electricity.
— ſalts.
— gaſes.
— bodies that act mechanically.

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* There ſeems to be a want of preciſion in claſſing bones with integuments, or integuments with bones, as is done in D'Azyr's table. Comparatively ſpeaking, bones are confined to a few genera of living bodies, and are never ſubject to periodical changes like the integuments or cuticular coat of the alimentary canal in ſome animals. For the ſake of perſpicuity, it could have been wiſhed that either anatomiſts or phyſiologiſts had defined bones in a manner different from what they have done, and as far as poſſible avoided thoſe looſe and inaccurate expreſſions which diſgrace ſcience; for ſome ſpeak of animals having their bones, by which they mean ſhells, on their outſide, and the muſcles within them. Some ſpeak of ſolid and compact bones that were once cartilages, membranes, nay a mere jelly; and ſome ſpeak of bones in general as the hardeſt, moſt ſolid, and moſt inflexible parts of the organized body.

9. Motion.
Locomotion performed
By legs.
— wings.
— fins.
— the tail.
— organs which fall not properly under theſe deſcriptions.
— the ſpringineſs of the body or of ſome part of it.
— contrivances which fit living bodies for being moved by foreign agents*.

10. Habit
Accommodates with reſpect
To reſpiration.
— digeſtion.
— abſorption.
— circulation.
— nutrition.
— ſecretion.
— integumation.
— irritability.
— motion.
— transformation.
— generation.
— ſleep.
— death.
— form.
— ſize.
— climate.
— propenſity.
— the healing of parts that are morbid.
— the renewal of thoſe that are broken off.

11. Transformation
Takes place
By a change of proportion among the parts.
—————— of their form.
— throwing off old parts.
— an addition of new ones of a different uſe, ſtructure, and form.
— a change of the whole form together.
—————— of qualities, propenſities, manners.

12. Generation.
Performed
By the temporary union of two ſexes.
— the ſpontaneous ſeparation of parts.
— organs ſituated in the breaſt.
—————— in the ſide.
—————— near to the head.
—————— in the oppoſite extremity.
— an intrant organ of the male and a recipient organ of the female.
— an intrant organ of the female and a recipient organ of the male.
— the ſtamina and piſtils of flowers.
— the ſeminal ſecretion of the male thrown into the organs of the female.
—————————— ſprinkled at the entrance of the female organs.
—————————— thrown upon them from a diſtance.
—————————— tranſported to them by the winds.
—————————— ſprinkled on the embryo after emiſſion.
—————————— diſſolved in a fluid ſecreted by the female before it can rightly perform its office.
—————————— diſſolved in water.
—————————— diſſolved perhaps ſometimes in air, as in the caſe of diœcious plants, where it probably acts like an aroma.

13. Sleep.
Natural ſleep is occaſioned
By quietneſs.
— the abſence of ſtimuli.
— the ſameneſs of ſtimuli when long continued.
— deficient aſſimilation.
— deficient irritability, which is owing ſometimes to the weakneſs, inattention, or confined powers of the mental principle.

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* The pulp which ſurrounds ſeeds is often the means of their propagation. Animals ſwallow the ſeeds for the ſake of the pulp; and the ſeeds remaining indigeſtible, are carried to a diſtance, and diſcharged with the fæces.

14. Death.
Happens naturally to ſome ſpecies of living bodies
After hours.
—— days.
—— weeks.
—— months.
—— ſeaſons.
—— years.
Not till after centuries.

All living bodies are much exhauſted after performing the act of generation, and many of the inferior plants and animals begin immediately to ſicken and decay.

Notwithſtanding what we have here offered to the reader's conſideration, it muſt be confeſſed, that concerning many uſes of the parts, and concerning different ſpecies of variety in the form, ſtructure, and poſition of the organs, much is ſtill reſerved for further reading, for further obſervation, and for future phyſiological arrangement.

PHYTOLACCA, pokeweed, or *American Nightſhade*, in botany, is of the decandria icoſandria claſs of plants. It grows naturally in the province of Virginia in America. It hath a thick, fleſhy, perennial root, divided into ſeveral parts as large as middling parſneps. From this riſe many purpliſh, herbaceous ſtalks, about an inch thick, and ſix or ſeven feet long, which break into many branches, irregularly ſet with large, oval, ſharp-pointed leaves, ſupported on ſhort footſtalks. Theſe at firſt are of a freſh green colour, but as they grow old they turn reddiſh. At the joints and diviſions of the branches come forth long bunches of ſmall blueiſh-coloured flowers, conſiſting of five concave petals each, ſurrounding ten ſtamina and ten ſtyles. Theſe are ſucceeded by round depreſſed berries, having ten cells, each of which contains a ſingle ſmooth ſeed.

In Virginia and other parts of America the inhabitants boil the leaves, and eat them in the manner of ſpinach. They are ſaid to have an anodyne quality, and the juice of the root is violently cathartic. The ſtems when boiled are as good as aſparagus. The Portugueſe had formerly a trick of mixing the juice of the berries with their red wines, in order to give them a deeper colour; but as it was found to debaſe the flavour and to make the wine deleterious, the matter was repreſented to his Portugueſe majeſty, who ordered all the ſtems to be cut down yearly before they produced flowers, thereby to prevent any further adulteration. The ſame practice was common in France till it was prohibited by an edict of Louis XVI. and his predeceſſor under pain of death. This plant has been ſaid to cure cancers; but the truth of this aſſertion has not been indiſputably proved, and does not appear very probable.

PHYTOLOGY, a diſcourſe concerning the kinds and virtues of plants. See Botany, and Materia *Medica*.

PHYTON, a general of the people of Rhegium againſt Dionyſius, the tyrant of Sicily. He was taken by the enemy, and tortured, and his ſon was thrown into the ſea. See Syracuse.

PIA mater. See Anatomy.

PIABA, in ichthyology, is a ſmall freſh-water fiſh, caught in all the rivers and brooks in the Braſils, and in ſome other parts in America. It is about the bigneſs of the common minnow; is well taſted, and much eſteemed by the natives.

PIABUCU, in ichthyology, an American fiſh eaten in many places by the natives. It is ravenous, and ſo greedy of blood, that if a perſon goes into the water with a wound in any part of his body, the piabucu will make up to it to ſuck the blood. It ſeldom exceeds four inches in length.

PIACENZA is a city of Italy, in the duchy of Parma, in E. lon. 10. 25. N. lat. 45. It is a large handſome city, whoſe name is derived by ſome from its pleaſant ſituation, in a fruitful plain, on the Via Æmilia, about half a mile from the Po. It is the ſee of a biſhop ſuffragan of Bologna, and has a univerſity, but of no great fame. It is defended by a wall and a ſtrong citadel, and is reckoned about three miles in circumference, ſo that it is ſomewhat bigger than Parma. The houſes are low, but prettily built; the great ſtreet called the *Stradone* is in a direct line and of equal breadth, with a foot-way fenced with poſts on each ſide like London, and is about 3000 feet long. The houſes are generally built of brick, and ſome of them are prettily painted. The cathedral is an old ſtructure, but well adorned within. The duke of Parma, who is ſovereign of Piacenza, has a palace in the city built by Vignola. There are many excellent paintings in this place. There are two chapels painted, one with the hiſtory of St. Catherine, and the other with a picture of Chriſt, as is alſo the altar of the church of St. Auguſtin, all by Pordenone. In the ſame church there is a fine picture of the bleſſed Virgin, St. Peter, and St. Paul, by Paolo Veroneſe. At the Capuchins there is a Francis by Guercino. There is a fountain ſaid to have been erected here by Julius Cæſar, and the equeſtrian ſtatues of the famous general Alexander I. duke of Parma and Placentia, and of his ſon Ranuccio, both in the great ſquare. In the palace of Scotti, there are a great many fine pictures by Lanfranco, who had been a page in their family, and among the reſt the rape of Helen, the taking of Troy, the bleſſed Virgin, and St. Francis. The trade of this city conſiſts chiefly in their cheeſe, as at Parma, theſe cities being ſurrounded with the richeſt paſture-grounds in Italy; though the greateſt part of what we call the Parmeſan cheeſe is made in the duchy of Milan, and particularly at Lodi. See *Parmeſan* Cheese. Without the walls, which are waſhed by the rivers Trebbia and Po, there is a large ſeminary or college, magnificently erected by cardinal Alberoni, a native of this city, but conſiderably hurt by the modern Goths in the laſt war. Towards the north of the city is the mouth of the river Trebbia, famous for the victory which Hannibal obtained over the Romans.

PIASTUS, a native of Poland, was originally a wheelwright, and the ſon of Colliſco, a citizen of Cruſwitz. He flouriſhed in the year 830, when on the extinction of the family of Popiel great diſputes aroſe about his ſucceſſor, and Cracow was afflicted with a ſevere famine. During this extremity, when the people were dropping down in the ſtreets, two angels in human forms, as the ſtory is told, took up their reſidence with Piaſtus, who was celebrated for his piety and extenſive charity. He had nothing left but a ſmall caſk of the common liquor of the country, and this he preſented to his new gueſts, who, charmed with his hoſpitality, promiſed him the crown of Poland. The faith of Piaſtus was equal to his other virtues: he implicitly believed the word of his gueſts, and piouſly followed their directions in every particular. He was ordered to diſtribute the liquor out of his little caſk to the multitude: he did ſo, and found that it was inexhauſtible. The people were aſtoniſhed; all cried out, "A miracle!" and the electors determined to chooſe a perſon in whoſe favour Heaven had ſo viſibly declared: Piaſtus was accordingly taken from his ſhop, and raiſed to the ducal dignity.

Such is the relation of the canon of Cracow, which differs in many particulars from the account given by Guagnini, and ſeveral other hiſtorians. According to them, Piaſtus had prepared a ſmall collation, to entertain ſome friends who were aſſembled at the birth of a child. Two pilgrims, Paul and John, afterwards murdered at Rome, came about this time to Cracow. They begged charity at the door of the election-hall, and were rudely repulſed; upon which they ſtumbled on the houſe of Piaſtus, and were kindly received. The miracle we have mentioned was wrought by them; and the two pilgrims, and not angels, were the inſtruments of the elevation of the hoſpitable wheelwright. Though we pay but little regard to the marvellous means by which Piaſtus aſcended the ducal throne of Poland, it would be preſumptuous entirely to omit a fact atteſted by all the writers upon this ſubject: it was proper, therefore, to take notice of it, and we leave the reſt to the reader's judgment.

Being now raiſed to the ſupreme dignity, he was not intoxicated with his proſperity. His natural charity, benevolence, and ſweetneſs of diſpoſition, remained: nothing was altered but his power of doing good. He was truly called the father of his people: the injured never returned unredreſſed, nor merit unrewarded. Piaſtus wiped the tear from the eyes of the widow; and was himſelf the guardian of the orphan, and the general patron of the poor and diſtreſſed. His excellent inclinations ſerved him in the room of great abilities; and the happineſs that his people enjoyed made them forget that their prince was not born a ſtateſman and a warrior. Several inteſtine commotions aroſe during his adminiſtration, all which he quelled by the mildneſs and clemency of his nature: his nobility were aſhamed of rebelling againſt a ſovereign who devoted his whole life to render his people happy. He removed the court from Cruſwitz, a city which he deteſted, becauſe it was the ſcene of Popiel's crimes and tragical end, and fixed his reſidence at Gneſna, where he died beloved, eſteemed, and even adored by his ſubjects.

It is in memory of this excellent prince, that all the natives of Poland, who have been ſince promoted to the ducal or regal dignity, were called Piaſtes, in contradiſtinction to the foreigners.

Piaſtus aſſociated his ſon Ziemovitus with him in the government before his death; a circumſtance of much benefit to the people.

PIAZZA, in building, popularly called *piache*, an Italian name for a portico, or covered walk, ſupported by arches. The word literally ſignifies a broad open place or ſquare; whence it alſo became applied to the walks or porticoes around them.

PIBROCH, is a ſpecies of tune peculiar (ſays Dr. Beattie) to the Highlands and Weſtern Iſles of Scotland. It is performed on a bagpipe, and differs totally from all other muſic. Its rhythm is ſo irregular, and its notes, eſpecially in the quick movement, ſo mixed and huddled together, that a ſtranger finds it almoſt impoſſible to reconcile his ear to it, ſo as to perceive its modulation. Some of theſe pibrochs, being intended to repreſent a battle, begin with a grave motion reſembling a march, then gradually quicken into the onſet; run off with noiſy confuſion and turbulent rapidity, to imitate the conflict and purſuit; then ſwell into a few flouriſhes of triumphant joy; and perhaps cloſe with the wild and ſlow wailings of a funeral proceſſion.

PICA, in ornithology. See Corvus, ſp. 9.

Pica *marina*, in ornithology. See the articles Hæmatopus and Alca.

Pica, in medicine, a depravation of appetite, which makes the patient long for what is unfit for food, or altogether incapable of affording nouriſhment; as chalk, aſhes, coals, plaſter-lime, &c.

Pica, or *pye*, had formerly the ſame ſenſe as *ordinal*, meaning a table or directory, pointing out the order in which the devotional ſervices appointed for different occaſions were to be performed. Accordingly we are told it is derived from Πι, a contraction of ϖιναξ, *a table*: and by others from *litera picata*, a great black letter at the beginning of ſome new order in the prayer. The term was uſed in a ſimilar ſenſe by officers of civil courts, who called their kalendars or alphabetical catalogues, directing to the names and things contained in the rolls and records of their courts, the *pyes*.

PICARD, a native of the Netherlands, who founded a ſect the profeſſors of which were denominated *Picards*. See the article Picards.

Picard (John), an able mathematician, and one of the moſt learned aſtronomers of the 17th century, was born at Fleche, and became prieſt and prior of Rillie in Anjou. Going to Paris, he was in 1666 received into the Academy of Sciences in quality of aſtronomer. In 1671, he was ſent, by order of the king, to the caſtle of Uraniburg, built by Tycho-Brahe in Denmark, to make aſtronomical obſervations there; and from thence he brought the original manuſcripts written by Tycho-Brahe, which are the more valuable as they differ in many places from the printed copies, and contain a book more than has yet appeared. He made important diſcoveries in aſtronomy; and was the firſt who travelled through ſeveral parts of France, to meaſure a degree of the meridian. His works are, 1. A treatiſe on levelling. 2. Fragments of dioptrics. 3. *Experimenta circa aquas effluentes*. 4. *De menſuris*. 5. *De menſura liquidorum & aridorum*. 6. A voyage to Uraniburg, or aſtronomical obſervations made in Denmark. 7. Aſtronomical obſervations made in ſeveral parts of France, &c. Theſe, and ſome other of his works, which are much eſteemed, are in the ſixth and ſeventh volumes of the Memoirs of the Academy of Sciences.

PICARDS, a religious ſect which aroſe in Bohemia in the 15th century.

Picard, the author of this ſect, from whom it derived its name, drew after him, as has been generally ſaid, a number of men and women, pretending he would reſtore them to the primitive ſtate of innocence wherein man was created: and accordingly he aſſumed the title of the *New Adam*. With this pretence he taught his followers to give themſelves up to all impurity; ſaying that therein conſiſted the liberty of the ſons of God; and that all thoſe not of their ſect were in bondage. He firſt publiſhed his notions in Germany and the Low Countries, and perſuaded many people to go naked, and gave them the name of *Adamites*. After this he ſeized on an iſland in the river Lauſnecz, ſome leagues from Thabor, the head quarters of Ziſca, where he fixed himſelf and his followers. His women were common, but none were allowed to enjoy them without his permiſſion: ſo that when any man deſired a particular woman, he carried her to Picard, who gave him leave in theſe words, *Go, increaſe, multiply, and fill the earth.*

At length, however, Ziſca, general of the Huſſites, (famous for his victories over the emperor Sigiſmund,) hurt at their abominations, marched againſt them, made himſelf maſter of their iſland, and put them all to death except two; whom he ſpared, that he might learn their doctrine.

Such is the account which various writers, relying on the authorities of Æneas Sylvius and Varillas, have given of the Picards, who appear to have been a party of the Vaudois, that fled from perſecution in their own country, and ſought refuge in Bohemia. It is indeed doubtful whether a ſect of this denomination, chargeable with ſuch wild principles and ſuch licentious conduct, ever exiſted; and it is certainly aſtoniſhing that Mr. Bayle, in his art. *Picards,* ſhould adopt the reproachful repreſentations of the writers juſt mentioned: for it appears probable at leaſt that the whole is a calumny invented and propagated in order to diſgrace the Picards, merely becauſe they deſerted the communion and proteſted againſt the errors of the church of Rome. Laſitius informs us, that Picard, together with 40 other perſons, beſides women and children, ſettled in Bohemia in the year 1418. Balbinus the Jeſuit, in his *Epitome Rerum Bohemicarum*, lib. ii. gives a ſimilar account, and charges on the Picards none of the extravagancies or crimes aſcribed to them by Sylvius. Schlecta, ſecretary of Ladiſlaus, king of Bohemia, in his letters to Eraſmus in which he gives a particular account of the Picards, ſays that they conſidered the pope, cardinals, and biſhops of Rome, as the true Antichriſts, and the adorers of the conſecrated elements in the euchariſt as downright idolaters; that they denied the corporal preſence of Chriſt in this ordinance; that they condemned the worſhip of ſaints, prayers for the dead, auricular confeſſion, the penance impoſed by prieſts, the feaſts and vigils obſerved in the Romiſh church; and that they confined themſelves to the obſervance of the ſabbath, and of the two great feaſts of Chriſtmas and Pentecoſt. From this account it would appear that they were no other than the Vaudois; and M. de Beauſobre has ſhown that they were both of the ſame ſect, though under different denominations. Beſides, it is certain that the Vaudois were ſettled in Bohemia in the year 1178, where ſome of them adopted the rites of the Greek, and others thoſe of the Latin church. The former were pretty generally adhered to till the middle of the 14th century, when the eſtabliſhment of the Latin rites cauſed great diſturbance. On the commencement of the national troubles in Bohemia, on account of the oppoſition to the papal power (ſee MORAVIANS), the Picards more publicly avowed and defended their religious opinions; and they formed a conſiderable body in an iſland by the river Launitz or Lauſnecz, in the diſtrict of Bechin, and, recurring to arms, were defeated by Ziſca. *Encyclop.* art. Picards.

PICARDY, a late province of France, bounded on the N. by Hainault, Artois, and the Straits of Dover; on the E. by Champagne; on the S. by the Iſle of France; and on the W. by Normandy and the Engliſh Channel. It now forms the department of Somme.

PICART (BERNARD), a celebrated engraver, ſon of Stephen Picart, alſo a famous engraver, was born at Paris in 1673. He learned the elements of his art from his father, and ſtudied architecture and perſpective under Sebaſtian Le Clerc. As he embraced the reformed religion, he ſettled in Holland to enjoy the free exerciſe of it; where his genius produced thoſe maſterpieces which made him eſteemed the moſt ingenious artiſt of his age. A multitude of books are embelliſhed with plates of his engraving. He died in 1733.

PICCOLOMINI (ALEXANDER), archbiſhop of Patras, and a native of Sienna, where he was born about the year 1508, was of an illuſtrious and ancient family, which came originally from Rome, but afterwards ſettled at Sienna. He compoſed with ſucceſs for the theatre; but he was not more diſtinguiſhed by his genius, than by the purity of his manners, and his regard to virtue. His charity was very great; and was chiefly exerted in relieving the neceſſities of men of letters. He has left behind him a number of works in Italian. The moſt remarkable of which are, 1. Various Dramatic Pieces, which laid the firſt foundation of his character as a writer. 2. A Treatiſe on the Sphere. 3. A Theory of the Planets. 4. A Tranſlation of Ariſtotle's Art of Rhetoric and Poetry, in 4to. 5. A Syſtem of Morality, publiſhed at Venice, 1575, in 4to; tranſlated into French by Peter de Larivey in 4to; and printed at Paris, 1581. Theſe, with a variety of other works, prove his extenſive knowledge in natural philoſophy, mathematics, and theology. He was the firſt who made uſe of the Italian language in writing upon philoſophical ſubjects. He died at Sienna the 12th of March 1578, aged 70. A particular catalogue of his works may be ſeen in the Typographical Dictionary. There is one performance aſcribed to this author, entitled *Dialogo della bella Creanza delle Donne,* (printed at Milan, 1558, and at Venice, 1574, in 8vo.); which but ill ſuits the dignity of a prelate. It is filled with maxims which have an evident tendency to hurt the morals of young women. Piccolomini's name, indeed, is not in the title page; and it has all the appearance of being a juvenile production. It is very ſcarce; and the public would ſuſtain no loſs by its being entirely out of print. It was tranſlated into French by F. d'Amboiſe, and publiſhed at Lyons, in 16mo, under the title of *Inſtruction des Jeunes Dames.* It was afterwards reprinted in 1583, under that of *Dialogue & Devis des Demoiſelles.*

PICCOLOMINI (Francis), of the ſame family with the foregoing, was born in 1520, and taught philoſophy with ſucceſs, for the ſpace of 22 years, in the moſt celebrated univerſities of Italy, and afterwards retired to Sienna, where he died, in 1604, at the age of 84. The city went into mourning on his death. His works are, 1. Some Commentaries upon Ariſtotle, printed at Mayence, 1608, in 4to. 2. *Univerſa Philoſophia de Moribus,* printed at Venice, 1583, in folio. He laboured to revive the doctrine of Plato, and endeavoured alſo to imitate the manners of that philoſopher. He had for his rival the famous James Zabarella, whom he excelled in facility of expreſſion and neatneſs of diſcourſe; but to whom he was much inferior in point of argument, becauſe he did not examine matters to the bottom as the other did; but preſſed too rapidly from one propoſition to another.

PICCOLOMINI, of *Arragon* (Octavius), duke of Amalfi, prince of the Empire, a general of the emperor's army, and knight of the order of the Golden Fleece, was born in 1599. He firſt bore arms among the Spaniſh troops in Italy. He afterwards ſerved in the army of Ferdinand II. who ſent him to the relief of Bohemia, and entruſted him with the command of the imperial troops in 1634. After having ſignalized himſelf at the battle of Nortlingue, he made marſhal de Chatillon raiſe the ſiege of St. Omer. He had the good fortune to gain a victory over marquis de Feuquieres in 1639: nor did the loſs of the battle of Wolfenbuttel, in 1651, impair his glory. He died on the 10th of Auguſt 1656, being five years after, aged 57, without iſſue; and with the character of an able negotiator and an active general. The celebrated Caprara was his nephew.

PICCOLOMINI (James), whoſe proper name was *Ammanati,* took that of *Piccolomini* in honour of his patron Pius II. He was born in a village near Lucca in 1422. He became biſhop of Malſi, afterwards of Freſcati; a cardinal in 1461, under the name of *Cardinal de Pavie*; and died in 1479, at the age of 57, of an indigeſtion of figs. He left 8000 piſtoles in the bankers hands, which Pope Sixtus IV. claimed; and of which he gave a part to the Hoſpital of the Holy Ghoſt. His works, which conſiſt of ſome Letters, and a Hiſtory of his own time, were printed at Milan, in 1521, in folio. His hiſtory, entitled *Commentaries*, commences the 18th of June 1464, and ends the 6th of December 1469. They may very properly be conſidered as a Sequel of Pope Pius II.'s Commentaries, which end with the year 1463.

Piccolomini, (Æneas Sylvius). See Pius II.

PICENTIA, (Strabo, Pliny), the capital of the Picentini, whoſe territory, called *Ager Picentinus*, a ſmall diſtrict, lay on the Tuſcan Sea, from the *Promontorium Minervæ*, the ſouth boundary of Campania on the coaſt, to the river Silarus, the north boundary of Lucania, extending within-land as far as the Samnites and Hirpini, though the exact termination cannot be aſſigned. The Greeks commonly confound the *Picentini* and *Picentes*, but the Romans carefully diſtinguiſh them. The former, with no more than two towns that can be named, *Silernum* and *Picentia*; the ſituation of both doubtful: only Pliny ſays the latter ſtood within-land, at ſome diſtance from the ſea. Now thought to be *Bicenza* (Holſtenius), in the Principato Citra of Naples.

PICENUM, (Cæſar, Pliny, Florus); Picenus Ager, (Cicero, Salluſt, Livy, Tacitus); *Ager Picentium*, (Varro): a territory of Italy, lying to the eaſt of Umbria, from the Apennine to the Adriatic; on the coaſt extending from the river Aeſis on the north, as far as the *Prætutiani* to the ſouth. In the upper or northern part of their territory the Umbri excluded them from the Apennine, as far as Camerinum, (Strabo); but in the lower or ſouthern part they extended from the Adriatic to the Apennine. A very fruitful territory, and very populous. *Picentes*, the people, (Cicero); from the ſingular, *Picens*, (Livy): different from the *Picentini*, on the Tuſcan ſea, though called ſo by the Greeks; but Ptolemy calls them *Piceni*, as does alſo Pliny. Their territory at this day is ſuppoſed to form the greateſt part of the March of Ancona, (Cluverius).

PICHFORD, in the county of Salop, ſituated on the ſouth-eaſt ſide of Shrewſbury, near Condover. It is noted for a ſpring of pitchy water (from whence ſome derive its name), on the top of which there always flows a ſort of liquid bitumen. Over moſt of the coal pits hereabouts there lies a ſtratum of blackiſh rock; of which, by boiling and grinding, they make pitch and tar, and alſo diſtil an oil from it.

PICHINCHA, a mountain in Peru. See Peru.

PICKERING, in the north riding of Yorkſhire, 13 miles from Scarborough, and 225 from London, is a pretty large town belonging to the duchy of Lancaſter, on a hill among the wild mountains of Blakemore: having the foreſt of Pickering on the north, and Pickering-common on the ſouth. It is ſaid to have been built 270 years before Chriſt by Peridurus, a king of the Britons, who was buried here. It had once a caſtle, the ruins of which are ſtill to be ſeen; to whoſe juriſdiction many of the neighbouring villages were ſubject: and the adjacent territory, commonly called Pickering-Lath, or the liberty or foreſt of Pickering, was given by Henry III. to his ſon Edmund earl of Lancaſter. A court is kept here for all actions under 40s. ariſing within the honour of Pickering.

PICKETS, in fortification, ſtakes ſharp at one end, and ſometimes ſhod with iron, uſed in laying out the ground, of about three feet long; but, when uſed for pinning the faſcines of a battery, they are from three to five feet long.

Pickets, in artillery, are about five or ſix feet long, ſhod with iron, to pin the park lines, in laying out the boundaries of the park.

Pickets, in the camp, are alſo ſtakes of about ſix or eight inches long, to faſten the tent cords, in pitching the tents; alſo, of about four or five feet long, driven into the ground near the tents of the horſemen, to tie their horſes to.

Picket, an out-guard poſted before an army, to give notice of an enemy approaching.

Picket, a kind of puniſhment ſo called, where a ſoldier ſtands with one foot upon a ſharp-pointed ſtake. The time of his ſtanding is limited according to the offence.

PICKLE, a brine or liquor, commonly compoſed of ſalt, vinegar, &c. ſometimes with the addition of ſpices, wherein meat, fruit, and other things, are preſerved and ſeaſoned.

PICO, one of the Azore Iſlands, is ſo called from ſome lofty mountains on it: or rather from one very high mountain, terminating like Teneriffe in a peak, and reputed by ſome writers equal to it in height. This iſland lies about four leagues ſouth-weſt from St. George, twelve from Tercera, and about three leagues ſouth-eaſt of Fayal; in W. lon. 28. 21. and N. lat. 38. 29. The mountain Pico, which gives name to the iſland, is filled with diſmal dark caverns or volcanoes, which frequently vomit out flames, ſmoke, and aſhes, to a great diſtance. At the foot of this mountain towards the eaſt is a ſpring of freſh water generally cold, but ſometimes ſo heated with the ſubterraneous fire, as to ruſh forth in torrents with a kind of ebullition like boiling water; equalling that in heat, and ſending forth a ſteam of ſulphureous fetid vapours, liquefied ſtones, minerals, and flakes of earth all on fire, in ſuch quantities, and with ſuch a violence, as to have formed a kind of promontory vulgarly called *Myſterios*, on the declivity of the coaſt, and at the diſtance of 1200 paces from the fountain. Such at leaſt is the account of Ortelius; though we do not find this laſt circumſtance of the promontory confirmed by later obſervations. The circumference of Pico is computed at about 15 leagues: and its moſt remarkable places are Pico, Lagoas, Santa Cruce or Cruz, San Sebaſtian, Peſquin, San Rocko, Playa, and Magdalena; the inhabitants of which live wholly on the produce of the iſland, in great plenty and felicity. The cattle are various, numerous, and excellent in their ſeveral kinds: it is the ſame with the vine; and its juice, prepared into different wines, the beſt in the Azores. Beſides cedar and other timber, they have a kind of wood which they call *teixo*, ſolid and hard as iron; and veined, when finely poliſhed, like a rich ſcarlet tabby; which colour it has in great perfection. The longer it is kept, the more beautiful it grows: hence it is, that the teixo tree is felled only for the king's uſe or by his order; and is prohibited from being exported as a common article of trade.

Pico *Marina*, a ſea fiſh common at Kongo in Africa, derives its name from the reſemblance of its mouth to the beak of a wood-pecker. It is of a large ſize, and prodigious ſtrength, has four fins on its back, three under its belly, and one on each ſide of its head; its tail is large and forked, by which it cuts the waves with ſurpriſing force and velocity. It is at war with every fiſh that ſwims, and with every thing it meets in its way, without being intimidated by the largeſt veſſels; a ſurpriſing inſtance of which intrepidity we are told by ſome miſſionaries, whoſe ſhip was attacked by one of them, near theſe coaſts, in the dead of night. The violence of the ſhock which it gave to the veſſel quickly awakened the captain and the reſt of the people; who immediately ran to the ſhip's ſide, where they perceived, by moon-light, this huge monſter faſtened by its forehead to the veſſel, and making the ſtrongeſt efforts to diſengage itſelf; upon which ſome of them tried to pierce him with their pikes, but he got off before they could accompliſh their aim. On the next morning, upon viſiting that ſide of the veſſel, they found, about a foot below the ſurface of the water, a piece of its bony ſnout ſtuck faſt into the wood, and two or three inches of it projecting outwards. They went preſently after to viſit the inſide of the ſhip, and diſcovered about five or ſix inches more of the point of the horn which had penetrated through the plank.

PICQUERING, a flying war, or ſkirmiſh, made by ſoldiers detached from two armies for pillage, or before a main battle begins.

PICQUET, or Picket. See Piquet.

PICRAMNIA, in botany: A genus of the pentandria order, belonging to the diœcia claſs of plants; and in the natural method ranking with thoſe that are doubtful. The calyx is tripartite; the corolla has three petals; the ſtamina from three to five, awl ſhaped, and ſeem to join together at the baſe; there are two ſtyli, which are ſhort and bent backwards; the berry is roundiſh, and contains two oblong ſeeds, and ſometimes one ſeed only. There is only one ſpecies, viz. the antideſma, or murjoe buſh. This ſhrub is frequent in copſes and about the ſkirts of woods in Jamaica, riſing about eight or nine feet from the ground. The leaves are of an oval form, pointed, and placed in an alternate form along the branches; the flower-ſpikes are long, pendulous, and ſlender; the florets ſmall and white: the berries are numerous; at firſt red, then of a jet black colour; the pulp is ſoft, and of a purple complexion. The whole plant is bitter, and eſpecially the berry. The negroes make a decoction of them, and uſe it in weakneſſes of the ſtomach and in venereal caſes.

PICRANIA amara, or *Bitter Wood*, is a tall and beautiful timber tree, common in the woods of Jamaica. It is a new genus, belonging to the pentandria monogynia of Linnæus. The name is expreſſive of its ſenſible qualities. Every part of this tree is intenſely bitter: and even after the tree has been laid for floors many years, whoever rub or ſcrape the wood feel a great degree of bitterneſs in their mouth or throat. Cabinet-work made of this wood is very uſeful, as no inſect will live near it. This tree has a great affinity to the *Quaſſia Amara* of Linnæus; in lieu of which it is uſed as an antiſeptic in putrid fevers. When uſed, leſs of it will do than of the *Quaſſia Amara* of Surinam. See Quassia.

PICRIS, Ox-tongue; a genus of the polygamia æqualis order, belonging to the ſyngeneſia claſs of plants. There are four ſpecies, of which the only remarkable one is the echioides, or common ox-tongue, growing ſpontaneouſly in corn-fields in Britain. It has undivided leaves embracing the ſtem, with yellow bloſſoms, which ſometimes cloſe ſoon after noon, at other times remain open till nine at night. It is an agreeable potherb while young. The juice is milky, but not too acrid.

PICRIUM, in botany: A genus of the monogynia order, belonging to the tetrandria claſs of plants; and in the natural method ranking with thoſe that are doubtful. The calyx is monophyllous and quinquefid; the corolla monopetalous, and its tube is ſhort; the filaments are four in number, and hooded at the place of their inſertion; the ſtyle long and thick; the ſtigma bilamellated; the capſule is round, bivalved, and contains a number of ſmall ſeeds.—There are two ſpecies, viz. the *ſpicata* and *ramoſa*; both natives of Guiana. Both ſpecies are bitter, and employed in dyſpepſy, and to promote the menſes: they are alſo recommended in viſceral obſtructions.

PICTET (Benedict), born at Geneva, in 1655, of a diſtinguiſhed family, proſecuted his ſtudies with great ſucceſs. After having travelled into Holland and England, he taught theology in his own country with an extraordinary reputation. The univerſity of Leyden, after the death of Spantreina, ſolicited him to come and fill his place; but he thought that his own country had the beſt right to his ſervices: and for that generoſity he received its thanks by the mouth of the members of council. A languiſhing diſorder, occaſioned by too much fatigue, haſtened his death; which happened on the 9th of June 1724, at the age of 69 years. This miniſter had much ſweetneſs and affability in his manner. The poor found in him a comforter and a father. He publiſhed a great number of works in Latin and French, which are much eſteemed in Proteſtant countries. The principal of theſe are, 1. A Syſtem of Chriſtian Theology, in Latin, 3 vols. in 4to; the beſt edition of which is that of 1721. 2. Chriſtian Morality, printed at Geneva, 1710, 8 vols. in 12mo. 3. The Hiſtory of the 11th and 12th centuries; intended as a ſequel to that of Sueur, printed in 1713, 2 vols. in 4to. The Continuator is held in higher eſtimation than the firſt author. 4. Several Controverſial Treatiſes. 5. A great number of tracts on morality and piety; among which we muſt diſtinguiſh "the Art of Living and Dying well;" publiſhed at Geneva, 1705, in 12mo. 6. Some Letters. 7. Some Sermons, from 1697 to 1721; 4 vols. in 8vo. With a vaſt number of other books, the names of which it would be tedious to mention; but which, as Mr. Sennebier ſays, "all ſhow evident marks of piety and good ſenſe."

Pictet (John-Louis), a counſellor of Geneva, born in 1739, was of the ſame family. He was member of the Council of Two Hundred; Counſellor of State and Syndic; and died in 1781. He applied himſelf to the ſtudy of aſtronomy, and made ſeveral voyages into France and England for his improvement. Few men were ever bleſſed with a clearer or more enlightened underſtanding. He has left in manuſcript the "Journal of a Voyage which he made to Ruſſia and Siberia in 1768 and 1769, in order to obſerve the tranſit of Venus over the ſun's diſk;" a work very intereſting, from the lively deſcriptions which it gives both of men and of nature.

PICTLAND. See Pentland.

PICTS, the name of one of thoſe nations who anciently poſſeſſed the north of Britain. It is generally believed that they were ſo called from their cuſtom of painting their bodies; an opinion which Camden ſupports with great erudition. (See Gough's edition, vol. 1. p. xci. of the preface.) It is certainly liable, however, to conſiderable objections; for, as this cuſtom prevailed among the other ancient inhabitants of Britain, who uſed the *glaſtum* of Pliny and the *vitrum* of Mela for the like purpoſe, it may be aſked, Why was the name of *Picti* confined by the Romans to only one tribe, when it was equally applicable to many others? Why ſhould they deſign them only by an epithet, without ever annexing their proper name? Or why ſhould they impoſe a new name on this people only, when they give their proper name to every other tribe which they have occaſion to ſpeak of? As theſe queſtions cannot be anſwered in any ſatisfactory manner, it is plain we muſt look for ſome other derivation of the name.

The Highlanders of Scotland, who ſpeak the ancient language of Caledonia, expreſs the name of this once famous nation by the term *Pictich*; a name familiar to the ears of the moſt illiterate, who could never have derived it from the Roman authors. The word *Pictich* means *pilferers* or *plunderers*. The appellation was probably impoſed upon this people by their neighbours, or aſſumed by themſelves, ſome time after the reign of Caracalla, when the unguarded ſtate of the Roman province, on which this people bordered, gave them frequent opportunities of making incurſions thither, and committing depredations. Accordingly this name ſeems to have been unknown till the end of the 3d century. Eumenius the panegyriſt is the firſt Roman author who mentions this people under their new name of *Pictich*, or, with a Latin termination, *Picti*. When we ſay that this name may have been probably aſſumed for the reaſon juſt now mentioned, we muſt obſerve, that, in thoſe days of violence, the character of a robber was attended with no diſgrace. If he had the addreſs to form his ſchemes well, and to execute them ſucceſsfully, he was rather praiſed than blamed for his conduct; providing he made no encroachments on the property of his own tribe or any of its allies. We mean this as no peculiar-ſtigma upon the Picts; for other nations of antiquity, in the like rude ſtate, thought and acted as they did.' See *Thucydides*, lib. 3. p. 3. and *Virg. Æn.* 7. 745—749.

Concerning the origin of the Picts, authors are much divided. Boethius derives them from the Agethyrſi, Pomponius Lætus from the Germans, Bede from the Scythians, Camden * and Father Innes from the ancient Britons, Stillingfleet from a people inhabiting the Cimbrica Cherſoneſus, and Keating and O'Flaherty, on the authority of the Pſalter Caſhel, derive them from the Thracians. But the moſt probable opinion is, that they were the deſcendants of the old Caledonians. Several reaſons are urged in ſupport of this opinion by Dr. Macpherſon; and the words of Eumenes, "Caledonum, aliorumque Pictorum, ſilvas," &c. plainly imply that the Picts and Caledonians were one and the ſame people.

As there has been much diſpute about the origin of the Picts, ſo there has been likewiſe about their language. There are many reaſons which make it plain that their tongue was the Gaelic or Celtic; and theſe reaſons are a further confirmation of their having been of Caledonian extract. Through the eaſt and north-eaſt coaſts of Scotland (which were poſſeſſed by the Picts) we meet with an innumerable liſt of names of places, rivers, mountains, &c. which are manifeſtly Gaelic. From a very old regiſter of the priory of St. Andrew's (Dalrymple's Collections, p. 122.) it appears, that in the days of Hungus, the laſt Pictiſh king of that name, St. Andrew's was called *Mukroſs*; and that the town now called *Queensferry* had the name of *Ardchinnecachan*. Both theſe words are plain Gaelic. The firſt ſignifies "the heath or promontory of boars;" and the latter, "the height or peninſula of Kenneth." In the liſt of Pictiſh kings publiſhed by Father Innes, moſt of the names are obviouſly Gaelic, and in many inſtances the ſame with the names in the liſt of Scottiſh or Caledonian kings publiſhed by the ſame author. Had Innes underſtood any thing of this language, he would not have ſuppoſed with Camden that the Picts ſpoke the Britiſh tongue. It was unlucky that the two words on which they built their conjecture (*Strath* and *Aber*) are as common in the Gaelic as they could have been in the Britiſh, and at this day make a part of the names of places in countries to which the Pictiſh empire never extended. The names of *Strathfillan* and *Lochaber* may ſerve as inſtances.

The venerable Bede, as much a ſtranger to the Celtic as either of the antiquaries juſt now mentioned, is equally unhappy in the ſpecimen which he gives of the Pictiſh language in the word *pennabel*, "the head of the wall." Allowing the commutation of the initial *p* into *c*, as in ſome other caſes, this word has ſtill the ſame meaning in Gaelic which Bede gives it in the Pictiſh. It is true, there might have been then, as well as now, a conſiderable difference between various dialects of the Celtic; and thus, perhaps, that pious author was led to diſcover five languages in Britain *agreeably to the five books of Moſes*: a conceit from which the good man derived a great deal of harmleſs ſatisfaction.

The Picts of the earlieſt ages, as appears from the joint teſtimony of all writers who have examined the ſubject, poſſeſſed only the eaſt and north-eaſt coaſt of Scotland. On one ſide, the ancient Drumalbin, or that ridge of mountains reaching from Lochlomond near Dumbarton to the frith of Taine, which ſeparates the county of Sutherland from a part of Roſs, was the boundary of the Pictiſh dominions. Accordingly we find in the Life of Columba, that, in travelling to the palace of Brudius, king of the Picts, he travelled over Drumalbin, the *Dorſum Britanniæ* of Adamnan. On the other ſide, the territory of the Picts was bounded by the Roman province. After Britain was relinquiſhed by the emperor Honorius, they and the Saxons by turns were maſters of thoſe countries which lie between the frith of Edinburgh and the river Tweed. We learn from Bede, that the Saxons were maſters of Galloway when he finiſhed his Eccleſiaſtical Hiſtory. The Picts, however, made a conqueſt of that country ſoon after; ſo that, before the extinction of their monarchy, all the territories bounded on the one ſide by the Forth and Clyde, and on the other by the Tweed and Solway, fell into their hands.

The hiſtory of the Picts, as well as of all the other ancient inhabitants of Britain, is extremely dark. The Iriſh hiſtorians give us a long liſt of Pictiſh kings, who reigned over Pictavia for the ſpace of eleven or thirteen centuries before the Chriſtian era. After them Innes, in his Critical Eſſay, gives us a liſt of above fifty, of whom no leſs than five held the ſceptre, each for a whole century. It is probable that theſe writers had confounded the hiſtory of the Picts with that of their anceſtors the old Caledonians. In any other view, their accounts of them are highly fabulous; and have been long ago confuted by Dr. Macpherſon of Slate, an antiquary of much learning and reſearch. The Picts, as has been already obſerved, were probably not known by that name before the 2d or 3d century. Adamnan, abbot of Iona, is the firſt author that expreſsly mentions any Pictiſh king: and the oldeſt after him is Bede. We are informed by theſe two writers, that St. Columba converted Brudius king of the Picts to the Chriſtian faith. Columba came into Britain in the year of the vulgar era 565. Before that period we have no general record to aſcertain ſo much as the name of any Pictiſh king. The hiſtory of *Druſt* or *Dreſt*, who is ſaid to have reigned over the Picts in the beginning of the fifth century, when St. Ninian firſt preached the goſpel to that nation, has all the appearance of fiction †. His having reigned a hundred years, and his putting an end to a hundred wars, are ſtories which exceed all the bounds of probability.

Brudius, the contemporary of Columba, is the firſt Pictiſh king mentioned by any writer of authority.

What figure his anceſtors made, or who were his ſucceſſors on the throne of Pictavia, cannot be aſcertained. Bede informs us, that, during the reign of one of them, the Picts killed Egfred king of Northumberland in battle, and deſtroyed the greateſt part of his army. The ſame author mentions another of their kings called *Naitan*, for whom he had a particular regard. It was to this *Naitan* that Ceolfrid, abbot of Wiremouth, wrote his famous letter concerning Eaſter and the Tonſure ‡;

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* See *Gough's edition of Camden*, Vol. I. Preface, p. xc. and the *Ancient Univerſal Hiſtory*, Vol. XVII. p. 3), &c.

† According to Camden, this converſion happened about the year 630, in the ſouthern Pictiſh provinces; while the northern, which were ſeparated by fruitful mountains, were converted by Columba.

‡ We are told by ſome authors that Columba taught the Picts to celebrate Eaſter always on a Sunday between the 14th and 20th of March, and to obſerve a different method of tonſure from the Romans, leaving an imperfect appearance of a crown. This occaſioned much diſpute till Naitan brought his ſubjects at length to the Roman rule. In that age many of the Picts went on a pilgrimage to Rome, according to the cuſtom of the times; and amongſt the reſt we find two perſons mentioned in the antiquities of St. Peter's church: *Aſterius* count of the Picts, and *Syra* with his countrymen, performed their vow.

a letter in which Bede himſelf is ſuppoſed to have had a principal hand. Roger Hoveden and Simon of Durham mention two other Pictiſh kings, *Onnuſt* and *Kinoth*, the firſt of whom died in 761, and the latter flouriſhed about the year 774, and gave an aſylum to Alfred of Northumberland, who was much about that time expelled his kingdom. The accounts given by the Scots hiſtorians of ſeveral other Pictiſh kings cannot be depended on; nor are the ſtories told by the Britiſh hiſtorians, Geoffroy of Monmouth and the author of the *Eulogium Britanniæ*, worthy of much greater credit.

In the ninth century the Pictiſh nation was totally ſubdued by the Scots in the reign of Kenneth Macalpin. Since that time their name has been loſt in that of the conquerors, with whom they were incorporated after this conqueſt: however, they ſeem to have been treated by the Scottiſh kings with great lenity, ſo that for ſome ages after they commanded a great deal of reſpect. The prior of Hogulſtead, an old Engliſh hiſtorian, relates, that they made a conſiderable figure in the army of David the Saint, in his diſputes with Stephen king of England. In a battle fought in the year 1136, by the Engliſh on one ſide, and the Scots and Picts on the other, the latter inſiſted on their hereditary right of leading the van of the Scots army, and were indulged in that requeſt by the king.

The principal ſeat of the Pictiſh kings was at Abernethy. Brudius, however, as appears from the accounts given by Adamnan, in his Life of Columba, had a palace at Inverneſs, which was probably near the extremity of his territory in that quarter; for there is no good reaſon for believing, with Camden, that this king had any property in the Weſtern Iſles, or that he had made a gift of Iona to St. Columba when he viſited him in that place.

With reſpect to the manners and cuſtoms of the Picts, there is no reaſon to ſuppoſe they were any other than thoſe of the old Caledonians and Scots, of which many particulars are related in the Greek and Roman writers who have occaſion to ſpeak of thoſe nations.

Upon the decline of the Roman empire, cohorts of barbarians were raiſed, and Picts were invited into the ſervice, by Honorius, when peace was every where reſtored, and were named *Honoriaci.* Thoſe under Conſtantine opened the paſſes of the Pyrenean mountains, and let the barbarous nations into Spain. From this period we date the civilization of their manners, which happened after they had by themſelves, and then with the Scots, ravaged this Roman province.

Picts *Wall*, in antiquity, a wall begun by the emperor Adrian, on the northern bounds of England, to prevent the incurſions of the Picts and Scots. It was firſt made only of turf ſtrengthened with paliſadoes, till the emperor Severus, coming into Britain in perſon, built it with ſolid ſtone. This wall, part of which ſtill remains, began at the entrance of the Solway Frith in Cumberland, and running north-eaſt extended to the German Ocean. See Adrian and Severus.

PICTURE, a piece of painting, or a ſubject repreſented in colours, on wood, canvaſs, paper, or the like. See Painting.

PICTURESQUE beauty, ſays a late writer on that ſubject, refers to "ſuch beautiful objects as are ſuited to the pencil." This epithet is chiefly applied to the works of nature, though it will often apply to works of art alſo. Thoſe objects are moſt properly denominated pictureſque which are diſpoſed by the hand of nature with a mixture of *varied rudeneſs*, *ſimplicity*, and *grandeur*. A plain neat garden, with little variation in its plan, and no ſtriking grandeur in its poſition, diſplays too much of art, deſign, and uniformity, to be called pictureſque. "The ideas of *neat* and *ſmooth* (ſays Mr. Gilpin), inſtead of being pictureſque, in fact diſqualify the object in which they reſide from any pretenſions to pictureſque beauty. Nay, farther, we do not ſcruple to aſſert, that roughneſs forms the moſt eſſential point of difference between the beautiful and the pictureſque; as it ſeems to be that particular quality which makes objects chiefly pleaſing in painting. I uſe the general term *roughneſs*; but, properly ſpeaking, roughneſs relates only to the ſurfaces of bodies: when we ſpeak of their delineation, we uſe the word *ruggedneſs*. Both ideas, however, equally enter into the pictureſque, and both are obſervable in the ſmaller as well as in the larger parts of nature; in the outline and bark of a tree, as in the rude ſummit and craggy ſides of a mountain.

"Let us then examine our theory by an appeal to experience, and try how far theſe qualities enter into the idea of pictureſque beauty, and how far they mark that difference among objects which is the ground of our inquiry.

"A piece of Palladian architecture may be elegant in the laſt degree; the proportion of its parts, the propriety of its ornaments, and the ſymmetry of the whole, may be highly pleaſing; but if we introduce it in a picture, it immediately becomes a formal object, and ceaſes to pleaſe. Should we wiſh to give it pictureſque beauty, we muſt uſe the mallet inſtead of the chiſel; we muſt beat down one half of it, deface the other, and throw the mutilated members around in heaps; in ſhort, from a ſmooth building we muſt turn it into a rough ruin. No painter who had the choice of the two objects would heſitate a moment.

"Again, why does an elegant piece of garden-ground make no figure on canvaſs? The ſhape is pleaſing, the combination of the objects harmonious, and the winding of the walk in the very line of beauty. All this is true; but the ſmoothneſs of the whole, though right and as it ſhould be in nature, offends in picture. Turn the lawn into a piece of broken ground, plant rugged oaks inſtead of flowering ſhrubs, break the edges of the walk, give it the rudeneſs of a road, mark it with wheel-tracks, and ſcatter around a few ſtones and bruſhwood; in a word, inſtead of making the whole ſmooth, make it rough, and you make it alſo pictureſque. All the other ingredients of beauty it already poſſeſſed." On the whole, pictureſque compoſition conſiſts in uniting, in one whole, a variety of parts, and theſe parts can only be obtained from rough objects.

It is poſſible therefore to find pictureſque objects among works of art, and it is poſſible to make objects ſo; but the grand ſcene of pictureſque beauty is nature in all its original variety, and in all its irregular grandeur. "We ſeek it (ſays our author) among all the ingredients of landſcape, trees, rocks, broken grounds, woods, rivers, lakes, plains, valleys, mountains, and diſtances. Theſe objects in themſelves produce infinite variety; no two rocks or trees are exactly the ſame; they are varied a ſecond time by combination; and almoſt as much a third time by different lights and ſhades, and other aerial effects. Sometimes we find among them the exhibition of a whole, but oftener we find only beautiful parts."

Sublimity or grandeur alone cannot make an object pictureſque; for, as our author remarks, "however grand the mountain or the rock may be, it has no claim to this epithet, unleſs its form, its colour, or its accompaniments, have ſome degree of beauty. Nothing can be more ſublime than the ocean; but, wholly unaccompanied, it has little of the pictureſque. When we talk, therefore, of a ſublime object, we always underſtand that it is alſo beautiful; and we call it ſublime or beautiful only as the ideas of ſublimity or ſimple beauty prevail. But it is not only the form and the compoſition of the objects of landſcape which the pictureſque eye examines; it connects them with the atmoſphere, and ſeeks for all thoſe various effects which are produced from that vaſt and wonderful ſtorehouſe of nature. Nor is there in travelling a greater pleaſure than when a ſcene of grandeur burſts unexpectedly upon the eye, accompanied with ſome accidental circumſtance of the atmoſphere which harmonizes with it, and gives it double value."

There are few places ſo barren as to afford no picturesque ſcene.

> —————— ———Believe the muſe,
> She does not know that inauſpicious ſpot
> Where beauty is thus niggard of her ſtore.
> Believe the muſe, through this terreſtrial waſte
> The ſeeds of grace are ſown, profuſely ſown,
> Even where we leaſt may hope.——

Mr. Gilpin mentions the great military road between Newcaſtle and Carliſle as the moſt barren tract of country in England; and yet there, he ſays, there is "always ſomething to amuſe the eye. The interchangeable patches of heath and green-ſward make an agreeable variety. Often too, on theſe vaſt tracts of interſecting grounds, we ſee beautiful lights, ſoftening off along the ſides of hills; and often we ſee them adorned with cattle, flocks of ſheep, heath-cocks, grous, plover, and flights of other wild-fowl. A group of cattle ſtanding in the ſhade on the edge of a dark hill, and relieved by a lighter diſtance beyond them, will often make a complete picture without any other accompaniment. In many other ſituations alſo we find them wonderfully pleaſing, and capable of making pictures amidſt all the deficiencies of landſcape. Even a winding road itſelf is an object of beauty; while the richneſs of the heath on each ſide, with the little hillocks and crumbling earth, give many an excellent leſſon for a fore-ground. When we have no opportunity of examining the grand ſcenery of nature, we have every where at leaſt the means of obſerving with what a multiplicity of parts, and yet with what a general ſimplicity, ſhe covers every ſurface.

"But if we let the imagination looſe, even ſcenes like theſe adminiſter great amuſement. The imagination can plant hills, can form rivers and lakes in valleys, can build caſtles and abbeys, and, if it find no other amuſement, can dilate itſelf in vaſt ideas of ſpace."

Mr. Gilpin, after deſcribing ſuch objects as may be called picturesque, proceeds to conſider their ſources of amuſement. We cannot follow our ingenious author thro' the whole of this conſideration, and ſhall therefore finiſh our article with a ſhort quotation from the beginning of it. "We might begin (ſays he) in moral ſtyle, and conſider the objects of nature in a higher light than merely as amuſement. We might obſerve, that a ſearch after beauty ſhould naturally lead the mind to the great origin of all beauty, to the

> ————first good, firſt perfect, and firſt fair.

But though in theory this ſeems a natural climax, we inſiſt the leſs upon it, as in fact we have ſcarce ground to hope that every admirer of picturesque beauty is an admirer alſo of the beauty of virtue, and that every lover of nature reflects, that

> Nature is but a name for an *effect*,
> Whoſe *cauſe* is God.——

If, however, the admirer of nature can turn his amuſements to a higher purpoſe, if its great ſcenes can inſpire him with religious awe, or its tranquil ſcenes with that complacency of mind which is ſo nearly allied to benevolence, it is certainly the better. *Apponat lucro.* It is ſo much into the bargain; for we dare not promiſe him more from picturesque travel than a rational and agreeable amuſement. Yet even this may be of ſome uſe in an age teeming with licentious pleaſure; and may, in this light at leaſt, be conſidered as having a moral tendency."

PICUIPINIMA, in ornithology, is the name of a ſpecies of pigeon in Braſil. It is ſo very ſmall as ſcarce to exceed the lark in ſize. Its head, neck, and wings, are of a pale lead colour, with a black ſemilunar mark at the extremity of each wing; but its long wing-feathers, which are ſeen when the wings are expanded in flying, are of a reddiſh brown on one ſide, and blackiſh on the other, with black ends or tips; the tail is long, and is variegated with black, white, and brown; the belly is covered with white feathers, every one of which has a brown mark, of the ſhape of a half-moon, at the end.

PICUMNUS and PILUMNUS, were two deities at Rome, who preſided over the auſpices required before the celebration of nuptials. Pilumnus was ſuppoſed to patroniſe children, as his name ſeems in ſome manner to indicate, *quod pellat mala infantiæ.* The manuring of land was firſt invented by Picumnus, from which reaſon he is called *Sterquilinius.* Pilumnus is alſo invoked as the god of bakers and millers, as he is ſaid to have firſt invented the art of grinding corn.

PICUS, the WOODPECKER, in ornithology, a genus belonging to the order of picæ. The beak is ſtraight, and conſiſts of many ſides, and like a wedge at the point: the noſtrils are covered with briſtly feathers; the tongue is round like a worm, very long, and ſharp at the point, which is beſet with briſtles bent backwards.

The grand characteriſtic, ſays Latham, of theſe birds is the tongue, (which in no bird is ſimilar, the wryneck excepted, whoſe other characters, however, differ too widely to give it place in this claſs,) the muſcles neceſſary to the motions of which are ſingular and worthy of notice, affording the animal means of darting it forwards the whole length, or drawing it within the mouth at will. See *Ray on the Creation*, p. 143. *Derham's Phyſico-Theol.* p. 342. Note c. *Will. Orn.* p. 136. t. 21.

The ſame intelligent ornithologiſt enumerates no leſs than 50 different ſpecies of woodpeckers, beſides varieties of ſome of them which amount to nine more. Each of theſe ſpecies our readers cannot expect us to deſcribe; we ſhall therefore content ourſelves with ſuch as appear to be moſt remarkable.

1. The *picus martius*, or greateſt black woodpecker, is about the ſize of a jackdaw, being about 17 inches long; the bill is nearly two inches and a half in length, of a dark aſh-colour, and whitiſh on the ſides; the irides are pale yellow, and the eyelids are naked, according to Scopoli; the whole bird is black, except the crown of the head, which is vermilion; the firſt quill-feather is the ſhorteſt, and the two middle tail-feathers, which are longer than the others, make it appear a little rounded; the legs are of a lead colour, covered with feathers on the fore part for half their length.

"The female differs from the male in having the hind head only red, and not the whole crown of the head; and the general colour of the plumage has a ſtrong caſt of brown in it. It has likewiſe been obſerved, that the red on the hind head has been wholly wanting; and indeed both male and female are apt much to vary in different ſubjects; ſome having a much greater proportion of red on the head than others. This ſpecies is found on the continent of Europe, but not in plenty except in Germany. It is not an inhabitant of Italy, and is very rarely ſeen in France. Friſch mentions it as a bird common to his parts; and it is found alſo in Sweden, Switzerland, and Denmark, but not in winter.

"It is ſaid to build in old aſh and poplar trees, making large and deep neſts; and Friſch obſerves, that they often ſo excavate a tree, that it is ſoon after blown down with the wind; and that under the hole of this bird may often be found a buſhel of duſt and bits of wood. The female lays two or three white eggs, the colour of which, as Willughby obſerves, is peculiar to the whole of the woodpecker genus, or at leaſt all thoſe which have come under his inſpection."

2. The *picus principalis*, or white-billed woodpecker, is ſomewhat bigger than the laſt, being equal in ſize to a crow. It is 16 inches long, and weighs about 20 ounces. The bill is white as ivory, three inches long, and channelled; the irides are yellow, and on the hind head is an erect pointed creſt, of a fine red colour, ſome of the feathers of which are two inches long; the head itſelf, and the body in general, are black; but the lower part of the back, rump, and upper tail-coverts, are white; from the eye there ariſes a ſtripe of white, which paſſes on each ſide of the neck down to the back; three or four of the prime quills are black, but the reſt are white; the tail is cuneiform, and of the ſame colour as the body; the legs and claws are alſo black.

" This ſpecies inhabits Carolina, Virginia, New Spain, and Braſil, and is called by the Spaniards *carpenter*; and not without reaſon, as this as well as moſt of the other ſpecies make a great noiſe with the bill againſt the trees in the woods, where they may be heard at a great diſtance, as if carpenters were at work; making, according to Cateſby, in an hour or two, a buſhel of chips. He adds, likewiſe, that the Canadian Indians make uſe of the bills of theſe birds for coronets, ſetting them round in a wreath with the points outwards; and that the northern Indians purchaſe them of the ſouthern at the rate of two and three buck-ſkins per bill. Kalm ſays they are found in New Jerſey, though very ſeldom, and only at certain ſeaſons."

3. The *picus erythrocephalus*, or red-headed woodpecker, is about eight inches three quarters long, and weighs two ounces. The bill is an inch and a quarter in length, of a lead colour, with a black tip; the irides are duſky; the head and the neck are of a moſt beautiful crimſon; the back and wings are black; the rump, breaſt, and belly, are white; the ten firſt quills are black, the eleventh black and white, and the others are white with black ſhafts; the tail is black and cuneiform; the legs and claws are of lead colour. The cock and hen are very nearly alike.

" This ſpecies inhabits Virginia, Carolina, Canada, and moſt of the parts of North America; but at the approach of winter it migrates more or leſs to the ſouthward, according to the ſeverity of the ſeaſon; and upon this circumſtance the people of North America foretel the rigour or clemency of the enſuing winter. Kalm obſerves that it is a very common bird, and is very deſtructive to the maize-fields and orchards, pecking through the ears of maize, and deſtroying great quantities of apples. In ſome years they are more numerous than in others, when they attack the orchards where the ſweet apples grow, which they eat ſo far that nothing remains but the mere pills. Some years ſince there was a premium of twopence per head paid from the public fund, in order to extirpate this pernicious bird; but this has been neglected much of late. They are ſaid likewiſe to be very fond of acorns. In Virginia and Carolina they ſtay the whole year, but are not ſeen in ſuch numbers in winter as in ſummer. During the winter they are very tame, and are frequently known to come into the houſes in the ſame manner as the redbreaſt is wont to do in England. It is obſerved that this ſpecies is found chiefly in old trees; and the noiſe they make with their bills may be heard above a mile diſtant. It builds the earlieſt of all the woodpeckers, and generally pretty high from the ground. It is accounted by many people very good eating. Buffon is of opinion, that it is neceſſity alone that cauſes theſe birds to feed on vegetables of any kind, as it is contrary to the nature of the genus."

4. The *picus pubeſcens*, or little woodpecker, according to Cateſby, weighs only about an ounce and a half. Briſſon ſays, it is larger than the ſmalleſt of our European ſpecies, being about five inches and a half long. The bill is about eight lines long, and of a horn colour; the top of the head is black, and on each ſide above the eye is a white line; the hind head is red: the hind part of the neck, the back, and rump, are black, which is divided into two parts by a line of white paſſing down the middle to the rump; the ſcapulars, upper wing and tail coverts, are black; the greater wing coverts and quills are ſpotted with white; the under parts of the body are pale grey; the tail is black; the four middle feathers are plain, the reſt are barred with white and black; and the legs and claws are black.

The female has no red on the hind head. Linnæus tells us, that the outer tail feather is white, marked with four black ſpots. This ſpecies inhabits Virginia and Carolina. According to Kalm, it abounds in New Jerſey, where it is eſteemed of all others the moſt dangerous to orchards, and is the moſt daring. As ſoon as it has pecked one hole in a tree, it makes another cloſe to the firſt, in an horizontal direction, proceeding till it has made a circle of holes quite round the tree; and the apple-trees in the orchards have often ſeveral of theſe rings of holes round the ſtem, inſomuch that the tree frequently dries up and decays.

5. The *yellow woodpecker* is about nine inches long. The bill is of a yellowiſh white, and more than an inch long; the hind head is creſted; the head itſelf, the neck, and whole body, are covered with dirty white feathers; from the lower jaw to the ears, on each ſide, there is a red ſtripe; the wing coverts are brown, and edged with yellowiſh, and ſome of the greater ones are mixed with rufous on the inner web; the quills are brown or rufous; the tail is black, the legs and claws are grey.

" This ſpecies is common at Cayenne, and is called there *charpentier jaune*. It makes its neſt in old trees which are rotten within; making with its bill a hole from without, at firſt horizontal, but declining downwards as ſoon as it has pierced through the ſound part, till it is at laſt a foot and a half below the firſt opening. The female lays three white and nearly round eggs, and the young are hatched about the beginning of April. The male bears his ſhare in the work with the female, and in her abſence keeps ſentinel at the entrance of the hole. The note of this bird is a kind of whiſtle ſix times repeated, of which the two or three laſt are in a graver accent than the others. The female wants the red band on the ſide of the head which is ſeen in the male.

" Specimens vary; ſome are of that dirty white, as Briſſon deſcribes it, others of a light yellow; which laſt is the caſe in a ſpecimen in the Leverian muſeum: this is 13 inches in length.

" In the place referred to above, we find a bird imperfectly deſcribed by Mr. Fermin: he merely ſays, that it is a large ſpecies; that it has a fine red creſt on the head; the neck, breaſt, and belly, of a citron colour; and the wings blueiſh above. He only adds, that it may be diſtinguiſhed from others by the ſtrokes of the bill which it gives to the trees, and may be heard at a great diſtance."

6. The *picus auratus*, or gold-winged woodpecker, is about 11 inches long, and weighs about 5 ounces. The bill is an inch and a half long, and is ſomewhat bent, and is not ſquare but roundiſh, ridged only on the top, the point being ſharp; the upper parts of the head and neck are aſh-coloured; the hind head is red; the ſides of the head, throat, and fore part of the neck, are pale yellow; on each ſide of the head is a ſtripe of black, from the baſe of the lower jaw to the neck; the back, ſcapulars, and wing coverts, are of a grey brown

colour, tranſverſely ſtriated with black lines; the rump is whitiſh; the breaſt, belly, and ſides, are whitiſh yellow, and each feather is marked with a round black ſpot at the tip; on the middle of the breaſt there is a large creſcent of black; the thighs, upper and under tail coverts, are black and white mixed; the quills are brown, with yellow ſhafts ſpotted with brown on the outer edge; the tail is blackiſh, being outwardly edged with grey; the outer feather is dotted with whitiſh on the margins; the ſhafts of all but the two middle feathers are yellow half way from the baſe; and the legs and claws are brown.

The female differs in having the crown and neck behind grey-brown; the hind-head of a leſs vivid red; and the greater quills not ſpotted on the edges. She alſo wants the black liſt on the throat, but is otherwiſe like the male.

This ſpecies inhabits Virginia, Carolina, and Canada, and is plenty in New Jerſey, and about New York, where it is called by ſome *hittock* or *pint*, and by others *high-hole*[*]. Both the firſt names have ſome relation to its note; and perhaps the latter, from the ſituation of the neſt. It is almoſt continually on the ground, and is not obſerved to climb on the trees, like others of the genus. It lives chiefly on inſects[†], and is commonly very fat, ſo as to be thought very palatable for the table. It ſtays all the year; and as it cannot at all times get inſects, it muſt perhaps eat ſome kind of graſs or plants in the fields. Its form and ſome of its qualities make it reſemble the cuckow[‡]. Though it climbs not on trees, it flies to their tops and ſits occaſionally on the branches.

Forſter, in the Philoſophical Tranſactions, obſerves, that it is a bird of paſſage in the northern parts of America, viſiting the neighbourhood of Albany Fort in April, and leaving it in September: that it lays from four to ſix eggs, in hollow trees, and feeds on worms and other inſects. Called by the natives *ou-thee-quannow*.

The following ſpecies are pretty well known in Britain.

7. The *viridis*, or green woodpecker, weighs ſix ounces and a half; its length is 13 inches, the breadth 20 and a half; the bill is duſky, triangular, and near two inches long; the crown of the head is crimſon, ſpotted with black; the eyes are ſurrounded with black, and the males have a rich crimſon mark beneath the blackneſs; the back, neck, and leſſer coverts of the wings, are green; the rump of a pale yellow; the whole of the under part of the body is of a very pale green, and the thighs and vent are marked with duſky lines; the legs and feet are of a cinereous green; the tail conſiſts of ten ſtiff feathers, whoſe ends are generally broken, as the bird reſts on them in climbing; their tips are black; the reſt of each is alternately barred with duſky and deep green. Theſe birds feed entirely on inſects; and their principal action is that of climbing up and down the bodies or boughs of trees: for the firſt purpoſe they are provided with a long ſlender tongue, armed with a ſharp bony end barbed on each ſide, which by the means of a curious apparatus of muſcles they can exert at pleaſure, darting it to a great length into the clifts of the bark, transfixing and drawing out the inſects that lurk there. They make their neſts in the hollows of trees: in order therefore to force their way to thoſe cavities, their bills are formed ſtrong, very hard, and wedge-like at the end; Dr. Derham obſerves, that a neat ridge runs along the top, as if an artiſt had deſigned it for ſtrength and beauty. Yet it has not power to penetrate a ſound tree; their perforation of any tree is a warning to the owner to throw it down. Their legs are ſhort, but ſtrong; their thighs very muſcular; their toes diſpoſed two backward, two forward; the feathers of the tail are very ſtiff, ſharp-pointed, and bending downwards. The three firſt circumſtances do admirably concur to enable them to run up and down the ſides of trees with great ſecurity; and the ſtrength of the tail ſupports them firmly when they continue long in one place, either where they find plenty of food, or while they are forming an acceſs to the interior part of the timber. This form of the tail makes their flight very awkward, as it inclines their body down, and forces them to fly with ſhort and frequent jerks when they would aſcend, or even keep in a line. This ſpecies feeds oftener on the ground than any other of the genus: all of them make their neſts in the hollows of trees: and lay five or ſix eggs, of a beautiful ſemi-tranſparent white.

Willughby ſays that the female lays five or ſix eggs; which Pennant[§] alſo obſerves; adding, that they are of a beautiful ſemi-tranſparent white.

"Theſe birds ſometimes build in a hollow aſp or other tree, 15 or 20 feet from the ground. The male and female take it by turns to bore through the living part of the wood, till they come to the rotten part, wherein, after being hollowed out to a proper depth, they lay their eggs[‖], which are generally five and ſometimes ſix[¶] in number, greeniſh, with ſmall black ſpots. The young ones climb up and down the trees before they can fly. It is worthy of remark to obſerve with what nicety the holes of the woodpecker are made, as perfectly round as if made by the aſſiſtance of a pair of compaſſes. Nuthatches, ſtarlings, and bats, frequently build in theſe holes when deſerted.

"Both Friſch and Klein miſtake in ſaying that the females have not the red crown, for even the young ones in the neſt have the appearance of it; and I have had them brought to me when they could ſcarcely fly, when the red was mixed with brown; but they do not become of a full red till after the firſt moult. They are ſaid to be fond of bees in winter, making great havock among them. Salerne obſerves, that they are found in the markets in Italy, at Bologna; but this is not extraordinary, for the Italians eat all ſmall birds almoſt without exception.

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[*] "I have lately ſeen (ſays Latham) in the Leverian muſeum a bird which appears to be a mere variety, though brought from a far different country. This was much like the picus auratus in colour, but rather leſs in ſize. The bill exactly made like that bird, and brown; on each ſide of the jaw is a ſtripe of crimſon, like a whiſker; the under part of the wings of a pale red colour, not unlike what is called *red-lead:* and the ſhafts of the quills and tail, which in the other bird are yellow, in this are red; the plumage on the upper parts of the body is brown, beneath vinaceous, marked with round black ſpots; tail black, pointed, and each feather bifurcated at the tip, exactly like the American one. This was brought from the Cape of Good Hope. I have ſeen two ſpecimens of this bird."

[†] "In defect of inſects I have been informed (ſays Mr. Latham) that it feeds on the berries of the red cedar, and grows fat on them. This food has been both diſgorged by the mouth, after being ſhot, as well as found in the ſtomach on diſſection."

[‡] "Linnæus, in his tenth edition of the *Syſtema Naturæ*, had ranked this with the cuckows; and Buffon, from its ſimilarity to this genus, has placed it at the end of the woodpeckers of its claſs."

[§] *Br. Zool.* p. 242. where ſome pertinent obſervations on theſe birds may be found. Let the reader alſo conſult *Ray on the Creation*, p. 143. and *Derham's Phyſico-Theol.* p. 193, 339, 342.

[‖] "This is ſometimes ſo deep that they muſt feed their young quite in the dark; for I have been told by one, that he was obliged to thruſt his whole arm to the ſhoulder down the hollow of a tree before he could reach the eggs."

[¶] "I have ſeen ſix young ones together in one neſt." *Will. Orn.* p. 136.

"In Sir A. Lever's muſeum there is a variety of this bird, of a ſtraw-colour throughout, except the crown, which is faintly marked with red."

8. The *major*, or great ſpotted woodpecker, weighs two ounces three quarters; the length is nine inches; the breadth is 16. The bill is one and a quarter long, of a black horn colour. The irides are red. The forehead is of a pale buff colour; the crown of the head a gloſſy black; the hind-part marked with a rich deep crimſon ſpot. The cheeks are white; bounded beneath by a black line that paſſes from the corner of the mouth and ſurrounds the hind-part of the head. The neck is encircled with a black colour. The throat and breaſt are of a yellowiſh white; the vent feathers of a fine light crimſon. The back, rump, and coverts of the tail, and leſſer coverts of the wings, are black; the ſcapular feathers and coverts adjoining to them are white. The quill-feathers are black, elegantly marked on each web with round white ſpots. The four middle feathers of the tail are black, the next tipped with dirty yellow; the bottoms of the two outmoſt black; the upper parts a dirty white. The exterior feathers marked on each web with two black ſpots; the next with two on the inner web, and only one on the other. The legs are of a lead colour. The female wants that beautiful crimſon ſpot on the head; in other reſpects the colours of both agree. This ſpecies is much more uncommon than the preceding, and keeps altogether in the woods. This bird is pretty common in England, France, Germany, and other parts of Europe, frequenting the woods like the reſt of its genus, and is likewiſe met with in America. It is a very cunning bird; for, when a perſon has ſeen one on a tree, he is almoſt ſure to loſe ſight of it, if the tree is large, and the obſerver not very attentive; for, the moment it ſpies any one, it will creep behind a branch, and there lie ſecure till the danger is over. The extreme facility with which birds of the woodpecker kind deſcend as well as aſcend the trees is worthy admiration, ſeeming to do both with equal eaſe to itſelf. We do not find any one who has noticed the colour of the eggs; but Buffon mentions having found a neſt with ſix young ones in an old decayed aſp tree, 30 feet from the ground.

9. The *medius*, or middle-ſized woodpecker, agrees with the preceding in colours and ſize, excepting that the crown of the head in this is of a rich crimſon; the crown of the head in the male of the former black; and the crimſon is in form of a bar on the hind part. Birds thus marked have been ſhot in Lancaſhire and other parts of England; but Mr. Pennant is doubtful whether they are varieties or diſtinct ſpecies. "Briſſon (ſays Latham) quotes many authors who have deſcribed this bird, but I am not clear in its being a diſtinct ſpecies. It is certainly much more ſcarce in England than any other. Buffon is reconciled to its being a variety only; but if ſo, this variety is regular, at leaſt in all the ſpecimens which I have ſeen."

10. The *minor*, or leaſt ſpotted woodpecker, ſcarce weighs an ounce: the length is ſix inches; the breadth eleven. The forehead is of a dirty white: the crown of the head (in the male) of a beautiful crimſon: the cheeks and ſides of the neck are white, bounded by a bed of black beneath the former. The hind part of the head and neck, and the coverts of the wings, are black: the back is barred with black and white; the ſcapulars and quill-feathers ſpotted with black and white: the four middle feathers of the tail are black; the others varied with black and white: the breaſt and belly are of a dirty white: the crown of the head (in the female) is white; the feet are of a lead colour. It has all the characters and actions of the greater kind, but is not ſo often met with. Salerne tells us that this bird is not found in France; but Buffon affirms that it inhabits moſt of the provinces there. It approaches near habitations in winter, and may be ſeen in orchards adjoining to houſes; which no doubt it does for the ſake of food, finding about the trunks of the trees both caterpillars and larvæ of inſects of all kinds. It builds in a hole of a tree, and often diſputes the right of poſſeſſion with the little colemouſe, which laſt, as it is much weaker of the two, muſt yield the victory. Willughby ſays it is called in England by the name of *hickwall*. Linnæus, in his ſynonymes of this bird, quotes Haſſelquiſt for the ſame; but whoever will diligently read what this author ſays of the matter, will be convinced that the reference ſhould be to the greater rather than the leaſt of this genus. It is ſaid by him to inhabit the higher parts of Aſia.

Mr. Sonnerat mentions a bird found by him at Antigue, in the iſland of Panay, with the top of the head, and hind part of the neck, of a greyiſh black: on each ſide of the neck, two-thirds downwards, is a ſtripe of white, which begins juſt above the eye; and under this another of black from the eye to the ſhoulder. The upper part of the body is black and white: the under parts pale yellow, ſpotted with black. The tail is black above, and beneath barred with a dirty white and yellowiſh colour. The bill and legs blackiſh. The head had no red on it. Buffon ſuppoſes it to have been a female, and a variety only of our leaſt ſpotted woodpecker.

Picus (fab. hiſt.), a king of Latium, ſon of Saturn. He married Venilia, alſo called Canens, by whom he had Faunus. He was tenderly loved by the goddeſs Pomona, and he returned her affection. As he was one day hunting in the woods, he was met by Circe, who became deeply enamoured of him, and who changed him into a woodpecker, called by the name of *picus* among the Latins. His wife Venilia was ſo diſconſolate when ſhe was informed of his death, that ſhe pined away. Some ſuppoſe that Picus was the ſon of Pilumnus, and that he gave out prophecies to his ſubjects by means of a favourite woodpecker; from which circumſtance originated the fable of his being metamorphoſed into a bird.

Picus (John), earl of Mirandola, a prodigy of parts and learning, was the youngeſt child of John Francis Picus, earl of Mirandola and Concordia; and was born in the year 1463. The progreſs that he made in letters was ſo extremely rapid, that it was matter of aſtoniſhment to ſee even a boy one of the firſt poets and orators of his age. He was the ſcholar of R. Jochanan, a German Jew, who confirmed his natural fondneſs for the cabaliſtical writings, inſomuch that he is reported to have declared, that thoſe who dived into them dived in the true head ſpring; whereas thoſe rivulets that had flowed thence into Greece were no better than corrupt and ſtagnated waters. After viſiting the moſt famous univerſities of France and Italy, he went to Rome; where, in 1486, before he was 24 years of age, he publiſhed 900 propoſitions in logic, mathematics, phyſics, divinity, cabaliſtic learning, and magic, drawn not only from Greek and Latin, but even from Jewiſh and Arabian writers; ſubjoining to his advertiſement, that "if any philoſopher or divine would come to Rome to diſpute with him upon any or all of them, he would defray the expenſes of his journey from the remoteſt corners of Italy." He enjoyed, however, the honour of this diſputatious challenge quietly, without danger to his credit; for envy procured ſome of his propoſitions to be charged with hereſy, and he was forbid to diſpute upon them. As a proof of the ignorance of his oppoſers, we are told that a theologian who had ſhown himſelf very zealous in cenſuring his book, being aſked what was the meaning of the word *cabbala?* anſwered, that he was a wicked man and a heretic, who had written againſt Jeſus Chriſt, and that thoſe who followed his opinion were called cabbaliſts. At the age of 28, he confined himſelf wholly to the ſtudy of the Scriptures; and undertook to combat the Jews and Mahometans, as well as to confound judicial aſtrology; but in this intention his credit was alſo ſaved, though with the loſs of his life, by his dying in 1494, in his 32d year. He was called the *phœnix of his age*, and by Scaliger *Monſtrum ſine Vitio*. He compoſed a great number of works, which have often been printed both ſeparately and together. The following epitaph is upon his tomb:

Hic ſitus eſt Picus Mirandola: cætera nôrunt
Et Tagus et Ganges, forſan et Antipodes.

Picus (John Francis), prince of Mirandola, nephew of John Picus mentioned above, was born about the year 1469. He cultivated learning and the ſciences after the example of his uncle; but he had a principality and dominions to ſuperintend, which involved him in great troubles, and at laſt coſt him his life. He was twice driven from his principality, and twice reſtored; and at laſt, in 1533, was, together with his eldeſt ſon Albert, aſſaſſinated in his own caſtle by his nephew Galeoti. He was a great lover of letters; and ſuch of his works as were then compoſed were inſerted in the Straſburgh edition of his uncle's in 1504, and continued in future impreſſions, beſides ſome others which were never collected.

PIECE, in matters of money, ſignifies ſometimes the ſame thing with ſpecies; and ſometimes, by adding the value of the pieces, it is uſed to expreſs ſuch as have no other particular name. For the piece of eight, or piaſtre, ſee Money-*Table*.

Piece, is alſo a kind of money of account, or rather a manner of accounting, uſed among the negroes on the coaſt of Angola in Africa. See Money-*Table*.

Piece, in heraldry, denotes an ordinary or charge. The honourable pieces of the ſhield are the chief, feſs, bend, pale, bar, croſs, ſaltier, chevron, and in general all thoſe which may take up one-third of the field, when alone, and in what manner ſoever it be. See Heraldry.

Pieces, in the military art, include all ſorts of great guns and mortars. Battering pieces are the larger ſort of guns uſed at ſieges for making the breaches; ſuch are the 24-pounder and culverine, the one carrying a 24 and the other an 18 pound ball. Field-pieces are 12-pounders, demiculverines, 6 pounders, ſackers, minions, and 3-pounders, which march with the army, and encamp always behind the ſecond line, but in day of battle are in the front. A ſoldier's firelock is likewiſe called his *piece*.

PIEDMONT, a principality of Italy, 175 miles long and 40 broad; bounded on the north by Vallais, on the eaſt by the duchies of Milan and Montferrat, on the ſouth by the county of Nice and the territory of Genoa, and on the weſt by France and Savoy. It was formerly a part of Lombardy, but now belongs to the king of Sardinia, and lies at the foot of the Alps. It contains many high mountains, among which are rich and fruitful valleys, as populous as any part of Italy. In the mountains are mines of ſeveral kinds, and the foreſts afford a great deal of game. This country has a great trade in raw ſilk; and it produces alſo corn, rice, wine, fruits, hemp, flax, and cattle. Turin is the capital.

PIENES, a ſmall iſland of Japan, over againſt the harbour of Saccai, is famed not only for the beauty of its walks, to which crowds of people reſort from the city, but for a deity worſhipped there, to which vaſt numbers of perſons devote themſelves. They go from his temple to the ſea-ſide, where they enter into a boat provided for the purpoſe; then, launching into the deep, they throw themſelves overboard, loaded with ſtones, and ſink to the bottom. The temple of that deity, which is called Canon, is very large and lofty, and ſo are many others in the city itſelf; one in particular, dedicated to the gods of other countries, is thought the fineſt in the whole empire.

PIEPOUDRE *(Court of)*, the loweſt, and at the ſame time the moſt expeditious, court of juſtice known to the law of England. It is called piepoudre, *(curia pedis pulverizati,)* from the duſty feet of the ſuitors; or, according to Sir Edward Coke, becauſe juſtice is there done as ſpeedily as duſt can fall from the foot; upon the ſame principle that juſtice among the Jews was adminiſtered in the gate of the city, that the proceedings might be the more ſpeedy, as well as public. But the etymology given us by a learned modern writer is much more ingenious and ſatisfactory; it being derived, according to him, from *pied puldreaux*, "a pedlar," in old French, and therefore ſignifying the court of ſuch petty chapmen as reſort to fairs or markets. It is a court of record, incident to every fair and market; of which the ſteward of him who owns or has the toll of the market is the judge. It was inſtituted to adminiſter juſtice for all commercial injuries done in that very fair or market, and not in any preceding one. So that the injury muſt be done, complained of, heard, and determined, within the compaſs of one and the ſame day, unleſs the fair continues longer. The court hath cognizance of all matters of contract that can poſſibly ariſe within the precinct of that fair or market; and the plaintiff muſt make oath that the cauſe of an action aroſe there. From this court a writ of error lies, in the nature of an appeal, to the courts at Weſtminſter. The reaſon of its inſtitution ſeems to have been, to do juſtice expeditiouſly among the variety of perſons that reſort from diſtant places to a fair or market; ſince it is probable, that no other inferior court might be able to ſerve its proceſs, or execute its judgements, on both or perhaps either of the parties; and therefore, unleſs this court had been erected, the complaint muſt neceſſarily have reſorted even in the firſt inſtance to ſome ſuperior judicature.

PIER, in building, denotes a maſs of ſtone, &c. oppoſed by way of fortreſs to the force of the ſea, or a great river, for the ſecurity of ſhips that lie at anchor in any haven.

Piers *of a Bridge*. See Bridge and Architecture.

PIERCEA. See Rivinia.

PIERIA (anc. geog.), a diſtrict of Macedonia, contained between the mouths of the rivers Ludias and Peneus; extended by Strabo beyond the Ludias, to the river Axios on the north, and on the ſouth no farther than the Aliacmon, along the weſt ſide of the Sinus Thermaicus.—Another *Pieria* of Syria, the north part of Seleucia, or the *Antiochena*, ſituated on the Sinus Iſſicus, and lying next Cilicia to the north-weſt.

PIERIDES, in fabulous hiſtory, the daughters of Pierus a Macedonian prince, preſuming to diſpute with the Muſes for the prize of poetry, were turned into magpies. The name of *Pierides* was alſo given to the Muſes, from mount Pieris in Theſſaly, which was conſecrated to them; or, according to others, from Pierus, a Theſſalian poet, who was the firſt who ſacrificed to them. See Pieris.

PIERINO del Vaga, an eminent Italian painter, born of poor parents in Tuſcany, about the year 1500. He was placed apprentice with a grocer in Florence, and got ſome inſtructions from the painters to whom he was ſent with colours and pencils; but a painter named *Vaga* taking him to Rome, he was called *Del Vaga*, from living with him, his real name being *Buonacorſi*. He ſtudied anatomy, with the ſciences neceſſary for his profeſſion; and had ſomewhat of every thing that was good in his compoſitions. After Raphael's death, he joined with Julio Romano and Franciſco Penni to finiſh the works in the Vatican which were left imperfect by their common maſter; and, to confirm their friendſhip, married Penni's ſiſter. He gained the higheſt reputation by his performances in the palace of prince Doria at Genoa; but the multiplicity of his buſineſs, and the vivacity of his imagination, drained his ſpirits in the flower of his age; for he died in the year 1547. Of all Raphael's diſciples, Pierino kept the character of his maſter the longeſt, *i. e.* his exterior character and manner of deſigning; for he fell very ſhort of the fineneſs of Raphael's thinking. He had a peculiar genius for the decoration of places according to their cuſtoms. His invention in that kind of painting was full of ingenuity; grace and order are every where to be met with, and his diſpoſitions, which are ordinary in his pictures, are wonderful in his ornaments: ſome of theſe he has made little, and ſome great, and placed them both with ſo much art, that they ſet off one another by compariſon and contraſt. His figures are diſpoſed and deſigned according to Raphael's guſto; and if Raphael gave him at firſt ſome ſlight ſketches of ornaments, as he did to Giovanni d'Udine, he executed them to admiration. The tapeſtries of the ſeven planets, in ſeven pieces, which Pierino deſigned for Diana de Poitiers, and which were, when De Piles wrote, with Monſieur the firſt preſident at Paris, ſhow ſufficiently what he was, and that the above character does not exceed the truth.

PIERIS (anc. geog.), a mountain which is thought to have given name to Pieria of Macedonia; taking its name from Pierus a poet, who was the firſt that ſacrificed to the Muſes; thence called *Pierides*, if credit may be given to an ancient Scholiaſt on Juvenal.

PIERRE D'AUTOMNE is a French name, tranſlated from the Chineſe, of a medicinal ſtone, celebrated in the eaſt for curing all diſorders of the lungs. Many imagine it had its name of the autumn-ſtone from its being only to be made at that ſeaſon of the year; but it may certainly be made equally at all times. The Chineſe chemiſts refer the various parts of the body to the ſeveral ſeaſons of the year, and thus they refer the lungs to autumn. This is evident in their writings, and thus the ſtone for diſeaſes of the lungs came to be called *autumn-ſtone*. It is prepared as follows: They put 30 pints of the urine of a ſtrong and healthy young man into a large iron pot, and ſet it over a gentle fire. When it begins to boil, they add to it, drop by drop, about a large tea-cupful of rape-oil. They then leave it on the fire till the whole is evaporated to a thick ſubſtance like black mud. It is then taken out of the pot, and laid on a flat iron to dry, ſo that it may be powdered very fine. This powder is moiſtened with freſh oil, and the maſs is put into a double crucible, ſurrounded with coals, where it ſtands till it be thoroughly dried again. This is again powdered and put into a china veſſel, which being covered with ſilk cloth and a double paper, they pour on it boiling water, which makes its way, drop by drop, through theſe coverings, till ſo much is got in as is ſufficient to reduce it to a paſte. This paſte is well mixed together in the veſſel it is kept in, and this is put into a veſſel of water, and the whole ſet over the fire. The matter thus becomes again dried in *balneo mariæ*, and is then finiſhed. *Obſerv. ſur les Cout. de l'Aſie*, p. 258.

PIERRE (St.), is a large river in North America, ſcarcely inferior to the Rhine or the Danube, and navigable almoſt to its ſource. Together with many other large ſtreams, it falls into the great river Miſſiſſippi.

PIERRE (St.), or *St. Peter's*, the capital of Martinico, was built in 1665, in order to overawe the mutineers of the iſland who rebelled againſt its proprietors, the ſecond Weſt India Company, who were at the ſame time the proprietors of all the French Antilles. It is ſituated on the weſtern ſide of the iſland. The town extends along the ſhore, and a battery that commands the road is erected on the weſt ſide, which is waſhed by the river Royolan, or St. Peter. The town is divided into three wards; the middle, which is properly St. Peter's, begins at the fort, and runs weſtward to the battery of St. Nicholas. Under the walls of the ſecond ward ſhips at anchor ride more ſecurely than under the fort, on which account this ward is called the *Anchorage*. The third ward, called the *Gallery*, extends along the ſea-ſide from Fort St. Peter to the Jeſuit's River, and is the moſt populous part of the city. The houſes of St. Peter's ward are neat, commodious, and elegant, particularly thoſe of the governor of the iſland, the intendant, and the other officers. The pariſh church of St. Peter is a magnificent ſtone building, which belonged to the Jeſuits, with a noble front of the Doric order. The church of the Anchorage, which belongs to the Jacobine friars, is likewiſe of ſtone. It is a place of conſiderable trade, and is built with tolerable regularity. The houſes are moſtly conſtructed of a grey pumice-ſtone or lava, which is found on the ſtrand; and the high-ſtreet is, according to Dr. Iſert, above an Engliſh mile in length. It is ſuppoſed to contain about 2000 houſes, and 30,000 inhabitants, including negroes. St. Pierre, with the whole of the flouriſhing iſland of Martinico, was taken from the French in the month of March 1794, by the Britiſh land and ſea-forces under the command of Sir Charles Grey and Sir John Jervis, and will now, we preſume, continue annexed to the Britiſh crown: 125 veſſels loaded with the produce of the iſland, and of great value, were captured, 71 of which were in the harbour of St. Pierre.

PIETISTS, a religious ſect ſprung up among the Proteſtants of Germany, ſeeming to be a kind of mean between the Quakers of England and the Quietiſts of the Romiſh church. They deſpiſe all ſorts of eccleſiaſtical polity, all ſchool theology, and all forms and ceremonies, and give themſelves up to contemplation and the myſtic theology. Many groſs errors are charged on the Pietiſts, in a book entitled *Manipulus Obſervationum Antipietiſticarum*: but they have much of the air of polemical exaggeration, and are certainly not at all juſt. Indeed there are Pietiſts of various kinds: ſome running into groſs illuſions, and carrying their errors to the overturning of a great part of the Chriſtian doctrine, while others are only viſionaries; and others are very honeſt and good, though perhaps miſguided, people. They have been diſguſted with the coldneſs and formality of other churches, and have thence become charmed with the fervent piety of the Pietiſts, and attached to their party, without giving into the groſſeſt of their errors. See *Moſheim's Eccl. Hiſtory*, vol. iv. p. 454.

PIETISTS, otherwiſe called the *Brethren and Siſters of the Pious and Chriſtian Schools*, a ſociety formed in the year 1678 by Nicholas Barre, and obliged by their engagements to devote themſelves to the education of poor children of both ſexes.

PIETOLA, anciently called *Andes*, is a place within two Italian miles of Mantua, famous for being the birth-place of Virgil.

PIETY, is a virtue which denotes veneration for the Deity, and love and tenderneſs to our friends. This diſtinguiſhed virtue, like many others, received among the Romans divine honours, and was made one of their gods. Acilius Glabrio firſt erected a temple to this divinity, which he did upon the ſpot on which a woman had fed with her own milk her aged father, who had been impriſoned by order of the ſenate, and deprived of all aliment. The ſtory is well known, and is given at length in authors which are in the hands of every ſchool-boy. See *Cicero de Div.* 1. and *Valerius Maximus*, 5. c. 4. and our article FILIAL *Piety*.

If piety was thus practiſed and thus honoured in Heathen antiquity, it ſurely ought not to be leſs ſo among Chriſtians, to whom its nature is better defined, and to the practice of which they have motives of greater cogency. A learned and elegant writer has ſaid that the want of piety ariſes from the want of ſenſibility; and his obſervations and arguments are ſo juſt and ſo well expreſſed, that we cannot do better than tranſcribe them.

" It appears to me (ſays Dr. Knox), that the mind of man, when it is free from natural defects and acquired corruption, feels no leſs a tendency to the indulgence of devotion than to virtuous love, or to any other of the more refined and elevated affections. But debauchery and exceſs contribute greatly to deſtroy all the ſuſceptible delicacy with which nature uſually furniſhes the heart; and, in the general extinction of our better qualities, it is no wonder that ſo pure a ſentiment as that of piety ſhould be one of the firſt to expire.

“ It is certain that the underſtanding may be improved in a knowledge of the world, and in the arts of ſucceeding in it, while the heart, or whatever conſtitutes the ſeat of the moral and ſentimental feelings, is gradually receding from its proper and original perfection. Indeed experience ſeems to evince, that it is hardly poſſible to arrive at the character of a complete man of the world, without loſing many of the moſt valuable ſentiments of uncorrupted nature. A complete man of the world is an artificial being; he has diſcarded many of the native and laudable tendencies of his mind, and adopted a new ſyſtem of objects and propenſities of his own creation. Theſe are commonly groſs, coarſe, ſordid, ſelfiſh, and ſenſual. All, or either of theſe attributes, tend directly to blunt the ſenſe of every thing liberal, enlarged, diſintereſted; of every thing which participates more of an intellectual than of a ſenſual nature. When the heart is tied down to the earth by luſt and avarice, it is not extraordinary that the eye ſhould be ſeldom lifted up to heaven. To the man who ſpends his Sunday (becauſe he thinks the day fit for little elſe) in the counting-houſe, in travelling, in the tavern, or in the brothel, thoſe who go to church appear as fools, and the buſineſs they go upon as nonſenſe. He is callous to the feelings of devotion; but he is tremblingly alive to all that gratifies his ſenſes or promotes his intereſt.

“ It has been remarked of thoſe writers who have attacked Chriſtianity, and repreſented all religions merely as diverſified modes of ſuperſtition, that they were indeed, for the moſt part, men of a metaphyſical and a diſputatious turn of mind, but uſually little diſtinguiſhed for benignity and generoſity. There was, amidſt all their pretenſions to logical ſagacity, a cloudineſs of ideas, and a coldneſs of heart, which rendered them very unfit judges on a queſtion in which the heart is chiefly intereſted; in which the language of nature is more expreſſive and convincing, than all the dreary ſubtleties of the diſmal metaphyſicians. Even the reaſoning faculty, on which we ſo greatly value ourſelves, may be perverted by exceſſive refinement; and there is an abſtruſe, but vain and fooliſh philoſophy, which philoſophizes us out of the nobleſt parts of our noble nature. One of thoſe parts of us is our inſtinctive ſenſe of religion, of which not one of thoſe brutes which the philoſophers moſt admire, and to whoſe rank they wiſh to reduce us, is found in the ſlighteſt degree to participate.

“ Such philoſophers may be called, in a double ſenſe, the enemies of mankind. They not only endeavour to entice man from his duty, but to rob him of a moſt exalted and natural pleaſure. Such, ſurely, is the pleaſure of devotion. For, when the ſoul riſes above this little orb, and pours its adoration at the throne of celeſtial Majeſty, the holy fervour which it feels is itſelf a rapturous delight. Neither is this a declamatory repreſentation, but a truth felt and acknowledged by all the ſons of men; except thoſe who have been defective in ſenſibility, or who hoped to gratify the pride or the malignity of their hearts by ſingular and pernicious ſpeculation.

“ Indeed all diſputations, controverſial and metaphyſical writings on the ſubject of religion, are unfavourable to genuine piety. We do not find that the moſt renowned polemics in the church militant were at all more attentive than others to the common offices of religion, or that they were actuated by any peculiar degree of devotion. The truth is, their religion centred in their heads, whereas its natural region is the heart. The heart! confined, alas! in colleges or libraries, unacquainted with all the tender charities of huſband, father, brother, friend; ſome of them have almoſt forgotten that they poſſeſs a heart. It has long ceaſed to beat with the pulſations of love and ſympathy, and has been engroſſed by pride on conquering an adverſary in the ſyllogiſtic combat, or by impotent anger on a defeat. With ſuch habits, and ſo defective a ſyſtem of feelings, can we expect that a doctor of the Sorbonne, or the diſputing profeſſor of divinity, ſhould ever feel the pure flame of piety that glowed in the boſoms of Mrs. Rowe, Mrs. Talbot, or Mr. Nelſon?

“ It is however certain, that a devotional taſte and habit are very deſirable in themſelves, excluſive of their effects in meliorating the morals and diſpoſition, and promoting preſent and future felicity. They add dignity, pleaſure, and ſecurity to any age: but to old age they are the moſt becoming grace, the moſt ſubſtantial ſupport, and the ſweeteſt comfort. In order to preſerve them, it will be neceſſary to preſerve our ſenſibility; and nothing will contribute ſo much to this purpoſe as a life of temperance, innocence, and ſimplicity.”

PIG, in zoology. See Sus.

Guinea-Pig. See Mus.

Pig *of lead*, the eighth part of a fother, amounting to 250 pounds weight.

PIGANIOL de la force (John Aymar de), a native of Auvergne, of a noble family, applied himſelf with ardour to the ſtudy of geography, and of the hiſtory of France. With the view of improving himſelf in this ſtudy, he travelled into different provinces; and, in the courſe of his travels, made ſome important obſervations on the natural hiſtory, the commerce, the civil and eccleſiaſtical government of each province. Theſe obſervations were of great uſe to him in compiling the works he has left behind him, of which the chief are, 1. An Hiſtorical and Geographical Deſcription of France; the largeſt edition of which is that of 1753, in 15 vols. 12mo. It is the beſt work which has hitherto appeared on that ſubject, though it contains a great number of inaccuracies and even errors. 2. A Deſcription of Paris, in 10 vols. 12mo.; a work equally entertaining and inſtructive, and much more complete than the deſcription given by Germain Brice: beſides, it is written with an elegant ſimplicity. He publiſhed an abridgement of it in 2 vols. 12mo. 3. A Deſcription of the Caſtle and Park of Verſailles, Marly, &c. in 2 vols. 12mo.: it is very amuſing, and pretty well executed. Piganiol had alſo a concern with Abbé Nadal in the Journal of Trevoux. He died at Paris in February 1753, at the age of 80 years. This learned man was as much to be reſpected for his manners as for his talents. To a profound and varied knowledge he united great probity and honour, and all the politeneſs of a courtier.

PIGEON, in ornithology. See Columba.

Pigeon-*Houſe* is a houſe erected full of holes within for the keeping, breeding, &c. of pigeons, otherwiſe called a *dove cote*.

Any lord of a manor may build a pigeon-houſe on his land, but a tenant cannot do it without the lord's licence. When perſons ſhoot at or kill pigeons within a certain diſtance of the pigeon-houſe, they are liable to pay a forfeiture.

In order to erect a pigeon-houſe to advantage, it will be neceſſary, in the firſt place, to pitch upon a convenient ſituation; of which none is more proper than the middle of a ſpacious court-yard, becauſe pigeons are naturally of a timorous diſpoſition, and the leaſt noiſe they hear frightens them. With regard to the ſize of the pigeon-houſe, it muſt depend entirely upon the number of birds intended to be kept; but it is better to have it too large than too little; and as to its form, the round ſhould be preferred to the ſquare ones; becauſe rats cannot ſo eaſily come at them in the former as in the latter. It is alſo much more commodious; becauſe you may, by means of a ladder turning upon an axis, eaſily viſit all the neſts in the houſe, without the leaſt difficulty; which cannot ſo eaſily be done in a ſquare houſe. In order to hinder rats from climbing up the outſide of the pigeon-houſe, the wall ſhould be covered with tin-plates to a certain height, about a foot and a half will be ſufficient; but they ſhould project out three or four inches at the top, to prevent their clambering any higher.

The pigeon-houſe ſhould be placed at no great diſtance from water, that the pigeons may carry it to their young ones; and their carrying it in their bills will warm it, and render it more wholeſome in cold weather. The boards that cover the pigeon-houſe ſhould be well joined together, ſo that no rain may penetrate through it: and the whole building ſhould be covered with hard plaſter, and white-waſhed within and without, white being the moſt pleaſing colour to pigeons. There muſt be no window or other opening in the pigeon-houſe to the eaſtward; theſe ſhould always face the ſouth, for pigeons are very fond of the ſun, eſpecially in winter.

The neſts or covers in a pigeon-houſe ſhould conſiſt of ſquare holes made in the walls, of a ſize ſufficient to admit the cock and hen to ſtand in them. The firſt range of theſe neſts ſhould not be leſs than four feet from the ground, that, the wall underneath being ſmooth, the rats may not be able to reach them. Theſe neſts ſhould be placed in quincunx order, and not directly over one another. Nor muſt they be continued any higher than within three feet of the top of the wall: and the upper row ſhould be covered with a board projecting a conſiderable diſtance from the wall, for fear the rats ſhould find means to climb the outſide of the houſe.

M. Duhamel thinks that pigeons neither feed upon the green corn, nor have bills ſtrong enough to ſearch for its ſeeds in the earth; but only pick up the grains that are not covered, which would infallibly become the prey of other animals, or be dried up by the ſun. "From the time of the ſprouting of the corn, ſays he, pigeons live chiefly upon the ſeeds of wild uncultivated plants, and therefore leſſen conſiderably the quantity of weeds that would otherwiſe ſpring up; as will appear from a juſt eſtimate of the quantity of grain neceſſary to feed all the pigeons of a well-ſtocked dove houſe." But Mr. Worlidge and Mr. Liſle allege facts in ſupport of the contrary opinion. The latter relates, that a farmer in his neighbourhood aſſured him he had known an acre ſowed with peas, and rain coming on ſo that they could not be harrowed in, every pea was fetched away in half a day's time by pigeons: and the former ſays, "It is to be obſerved, that where the flight of pigeons falls, there they fill themſelves and away, and return again where they firſt roſe, and ſo proceed over a whole piece of ground, if they like it. Although you cannot perceive any grain above the ground, they know how to find it. I have ſeen them lie ſo much upon a piece of about two or three acres ſown with peas, that they devoured at leaſt three parts in four of the ſeed, which, I am ſure, could not be all above the ſurface of the ground. That their ſmelling is their principal director, I have obſerved. Having ſown a ſmall plat of peas in my garden, near a pigeon-houſe, and covered them ſo well that not a pea appeared above ground; in a few days, a parcel of pigeons were hard at work in diſcovering this hidden treaſure; and in a few days more I had not above two or three peas left out of about two quarts that were planted; for what they could not find before, they found when the buds appeared, notwithſtanding they were hoed in, and well covered. Their ſmelling alone directed them, as I ſuppoſed, becauſe they followed the ranges exactly. The injury they do at harveſt on the peas, vetches, &c. is ſuch that we may rank them among the greateſt enemies the poor huſbandman meets withal; and the greater, becauſe he may not erect a pigeon-houſe, whereby to have a ſhare of his own ſpoils; none but the rich being allowed this privilege, and ſo ſevere a law being alſo made to protect theſe winged thieves, that a man cannot encounter them even in defence of his own property. You have therefore no remedy againſt them, but to affright them away by noiſes or ſuch-like. You may, indeed, ſhoot at them; but you muſt not kill them; or you may, if you can, take them in a net, cut off their tails, and let them go; by which means you will impound them: for, when they are in their houſes, they cannot bolt or fly out of the tops of them, but by the ſtrength of their tails; after the thus weakening of which, they remain priſoners at home."

Carrier-PIGEON. See CARRIER-*Pigeon* and COLUMBA.

PIGMENTS, preparations uſed by painters, dyers, &c. to impart colours to bodies, or to imitate particular colours. See COLOUR *Making*, and DYEING.

PIGNEROL is a town of Italy in the province of Piedmont, in E. lon. 7. 15. N. lat. 44. 45. ſituated on the river Chizon, 10 miles ſouth-weſt of Turin, at the foot of the Alps, and the confines of Dauphiny. The town is ſmall, but populous, and extremely well fortified by the king of Sardinia ſince the treaty of Utrecht. It is defended by a citadel, on the top of the mountain, near which is the caſtle of Perouſe, which was built at the entrance of the valley of that name.

PIGNUT, or *Earthnut*. See BUNIUM.

PIGUS, in ichthyology, is the name of a ſpecies of leather-mouthed fiſh, very much reſembling the nature of the common carp; being of the ſame ſhape and ſize, and its eyes, fins, and fleſhy palate, exactly the ſame: from the gills to the tail there is a crooked dotted line; the back and ſides are blueiſh, and the belly reddiſh. It is covered with large ſcales; from the middle of each of which there riſes a fine pellucid prickle, which is very ſharp. It is an excellent fiſh for the table, being perhaps preferable to the carp; and it is in ſeaſon in the months of March and April. It is caught in lakes in ſome parts of Italy, and is mentioned by Pliny, though without a name. Artedi ſays it is a ſpecies of cyprinus, and he calls it the *cyprinus*, called *piclo* and *pigus*.

PI-HAHIROTH, (Moſes;) underſtood to be a mouth or narrow paſs between two mountains, called *Chiroth*, or *Eiroth*, and lying not far from the bottom of the weſtern coaſt of the Arabian gulf; before which mouth the children of Iſrael encamped, juſt before their entering the Red Sea, (Wells.)

PIISSKER, in ichthyology, is a fiſh of the muſtela kind, commonly called the *foſſile muſtela*, or *foſſile fiſh*. They are generally found as long as an ordinary man's hand is broad, and as thick as one's finger; but they ſometimes grow much longer: the back is of grey with a number of ſpots and tranſverſe ſtreaks, partly black and partly blue; the belly is yellow, and ſpotted with red, white, and black; the white are the larger, the others look as if they were made with the point of a needle; and there is on each of the ſides a longitudinal black and white line. There are ſome fleſhy excreſcences at the mouth, which are expanded in ſwimming; and when out of the water they are contracted. Theſe fiſhes run into caverns of the earth, in the ſides of rivers, in marſhy places, and penetrate a great way, and are often dug up at a diſtance from waters. Often, when the waters of brooks and rivers ſwell beyond their banks, and again cover them, they make their way out of the earth into the water; and when it deſerts them, they are often left in vaſt numbers upon the ground, and become a prey to ſwine. It is thought to be much of the ſame kind with the fiſgum fiſh; and it is indeed poſſible that the pæcilia of Schonefeldt is the ſame.

PIKE, in ichthyology. See ESOX. The pike never ſwims in ſhoals as moſt other fiſh do, but always lies alone: and is ſo bold and ravenous, that he will ſeize upon almoſt any thing leſs than himſelf. Of the ravenous nature of this fiſh we ſhall give the following inſtances. At Rycott in Oxfordſhire, in the year 1749, in a moat ſurrounding the earl of Abingdon's ſeat, there was a jack or pike of ſuch a monſtrous ſize, that it had deſtroyed young ſwans feathers and all. An old cobb ſwan having hatched five young, one after another was loſt till four were gone. At length an under gardener ſaw the fiſh ſeize the fifth. The old one fought him with her beak, and, with the aſſiſtance of the gardener, releaſed it, although he had got it under water. In the year 1765 a large pike was caught in the river Ouze, which weighed upwards of 28 pounds, and was ſold for a guinea. On gutting the fiſh, a watch with a black ribbon and two ſteel ſeals was found in its ſtomach, which, by the maker's name, &c. was found to belong to a perſon who had been drowned about ſix weeks before. This fiſh breeds but once in a year, which is in March. It is found in almoſt all freſh waters; but is very different in goodneſs, according to the nature of the places where it lives. The fineſt pike are thoſe which feed in clear rivers; thoſe in ponds and meres are inferior to theſe, and the worſt of all are thoſe of the fen ditches. They are very plentiful in theſe laſt places, where the water is foul and coloured; and their food, ſuch as frogs and the like, very plentiful, but very coarſe; ſo that they grow large, but are yellowiſh and high bellied, and differ greatly from thoſe which live in the clearer waters.

The fiſhermen have two principal ways of catching the pike; by the *ledger*, and by the *walking-bait*. The ledger-bait is fixed in one certain place, and may continue while the angler is abſent. This muſt be a live-bait, a fiſh or frog: and among fiſh, the dace, roach, and gudgeon, are the beſt; of frogs, the only caution is to chooſe the largeſt and yelloweſt that can be met with. If the bait be a fiſh, the hook is to be ſtuck through the upper lip. and the line muſt be 14 yards at leaſt in length: the other end of this is to be tied to a bough of a tree, or to a ſtick driven into the ground near the pike's haunt, and all the line wound round a forked ſtick, except about half a yard. The bait will by this means keep playing ſo much under water, and the pike will ſoon lay hold of it. If the bait be a frog, then the arming wire of the hook ſhould be put in at the mouth, and out at the ſide; and with a needle and ſome ſtrong ſilk, the hinder leg of one ſide is to be faſtened by one ſtitch to the wire-arming of the hook. The pike will ſoon ſeize this, and muſt have line enough to give him leave to get to his haunt and poach the bait.

The *trolling* for pike is a pleaſant method alſo of taking them: in this a dead bait ſerves, and none is ſo proper as a gudgeon. This is to be pulled about in the water till the pike ſeizes it; and then it is to have line enough, and time to ſwallow it: the hook is ſmall for this ſport, and has a ſmooth piece of lead fixed at its end to ſink the bait; and the line is very long, and runs through a ring at the end of the rod, which muſt not be too ſlender at top.

The art of *feeding* pike, ſo as to make them very fat, is the giving them eels; and without this it is not to be done under a very long time; otherwiſe perch, while ſmall, and their prickly fins tender, are the beſt food for them. Bream put into a pike-pond are a very proper food: they will breed freely, and their young ones make excellent food for the pike, who will take care that they ſhall not increaſe over much. The numerous ſhoals of roaches and ruds, which are continually changing place, and often in floods get into the pike's quarters, are food for them for a long time.

Pike, when uſed to be fed by hand, will come up to the very ſhore, and take the food that is given them out of the fingers of the feeder. It is wonderful to ſee with what courage they will do this, after a while practiſing; and it is a very diverting ſight, when there are ſeveral of them nearly of the ſame ſize, to ſee what ſtriving and fighting there will be for the beſt bits when they are thrown in. The moſt convenient place is near the mouth of the pond, and where there is about half a yard depth of water; for, by that means, the offal of the feedings will all lie in one place, and the deep water will ſerve for a place to retire into and reſt in, and will be always clean and in order.

Carp will be fed in the ſame manner as pike; and though by nature a fiſh as remarkably ſhy and timorous as the pike is bold and fearleſs, yet by cuſtom they will come to take their food out of the perſon's hand; and will, like the pike, quarrel among one another for the niceſt bits.

Pike, in war, an offenſive weapon, conſiſting of a wooden ſhaft, 12 or 14 feet long, with a flat ſteel head, pointed, called the *ſpear*. This weapon was long in uſe among the infantry; but now the bayonet, which is fixed on the muzzle of the firelock, is ſubſtituted in its ſtead. It is ſtill uſed by ſome of the officers of infantry, under the name of *ſponton*. The Macedonian phalanx was a battalion of pikemen. See Phalanx.

PILA marina, or the *ſea-ball*, in natural hiſtory, is the name of a ſubſtance very common on the ſhores of the Mediterranean, and elſewhere. It is generally found in the form of a ball about the ſize of the balls of horſe-dung, and compoſed of a variety of fibrillæ irregularly complicated. Various conjectures have been given of its origin by different authors. John Bauhin tells us, that it conſiſts of ſmall hairy fibres and ſtraws, ſuch as are found about the ſea-plant called *alga vitriariorum*; but he does not aſcertain what plant it owes its origin to. Imperatus imagined it conſiſted of the exuviæ both of vegetable and animal bodies. Mercatus is doubtful whether it be a congeries of the fibrillæ of plants, wound up into a ball by the motion of the ſea-water, or whether it be not the workmanſhip of ſome ſort of beetle living about the ſea-ſhore, and analogous to our common dung-beetle's ball, which it elaborates from dung for the reception of its progeny. Schreckius ſays it is compoſed of the filaments of ſome plant of the reed kind: and Welchius ſuppoſes it is compoſed of the pappous part of the flowers of the reed. Maurice Hoffman thinks it the excrement of the hippopotamus; and others think it that of the phoca or ſea-calf. Klein, who had thoroughly and minutely examined the bodies themſelves, and alſo what authors had conjectured concerning them, thinks that they are wholly owing to, and entirely compoſed of, the capillaments which the leaves, growing to the woody ſtalk of the *alga vitriariorum*, have when they wither and decay. Theſe leaves, in their natural ſtate, are as thick as a wheat ſtraw, and are placed ſo thick about the tops and extremities of the ſtalks, that they enfold, embrace, and lie over one another; and from the middle of theſe cluſters of leaves, and indeed from the woody ſubſtance of the plant itſelf, there ariſe ſeveral other very long, flat, ſmooth, and brittle leaves. Theſe are uſually four from each tuft of the other leaves; and they have ever a common vagina, which is membranaceous and very thin. This is the ſtyle of the plant; and the *pila marina* appears to be a cluſter of the fibres of the leaves of this plant, which cover the whole ſtalk, divided into their conſtituent fibres; and by the motion of the waves firſt broken and worn into ſhort ſhreds, and afterwards wound up together into a roundiſh or longiſh ball.

Pila, was a ball made in a different manner according to the different games in which it was to be uſed. Playing at ball was very common amongſt the Romans of the firſt diſtinction, and was looked upon as a manly exerciſe, which contributed both to amuſement and health. The pila was of four ſorts: 1ſt, *Follis* or *balloon*; 2d, *Pila Trigonalis*; 3d, *Pila Paganica*; 4th, *Harpaſtum*. All theſe come under the general name of pila. For the manner of playing with each of them, ſee the articles Follis, Trigonalis.

PILASTER, in architecture. See Architecture.

PILATE, or Pontius Pilate, was governor of Judea when our Lord was crucified. Of his family or country we know but little, though it is believed that he was of Rome, or at leaſt of Italy. He was ſent to govern Judea in the room of Gratus, in the year 26 or 27 of the vulgar era, and governed this province for ten years, from the 12th or 13th year of Tiberius to the 22d or 23d. He is repreſented both by Philo and Joſephus as a man of an impetuous and obſtinate temper, and as a judge who uſed to ſell juſtice, and to pronounce any ſentence that was deſired, provided he was paid for it. The ſame authors make mention of his rapines, his injuries, his murders, the torments that he inflicted upon the innocent, and the perſons he put to death without any form of proceſs. Philo in particular deſcribes him as a man that exerciſed an exceſſive cruelty during the whole time of his government, who diſturbed the repoſe of Judea, and gave occaſion to the troubles and revolt that followed after. St. Luke (xiii. 1, 2, &c.) acquaints us, that Pilate had mingled the blood of the Galileans with their ſacrifices; and that the matter having been related to Jeſus Chriſt, he ſaid, "Think you that theſe Galileans were greater ſinners than other Galileans becauſe they ſuffered this calamity? I tell you nay; and if you do not repent, you ſhall all periſh in like manner." It is unknown upon what occaſion Pilate cauſed theſe Galileans to be ſlain in the temple while they were ſacrificing; for this is the meaning of that expreſſion of mingling their blood with their ſacrifices. Some think they were diſciples of Judas the Gaulonite, who taught that the Jews ought not to pay tribute to foreign princes; and that Pilate had put ſome of them to death even in the temple; but there is no proof of this fact. Others think that theſe Galileans were Samaritans, whom Pilate cut to pieces in the village of Tirataba, as they were preparing to go up to mount Gerizim, where a certain impoſtor had promiſed to diſcover treaſures to them: but this event did not happen before the year 35 of the common era, and conſequently two years after the death of Jeſus Chriſt. At the time of our Saviour's Paſſion, Pilate made ſome endeavours to deliver him out of the hands of the Jews. He knew that they had delivered him up, and purſued his life with ſo much violence, only out of malice and envy (Matt. xxvii. 18.) His wife alſo, who had been diſturbed the night before with frightful dreams, ſent to tell him ſhe deſired him not to meddle in the affair of that juſt perſon (ib. 19.) He attempted to appeaſe the wrath of the Jews, and to give them ſome ſatisfaction, by whipping Jeſus Chriſt (John xix. 1. Matt. xxvii. 26.) He tried to take him out of their hands, by propoſing to deliver him or Barabbas, on the day of the feſtival of the paſſover. Laſtly, he had a mind to diſcharge himſelf from pronouncing judgment againſt him, by ſending him to Herod king of Galilee (Luke xxiii. 7, 8.) When he ſaw all this would not ſatisfy the Jews, and that they even threatened him in ſome manner, ſaying, he could be no friend to the emperor if he let him go (John xix. 12. 15.), he cauſed water to be brought, waſhed his hands before all the people, and publicly declared himſelf innocent of the blood of that juſt perſon (Matt. xxvii. 23, 24.); yet at the ſame time he delivered him up to his ſoldiers, that they might crucify him. This was enough to juſtify Jeſus Chriſt, as Calmet obſerves, and to ſhow that he held him as innocent; but it was not enough to vindicate the conſcience and integrity of a judge, whoſe duty it was as well to aſſert the cauſe of oppreſſed innocence as to puniſh the guilty and criminal. He ordered to be put over our Saviour's croſs, as it were, an abſtract of his ſentence, and the motive of his condemnation (John xix. 19.) *Jeſus of Nazareth, king of the Jews*, which was written in Latin, Greek, and Hebrew. Some of the Jews found fault with it, and remonſtrated to Pilate that he ought to have written *Jeſus of Nazareth, who pretended to be king of the Jews.* But Pilate could not be prevailed with to alter it, and gave them this peremptory anſwer, *That what he had written he had written.*

Towards evening, he was applied to for leave to take down the bodies from the croſs, that they might not continue there the following day, which was the paſſover and the ſabbath-day (John xix. 31.) This he allowed, and granted the body of Jeſus to Joſeph of Arimathea, that he might pay his laſt duties to it, (ib. 33.) Laſtly, when the prieſts, who had ſolicited the death of our Saviour, came to deſire him to ſet a watch about the ſepulchre, for fear his diſciples ſhould ſteal him away by night, he anſwered them, that they had a guard, and might place them there themſelves (Matt. xxvii. 65.) This is the ſubſtance of what the goſpel tells us concerning Pilate.

Juſtin Martyr, Tertullian, Euſebius, and after them ſeveral others both ancient and modern, aſſure us, that it was formerly the cuſtom for Roman magiſtrates to prepare copies of all verbal proceſſes and judicial acts which they paſſed in their ſeveral provinces, and to ſend them to the emperor. And Pilate, in compliance with this cuſtom, having ſent word to Tiberius of what had paſſed relating to Jeſus Chriſt, the emperor wrote an account of it to the ſenate, in a manner that gave reaſon to judge that he thought favourably of the religion of Jeſus Chriſt, and ſhowed that he ſhould be willing they would decree divine honours to him. But the ſenate was not of the ſame opinion, and ſo the matter was dropped. It appears by what Juſtin ſays of theſe acts, that the miracles of Jeſus Chriſt were mentioned there, and even that the ſoldiers had divided his garments among them. Euſebius inſinuates that they ſpoke of his reſurrection and aſcenſion. Tertullian and Juſtin refer to theſe acts with ſo much confidence as would make one believe they had them in their hands. However, neither Euſebius nor St. Jerome, who were both inquiſitive, underſtanding perſons, nor any other author that wrote afterwards, ſeem to have ſeen them, at leaſt not the true and original acts; for, as to what we have now in great number, they are not authentic, being neither ancient nor uniform. There are alſo ſome pretended letters of Pilate to Tiberius, giving a hiſtory of our Saviour; but they are univerſally allowed to be ſpurious.

Pilate being a man who, by his exceſſive cruelties and rapine, had diſturbed the peace of Judea during the whole time of his government, was at length depoſed by Vitellius the proconſul of Syria, in the 36th year of Jeſus Chriſt, and ſent to Rome to give an account of his conduct to the emperor. But though Tiberius died before Pilate arrived at Rome, yet his ſucceſſor Caligula baniſhed him to Vienne in Gaul, where he was reduced to ſuch extremity that he killed himſelf with his own hands. The evangeliſts call him governor, though in reality he was no more than procurator of Judea—not only becauſe governor was a name of general uſe, but becauſe Pilate in effect acted as one, by taking upon him to judge in criminal matters; as his predeceſſors had done, and other procurators in the ſmall provinces of the empire where there was no proconſul, conſtantly did. See *Calmet's Dictionary, Echard's Eccleſiaſtical Hiſtory*, and *Beauſobre's Annot.*

With regard to Pilate's wife, the general tradition is, that ſhe was named Claudia Procula or Proſcula; and in relation to her dream, ſome are of opinion, that as ſhe had intelligence of our Lord's apprehenſion, and knew by his character that he was a righteous perſon, her imagination, being ſtruck with theſe ideas, did naturally produce the dream we read of; but others think that this dream was ſent providentially upon her, for the clearer manifeſtation of our Lord's innocence.

PILATRE DU ROSIER (FRANCIS), was born at Metz the 30th of March 1756. He was firſt apprentice to an apothecary there, and afterwards went to Paris in queſt of further improvement. He applied himſelf to the ſtudy of natural hiſtory and of natural philoſophy, and had already acquired ſome reputation, when the diſcovery of M. de Montgolfier had juſt aſtoniſhed the learned world. On the 25th of October 1783, he attempted an aerial voyage with the marquis of Arlande. He performed ſeveral other excurſions in this way with brilliant ſucceſs, in the preſence of the royal family of France, of the king of Sweden, and of prince Henry of Pruſſia. He then reſolved to paſs into England by means of his aerial vehicle, and for that purpoſe he repaired to Boulogne, whence he roſe about ſeven o'clock in the morning of the 15th June 1785; but in half an hour after he ſet out, the balloon took fire, and the aeronaut, with his companion M. Romaine, were cruſhed to death by the fall of that machine, which was more ingenious perhaps than uſeful. See Aerostation. Pilatre's ſocial virtues and courage, which were very diſtinguiſhed, heightened the regret of his friends for his loſs. His merit as a chemiſt, and his experiments as an aeronaut, procured him ſome pecuniary reward, and ſome public appointments. He had a penſion from the king, was intendant of Monſieur's cabinets of natural philoſophy, chemiſtry, and natural hiſtory, profeſſor of natural philoſophy, a member of ſeveral academies, and principal director of Monſieur's muſeum.

PILCHARD, in ichthyology, a fiſh which has a general likeneſs to the herring, but differs in ſome particulars very eſſential. The body of the pilchard is leſs compreſſed than that of the herring, being thicker and rounder: the noſe is ſhorter in proportion, and turns up; the under jaw is ſhorter. The back is more elevated; the belly leſs ſharp. The dorſal fin of the pilchard is placed exactly in the centre of gravity, ſo that, when taken up by it, the body preſerves an equilibrium, whereas that of the herring dips at the head. The ſcales of the pilchard adhere very cloſely, whereas thoſe of the herring very eaſily drop off. The pilchard is in general leſs than the herring; but it is fatter, or more full of oil.

The pilchard appears in vaſt ſhoals off the Corniſh coaſts about the middle of July, diſappearing the beginning of winter, yet ſometimes a few return again after Chriſtmas. Their winter retreat is the ſame with that of the herring, and their motives for migrating the ſame. See Clupea. They affect, during ſummer, a warmer latitude; for they are not found in any quantities on any of our coaſts except thoſe of Cornwall, that is to ſay, from Fowey harbour to the Scilly iſles, between which places the ſhoals keep ſhifting for ſome weeks. The approach of the pilchard is known by much the ſame ſigns as thoſe that indicate the arrival of the herring. Perſons, called in Cornwall *huers*, are placed on the cliffs, to point to the boats ſtationed off the land the courſe of the fiſh. By the 1ſt of James I. c. 23, fiſhermen are empowered to go on the grounds of others to hue, without being liable to actions of treſpaſs, which before occaſioned frequent law-ſuits.

The emoluments that accrue to the inhabitants of that country are great, and are beſt expreſſed in the words of Dr. W. Borlaſe, in his *account of the Pilchard Fiſhery*. "It employs a great number of men on the ſea, training them thereby to naval affairs; employs men, women, and children, at land, in ſalting, preſſing, waſhing, and cleaning, in making boats, nets, ropes, caſks, and all the trades depending on their conſtruction and ſale. The poor is fed with the offals of the captures; the land with the refuſe of the fiſh and ſalt; the merchant finds the gains of commiſſion and honeſt commerce; the fiſherman, the gains of the fiſh. Ships are often freighted hither with ſalt, and into foreign countries with the fiſh, carrying off at the ſame time part of our tin. The uſual number of hogſheads of fiſh, exported each year, for ten years, from 1747 to 1756 incluſive, from the four ports of Fowey, Falmouth, Penzance, and St. Ives, in all amounts to 29,794; ſince it appears that Fowey has exported yearly 1732 hogſheads; Falmouth, 14,631 hogſheads and two-thirds; Penzance and Mounts-Bay, 12,149 hogſheads and one third; St. Ives, 1282 hogſheads. Every hogſhead for ten years laſt paſt, together with the bounty allowed for each when exported, and the oil made out of each, has amounted, one year with another, at an average, to the price of 1l. 13s. 3d.; ſo that the caſh paid for pilchards exported has, at a medium, annually amounted to the ſum of 49,532l. 10s." The numbers that are taken at one ſhooting out of the nets is amazingly great. Mr. Pennant ſays, that Dr. Borlaſe aſſured him, that on the 5th of October 1767, there were at one time incloſed in St. Ives's Bay 7000 hogſheads, each hogſhead containing 35,000 fiſh, in all 245,000,000.

PILE, in heraldry, an ordinary in form of a wedge, contracting from the chief, and terminating in a point towards the bottom of the ſhield.

Pile, among the Greeks and Romans, was a pyramid built of wood, whereon were laid the bodies of the deceaſed to be burnt. It was partly in the form of an altar, and differed in height according to the quality of the perſon to be conſumed. Probably it might originally be conſidered as an altar, on which the dead were conſumed as a burnt-offering to the infernal deities. The trees made uſe of in the erection of a funeral pile were ſuch as abounded in pitch or roſin, as being moſt combuſtible: if they uſed any other wood, it was ſplit, that it might the more eaſily catch fire. Round the pile were placed cypreſs boughs to hinder the noiſome ſmell. See Funeral.

Pile, in building, is uſed for a large ſtake rammed into the ground in the bottom of rivers, or in marſhy land, for a foundation to build upon. Pile is alſo uſed among architects for a *maſs* of building.

Pile, in coinage, denotes a kind of puncheon, which, in the old way of coining with the hammer, contained the arms or other figure and inſcription to be ſtruck on the coin. See Coinage. Accordingly we ſtill call the arms-ſide of a piece of money the *pile*, and the head the *croſs*; becauſe, in ancient coin, a croſs uſually took the place of the head in ours.

Pile-*Engine*, a very curious machine invented by Mr. Vauloué for driving the piles of Weſtminſter-bridge. It is repreſented in Plate 2, where A is a great upright ſhaft or axle, on which are the great wheel B, and the drum C, turned by horſes joined to the bars S, S. The wheel B turns the trundle X, on the top of whoſe axis is the fly O, which ſerves to regulate the motion, and alſo to act againſt the horſes, and to keep them from falling when the heavy ram Q is diſcharged to drive the pile P down into the mud in the bottom of the river. The drum C is looſe upon the ſhaft A, but is locked to the wheel B by the bolt Y. On this drum the great rope HH is wound; one end of the rope being fixed to the drum, and the other to the follower G, to which it is conveyed over the pulleys I and K. In the follower G is contained the tongs F, that takes hold of the ram Q by the ſtaple R, for drawing it up. D is a ſpiral or fuſy fixed to the drum, on which is wound the ſmall rope T that goes over the pulley U, under the pulley V, and is faſtened to the top of the frame at 7. To the pulley-block V is hung the counterpoiſe W, which hinders the follower T from accelerating as it goes down to take hold of the ram; for, as the follower tends to acquire velocity in its deſcent, the line T winds downwards upon the fuſy, on a larger and larger radius, by which means the counterpoiſe W acts ſtronger and ſtronger againſt it; and ſo allows it to come down with only a moderate and uniform velocity. The bolt Y locks the drum to the great wheel, being puſhed upward by the ſmall lever 2, which goes through a mortiſe in the ſhaft A, turns upon a pin in the bar 3, fixed to the great wheel B, and has a weight 4, which always tends to puſh up the bolt Y through the wheel into the drum. L is the great lever turning on the axis *m*, and reſting upon the forcing bar 5, 5, which goes through a hollow in the ſhaft A, and bears up the little lever 2.

By the horſes going round, the great rope H is wound about the drum C, and the ram Q is drawn up by the tongs F in the follower G, until the tongs come between the inclined planes E; which, by ſhutting the tongs at the top, opens it at the foot, and diſcharges the ram, which falls down between the guides *b b* upon the pile P, and drives it by a few ſtrokes as far into the mud as it will go; after which, the top part is ſawed off cloſe to the mud by an engine for that purpoſe. Immediately after the ram is diſcharged, the piece 6 upon the follower G takes hold of the ropes *a a*, which raiſe the end of the lever L, and cauſe its end N to deſcend and preſs down the forcing bar 5 upon the little lever 2, which, by pulling down the bolt Y, unlocks the drum C from the great wheel B; and then the follower, being at liberty, comes down by its own weight to the ram; and the lower ends of the tongs ſlip over the ſtaple R, and the weight of their heads cauſes them to fall outward and ſhut upon it. Then the weight 4 puſhes up the bolt Y into the drum, which locks it to the great wheel, and ſo the ram is drawn up as before.

As the follower comes down, it cauſes the drum to turn backward, and unwinds the rope from it, whilſt the horſes, great wheel, trundle, and fly, go on with an uninterrupted motion; and as the drum is turning backward, the counterpoiſe W is drawn up, and its rope T wound upon the ſpiral fuſy D.

There are ſeveral holes in the under ſide of the drum, and the bolt Y always takes the firſt one that it finds, when the drum ſtops by the falling of the follower upon the ram; until which ſtoppage the bolt has not time to ſlip into any of the holes.

This engine was placed upon a barge on the water, and ſo was eaſily conveyed to any place deſired. The ram was a ton weight; and the guides *b b*, by which it was let fall, were 30 feet high.

A new machine for driving piles has been invented by Mr. S. Bunce of Kirby-ſtreet, London. It will drive a greater number of piles in a given time than any other; and can be conſtructed more ſimply to work by horſes than Mr. Vauloue's engine above deſcribed. See Plate 2.

Fig. 1 and 2 repreſent a ſide and front ſection of the machine. The chief parts are A, fig. 1, which are two endleſs ropes, or chains connected by croſs pieces of iron B (ſee fig. 2.) correſponding with two croſs grooves cut diametrically oppoſite in the wheel C (fig. 1.), into which they are received; and by which means the rope or chain A is carried round. FHK is a ſide-view of a ſtrong wooden frame moveable on the axis H. D is a wheel, over which the chain paſſes, and turns within at the top of the frame. It moves occaſionally from F to G upon the centre H, and is kept in the poſition F by the weight I fixed to the end K. Fig. 3. L is the iron ram, which is connected with the croſs pieces by the hook M. N is a cylindrical piece of wood ſuſpended at the hook at O, which, by ſliding freely upon the bar that connects the hook to the ram, always brings the hook upright upon the chain when at the bottom of the machine, in the poſition of GP. See fig. 1.

When the man at S turns the uſual crane-work, the ram being connected with the chain, and paſſing between the guides, is drawn up in a perpendicular direction; and when it is near the top of the machine, the projecting bar Q of the hook ſtrikes againſt a croſs piece of wood at R (fig. 1.); and conſequently diſcharges the ram, whilſt the weight I of the moveable frame inſtantly draws the upper wheel into the poſition ſhown at F, and keeps the chain free of the ram in its deſcent. The hook, while deſcending, is prevented from catching the chain by the wooden piece N. For, that piece being ſpecifically lighter than the iron weight below, and moving with a leſs degree of velocity, cannot come in contact with the iron till it is at the bottom, and the ram ſtops. It then falls, and again connects the hook with the chain, which draws up the ram as before.

Mr. Bunce made a model of this machine, which performed perfectly well; and he obſerves, that, as the motion of the wheel C is uninterrupted, there appears to be the leaſt poſſible time loſt in the operation.

PILE-*Worms*, are a kind of worms found in the piles of the ſea-dikes in Holland. They are of very various ſizes; for ſome of the young ones are not above an inch or two in length, while others have been found thirteen or fourteen inches long. The heads of theſe creatures are covered with two hard ſhells or hemicrania; which together form a figure reſembling an auger; and with which they bore the wood. The beſt remedy againſt them is, to perforate the pile with many ſmall holes about an inch aſunder; then it muſt be done over with a varniſh in the hotteſt ſun; and, while the varniſh is hot, brick-duſt muſt be ſtrewed over it: and this being ſeveral times repeated, the pile will be covered with a ſtrong cruſt abſolutely impenetrable to all inſects.

PILES, in medicine, the ſame with hæmorrhoids. See MEDICINE.

PILEUS, in Roman antiquity, was the ordinary cap or hat worn at public ſhows and ſacrifices, and by the freedmen. It was one of the common rewards aſſigned to ſuch gladiators as were ſlaves, in token of their obtaining freedom.

PILEWORT (*Ranunculus ficaria*, Lin.), the root. This is a very ſmall plant, found in moiſt meadows and by hedge ſides. The roots conſiſt of ſlender fibres with ſome little tubercles among them, which are ſuppoſed to reſemble the hæmorrhoids. From thence it has been concluded, that this root muſt needs be of wonderful efficacy for the cure of that diſtemper: to the taſte, it is little other than mucilaginous; and although ſtill retained in ſeveral of the foreign pharmacopœias, it is hardly in uſe in this country.

PILGRIM, one who travels through foreign countries to viſit holy places, and to pay his devotion to the relicks of dead ſaints. See PILGRIMAGE. The word is formed from the Flemiſh *pelgrim*, or Italian *pelegrino*, which ſignifies the ſame; and thoſe originally from the Latin *peregrinus*, a "ſtranger or traveller."

PILGRIMAGE, a kind of religious diſcipline, which conſiſts in taking a journey to ſome holy place in order to adore the relicks of ſome deceaſed ſaint. Pilgrimages began to be made about the middle ages of the church; but they were moſt in vogue after the end of the 11th century, when every one was for viſiting places of devotion, not excepting kings and princes themſelves; and even biſhops made no difficulty of being abſent from their churches on the ſame account. The places moſt viſited were Jeruſalem, Rome, Compoſtella [*], and Tours; but the greateſt numbers now reſort to Loretto, in order to viſit the chamber of the bleſſed Virgin, in which ſhe was born, and brought up her ſon Jeſus till he was 12 years of age. For the pilgrimage of the followers of Mahomet, ſee MAHOMETANISM.

In every country where popery was eſtabliſhed, pilgrimages

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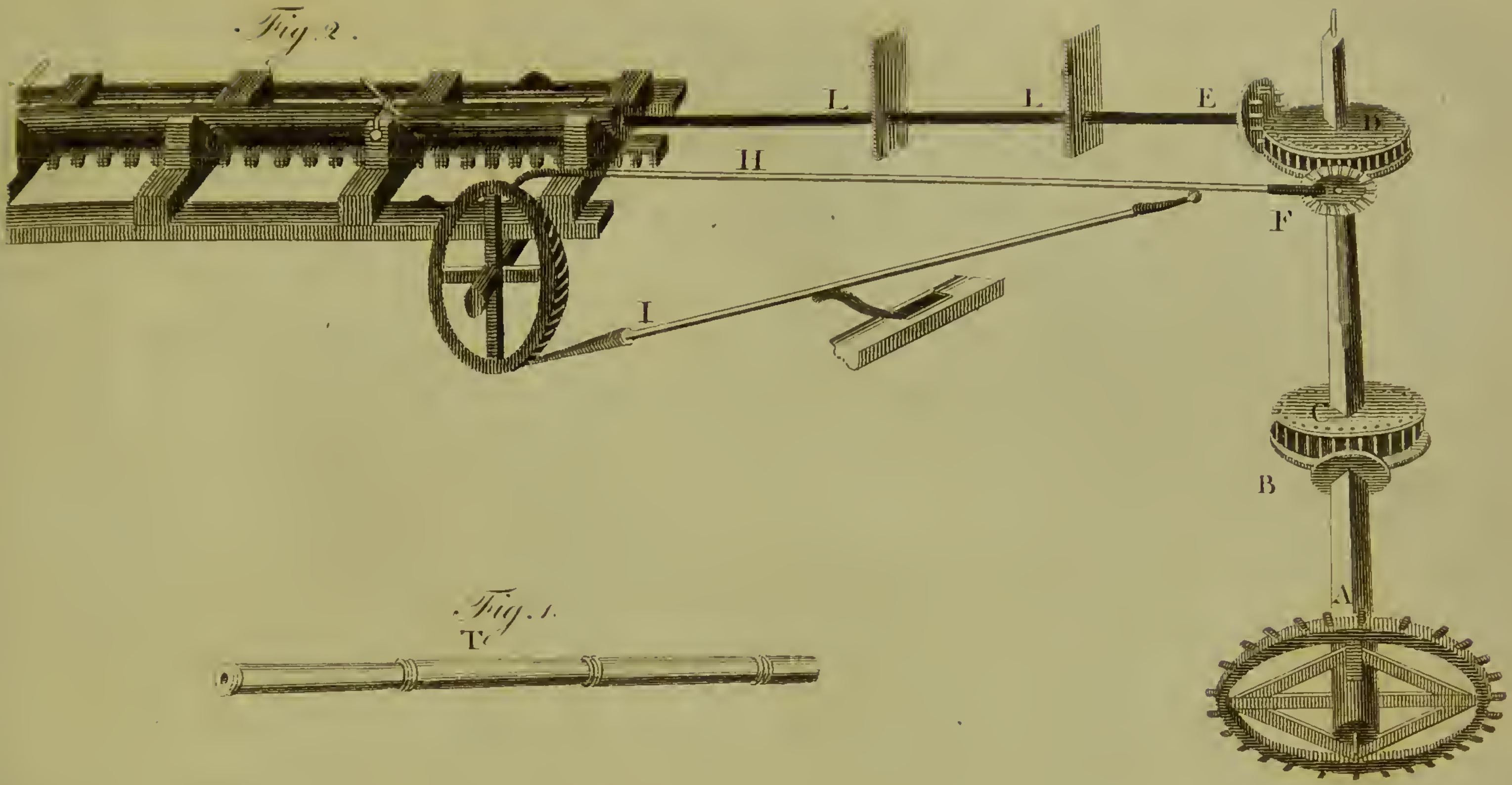
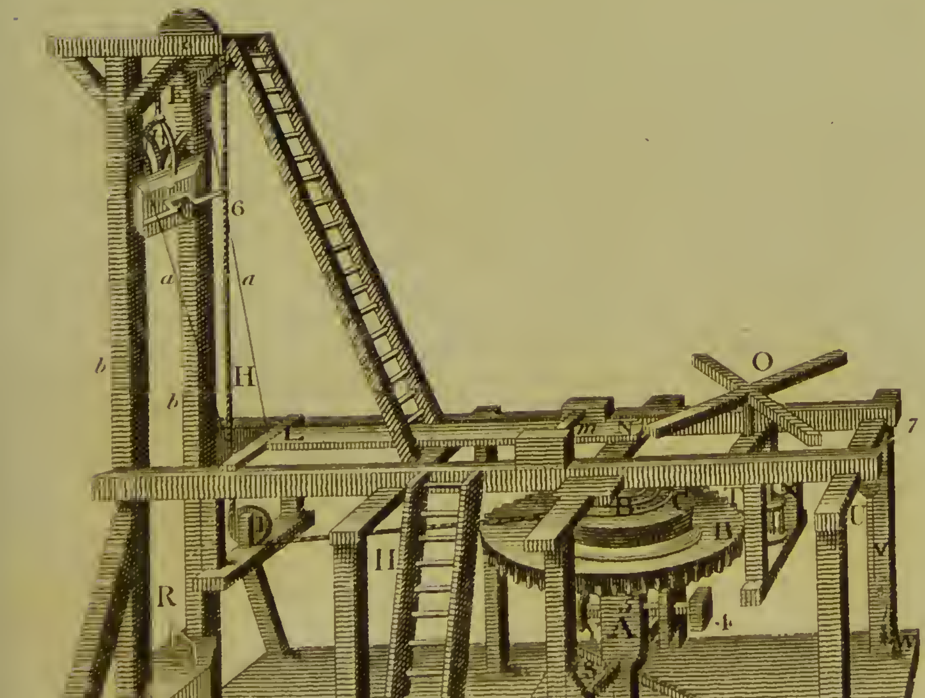
[*] It deſerves to be remarked here, that in the year 1428, under the reign of Henry VI. abundance of licences were granted from the crown of England to captains of Engliſh ſhips, for carrying numbers of devout perſons to the ſhrine of St. James of Compoſtella in Spain; provided, however, that thoſe pilgrims ſhould firſt take an oath not to take any thing prejudicial to England, nor to reveal any of its ſecrets, nor to carry out with them any more gold or ſilver than what would be ſufficient for their reaſonable expences. In this year there went out thither from England, on the ſaid pilgrimage, the following number of perſons: From London 280, Briſtol 200, Weymouth 122, Dartmouth 90, Yarmouth 60, Jerſey 60, Plymouth 40, Exeter 30, Poole 24, Ipſwich 20: in all 926 perſons.

Machine for boring wooden PIPES.

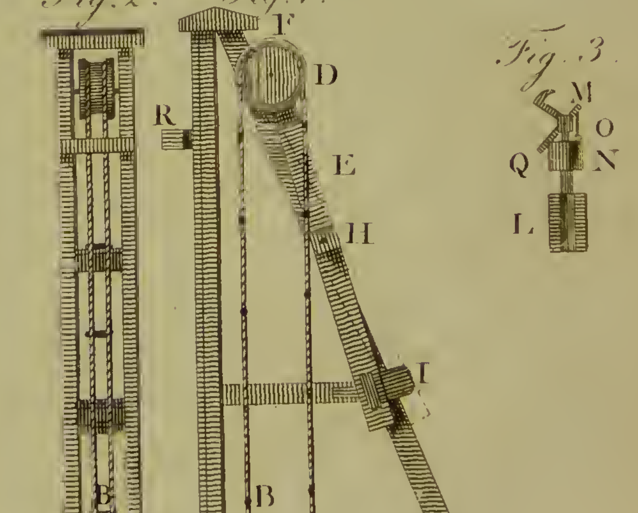


Vaulone's PILE Engine.



Bunce's PILE Engine

Fig. 2. Fig. 1.



were common ; and in thoſe countries which are ſtill popiſh, they continue. In England, the ſhrine of St. Thomas à Becket was the chief reſort of the pious ; and in Scotland, St. Andrew's ; where, as tradition informs us, was depoſited a leg of the holy apoſtle. In Ireland they ſtill continue ; for, from the beginning of May till the middle of Auguſt every year, crowds of popiſh penitents from all parts of that country reſort to an iſland near the centre of *Lough-ſin*, or *White Lake*, in the county of Donnegal, to the amount of 3000 or 4000. Theſe are moſtly of the poorer ſort, and many of them are proxies for thoſe who are richer ; ſome of which, however, together with ſome of the prieſts and biſhops on occaſion, make their appearance there. When the pilgrim comes within ſight of the holy lake, he muſt uncover his hands and feet, and thus walk to the water ſide, and is taken to the iſland for ſixpence. Here there are two chapels and 15 other houſes ; to which are added confeſſionals, ſo contrived, that the prieſt cannot ſee the perſon confeſſing. The penance varies according to the circumſtances of the penitent ; during the continuance of which (which is ſometimes three, ſix, or nine days) he ſubſiſts on oatmeal, ſometimes made into bread. He traverſes ſharp ſtones on his bare knees or feet, and goes through a variety of other forms, paying ſixpence at every different confeſſion. When all is over, the prieſt bores a gimblet hole through the pilgrim's ſtaff near the top, in which he faſtens a croſs peg ; gives him as many holy pebbles out of the lake as he cares to carry away, for amulets to be preſented to his friends, and ſo diſmiſſes him, an object of veneration to all other papiſts not thus initiated ; who no ſooner ſee the pilgrim's croſs in his hands, than they kneel down to get his bleſſing.

There are, however, other parts of Ireland ſacred to extraordinary worſhip and pilgrimage ; and the number of holy wells, and miraculous cures, &c. produced by them, is very great. That ſuch things ſhould exiſt in this enlightened age, and in a Proteſtant country, is indeed ſtrange ; but our wonder ceaſes, when we reflect that it is among the loweſt, and perhaps the worſt of the people. They who carry external religion to an extreme, and place that confidence in ceremony which belongs only to the ſpirit of it, are ſeldom diſtinguiſhed either for their wiſdom or their virtue. We do not deny, however, that they who carry matters to the other extreme, may be equally deſtitute of real knowledge and genuine morality.

Dr. Johnſon, in his *Raſſelas*, gives us ſome obſervations on pilgrimage, which are ſo much to the purpoſe, that we think we cannot do better than lay them before our readers. " Pilgrimage (ſaid Imlac, into whoſe mouth the obſervations are put), like many other acts of piety, may be reaſonable or ſuperſtitious according to the principles upon which it is performed. Long journeys in ſearch of truth are not commanded. Truth, ſuch as is neceſſary to the regulation of life, is always found where it is honeſtly ſought : change of place is no natural cauſe of the increaſe of piety, for it inevitably produces diſſipation of mind. Yet ſince men go every day to view the fields where great actions have been performed, and return with ſtronger impreſſions of the event, curioſity of the ſame kind may naturally diſpoſe us to view that country whence our religion had its beginning : and I believe no man ſurveys thoſe awful ſcenes without ſome confirmation of holy reſolutions. That the Supreme Being may be more eaſily propitiated in one place than in another, is the dream of idle ſuperſtition ; but that ſome places may operate upon our own minds in an uncommon manner, is an opinion which hourly experience will juſtify. He who ſuppoſes that his vices may be more ſucceſsfully combated in Paleſtine, will, perhaps, find himſelf miſtaken ; yet he may go thither without folly : he who thinks they will be more freely pardoned, diſhonours at once his reaſon and religion."

PILKINGTON (Lætitia), a famous poetical genius, the daughter of Dr. Van Lewin, a phyſician of Dublin, where ſhe was born in 1712. She was married very young to the Rev. Matthew Pilkington, a poet alſo of no inconſiderable merit ; and theſe two wits, as is often the caſe, lived very unhappily together. They were at length totally ſeparated, on the huſband accidentally diſcovering a gentleman in her bedchamber at two o'clock in the morning ; a circumſtance which ſhe accounted for in a very unſatisfactory manner. The ſtory is told at large in her Memoirs ; where ſhe ſays, " Lovers of learning, I am ſure, will pardon me, as I ſolemnly declare it was the attractive charms of a new book, which the gentleman would not lend me, but conſented to ſtay till I read it through, that was the ſole motive of my detaining him." As there are not wanting ſome who form objections to marrying learned wives, the chance of ſuch literary aſſignations may perhaps be added to the liſt of them. After this unlucky adventure, Mrs. Pilkington came to London ; and having recourſe to her pen for ſubſiſtence, through the means of Colley Cibber, ſhe lived ſome time on the contributions of the Great. She was however thrown into the Marſhalſea for debt ; and being ſet at liberty, opened a pamphlet ſhop. She raiſed at length a handſome ſubſcription for her Memoirs ; which are written with great ſprightlineſs and wit, containing ſeveral entertaining anecdotes of dean Swift, with whom ſhe was intimate, as well as many pretty little pieces of her poetry. This ingenious but unhappy woman is ſaid at laſt to have killed herſelf with drinking at Dublin, in 1750.

PILL, in pharmacy, a form of medicine reſembling a little ball, to be ſwallowed whole ; invented for ſuch as cannot take bitter and ill-taſted medicinal draughts ; as alſo to keep in readineſs for occaſional uſe without decaying. See Pharmacy.

PILLAR, in architecture. See Architecture.

Pillar, in the manege, is the centre of the ring, or manege-ground, round which a horſe turns, whether there be a pillar in it or not. Beſides this, there are pillars on the circumference or ſides of the manege-ground, placed at certain diſtances, by two and two, from whence they are called the *two pillars*, to diſtinguiſh them from that of the centre. The uſe of the pillar in the centre is for regulating the extent of ground, that the manege upon the volts may be performed with method and juſtneſs, and that they may work in a ſquare, by rule and meaſure, upon the four lines of the volts ; and alſo to break unruly high-mettled horſes, without endangering the rider. The two pillars are placed at the diſtance of two or three paces one from the other ; and the horſe is put between thoſe, to teach him to riſe before and yerk out behind, and put himſelf upon raiſed airs ; &c. either by the aids or chaſtiſements.

Pompey's Pillar. See Alexandria.

PILLARS, in antiquarian topography, are large ſingle ſtones ſet up perpendicularly. Thoſe of them which are found in this country have been the work of the Druids ; but as they are the moſt ſimple of all monuments, they are unqueſtionably more ancient than druidiſm itſelf. They were placed as memorials recording different events ; ſuch as remarkable inſtances of God's mercies, contracts, ſingular victories, boundaries, and ſometimes ſepulchres. Various inſtances of theſe monuments erected by the patriarchs occur in the Old Teſtament : ſuch was that raiſed by Jacob at Lug, afterwards by him named *Bethel* ; ſuch alſo was the pillar placed by him over the grave of Rachel. They were likewiſe marks of execrations and magical taliſmans.

Theſe ſtones, from having long been conſidered as objects of veneration, at length were by the ignorant and ſuperſtitious idolatrouſly worſhipped ; wherefore, after the introduction of Chriſtianity, ſome had croſſes cut on them, which was conſidered as ſnatching them from the ſervice of the devil. Vulgar ſuperſtition of a later date has led the common people to conſider them as perſons transformed into ſtone for the puniſhment of ſome crime, generally that of ſabbath-breaking; but this tale is not confined to ſingle ſtones, but is told alſo of whole circles: witneſs the monuments called the *hurlers* in Cornwall, and *Rollorich ſtones* in Warwickſhire. The firſt are by the vulgar ſuppoſed to have been once men, and thus transformed as a puniſhment for playing on the Lord's day at a game called *hurling*; the latter a pagan king and his army.

At Wilton, where the earl of Pembroke has a very magnificent houſe, there is a pillar of one piece of white Egyptian granite, which was brought from the temple of Venus Genetrix at Rome, near 14 feet high and 22 inches diameter, with an inſcription to Aſtarte or Venus.

PILLORY (*colliſtrigium*, "collum ſtringens;" *pilloria*, from the French *pilleur*, i. e. *depeculator*, or *pelori*; derived from the Greek *πυλη*, *janua*, a "door," becauſe one ſtanding on the pillory puts his head as it were through a door, and *οραω*, *video*), is an engine made of wood to puniſh offenders, by expoſing them to public view, and rendering them infamous. There is a *ſtatute of the pillory*, 51 Hen. III. And by ſtatute it is appointed for bakers, foreſtallers, and thoſe who uſe falſe weights, perjury, forgery, &c. 3 *Inſt.* 219. Lords of leets are to have a pillory and tumbrel, or it will be the cauſe of forfeiture of the leet; and a village may be bound by preſcription to provide a pillory, &c. 2 *Hawk.* P. C. 73.

PILOT, the officer who ſuperintends the navigation, either upon the ſea-coaſt or on the main ocean. It is, however, more particularly applied by our mariners to the perſon charged with the direction of a ſhip's courſe on or near the ſea-coaſt, and into the roads, bays, rivers, havens, &c. within his reſpective diſtrict.

Pilots of ſhips, taking upon them to conduct any ſhip from Dover, &c. to any place up the river Thames, are to be firſt examined and approved by the maſter and wardens of the ſociety of Trinity Houſe, &c. or ſhall forfeit 10l. for the firſt offence, 20l. for the ſecond, and 40l. for every other offence; one moiety to the informer, the other to the maſter and wardens; but any maſter or mate of a ſhip may pilot his own veſſel up the river: and if any ſhip be loſt through the negligence of any pilot, he ſhall be for ever after diſabled to act as a pilot. 3 Geo. I. c. 13. Alſo the lord-warden of the cinque ports may make rules for the government of pilots, and order a ſufficient number to ply at ſea to conduct ſhips up to the Thames: 7 Geo. I. c. 21. No perſon ſhall act as a pilot on the Thames, &c. (except in collier ſhips) without a licence from the maſter and wardens of Trinity Houſe at Deptford, on pain of forfeiting 20l. And pilots are to be ſubject to the government of that corporation; and pay ancient dues, not exceeding 1s. in the pound, out of wages, for the uſe of the poor thereof. Stat. 5 Geo. II. c. 20.

By the former laws of France, no perſon could be received as pilot till he had made ſeveral voyages and paſſed a ſtrict examination; and after that, on his return in long voyages, he was obliged to lodge a copy of his journal in the admiralty; and if a pilot occaſioned the loſs of a ſhip, he had to pay 100 livres fine, and to be for ever deprived of the exerciſe of pilotage; and if he did it deſignedly, be puniſhed with death. *Lex Mercat.* 70, 71.

The laws of Oleron ordain, That if any pilot deſignedly miſguide a ſhip, that it may be caſt away, he ſhall be put to a rigorous death, and hung in chains: and if the lord of a place, where a ſhip be thus loſt, abet ſuch villains in order to have a ſhare of the wreck, he ſhall be apprehended, and all his goods forfeited for the ſatisfaction of the perſons ſuffering; and his perſon ſhall be faſtened to a ſtake in the midſt of his own manſion, which, being fired on the four corners, ſhall be burned to the ground, and he with it. *Leg. Ol.* c. 25. And if the fault of a pilot be ſo notorious, that the ſhip's crew ſee an apparent wreck, they may lead him to the hatches and ſtrike off his head; but the common law denies this haſty execution. An ignorant pilot is ſentenced to paſs thrice under the ſhip's keel by the laws of Denmark. *Lex Mercat.* 70.

The regulations with regard to pilots in the royal navy are as follow: "The commanders of the king's ſhips, in order to give all reaſonable encouragement to ſo uſeful a body of men as pilots, and to remove all their objections to his majeſty's ſervice, are ſtrictly charged to treat them with good uſage, and an equal reſpect with warrant-officers.

"The purſer of the ſhip is always to have a ſet of bedding provided on board for the pilots; and the captain is to order the boatſwain to ſupply them with hammocks, and a convenient place to lie in, near their duty, and apart from the common men; which bedding and hammocks are to be returned when the pilots leave the ſhip.

"A pilot, when conducting one of his majeſty's ſhips in pilot water, ſhall have the ſole charge and command of the ſhip, and may give orders for ſteering, ſetting, trimming, or furling the ſails; tacking the ſhip; or whatever concerns the navigation: and the captain is to take care that all the officers and crew obey his orders. But the captain is diligently to obſerve the conduct of the pilot; and if he judges him to behave ſo ill as to bring the ſhip into danger, he may remove him from the command and charge of the ſhip, and take ſuch methods for her preſervation as ſhall be judged neceſſary; remarking, upon the log book, the exact hour and time when the pilot was removed from his office, and the reaſons aſſigned for it.

"Captains of the king's ſhips, employing pilots in foreign parts of his majeſty's dominions, ſhall, after performance of the ſervice, give a certificate thereof to the pilot; which being produced to the proper naval officer, he ſhall cauſe the ſame to be immediately paid; but if there be no naval-officer there, the captain of his majeſty's ſhip ſhall pay him, and ſend the proper vouchers, with his bill, to the navy-board, in order to be paid as bills of exchange.

"Captains of his majeſty's ſhips, employing foreign pilots to carry the ſhips they command into or out of foreign ports, ſhall pay them the rates due by the eſtabliſhment or cuſtom of the country, before they diſcharge them; whoſe receipts being duly vouched, and ſent, with a certificate of the ſervice performed, to the navy-board, they ſhall cauſe them to be paid with the ſame exactneſs as they do bills of exchange." *Regulations and Inſtructions of the Sea-ſervice*, &c.

Pilot-*Fiſh*, or *Gaſteroſteus Ductor*, in ichthyology, is a ſpecies of the gaſteroſteus, and is found in the Mediterranean and in the Atlantic ocean, chiefly towards the equator. See Pl. 40, Vol. VII. Cateſby, who gives a figure of it in its natural ſize, together with a ſhort deſcription, calls it *perca marina ſectoria*, or rudder-fiſh. One of them, which Gronovius deſcribes, was about four inches in length, and its greateſt breadth little more than an inch: the head is about a third of the body, and covered, excepting the ſpace between the ſnout and the eye, with ſcales ſcarcely perceptible, and covering one another like tiles: the iris of the eye is a ſilver grey; the jaws are of equal ſize, and furniſhed as well as the palate with ſmall teeth diſpoſed in groups; there is alſo a longitudinal row of teeth on the tongue. The trunk of the pilot-fiſh is oblong, a little rounded, but it appears quadrangular towards the tail, becauſe at this place the lines are thicker, and form a kind of membranaceous projection. The back fin is long, and furniſhed with ſeven radii; on the fore-part of this fin are three moveable prickles very ſhort; the fins on the breaſt have each of them 20 radii, forked at their extremity; the abdominal fins have ſix; that of the anus has 17 branches, of which the firſt is longeſt; this fin is preceded by a ſmall moveable prickle; that of the tail is thick, large, and forked. The pilot-fiſh is of a browniſh colour, changing into gold; a tranſverſal black belt croſſes the head; a ſecond paſſes over the body at the place of the breaſt; a third near the moveable prickles of the back; three others near the region of the anus; and a ſeventh at the tail.

Seafaring people obſerve, that this fiſh frequently accompanies their veſſels; and as they ſee it generally towards the fore-part of the ſhip, they imagined that it was guiding and tracing out the courſe of the veſſel, and hence it received the name of *pilot-fiſh*.

Oſbec tells us, that they are ſhaped like thoſe mackarels which have a tranſverſal line acroſs the body. "Sailors (continues he) give them the name of *pilots*, becauſe they cloſely follow the dog-fiſh, ſwimming in great ſhoals round it on all ſides. It is thought that they point out ſome prey to the dog-fiſh; and indeed that fiſh is very unwieldy. They are not only not touched, but alſo preſerved by it againſt all their enemies. Pſalm cvi. ver. 2. 'Who can utter the mighty acts of the Lord? Who can ſhow forth all his praiſe?' This ſcarce and remarkable fiſh I had an opportunity of deſcribing: it is *Scomber cœruleo-albus cingulis tranſverſis nigris ſex, dorſo monopterygio.* See the *Memoirs of the Swediſh Academy of Sciences for the year* 1755, vol. xvi. p. 71. of the Swediſh edition."

It likewiſe follows the ſhark, apparently for the purpoſe of devouring the remains of its prey. It is pretended that it acts as its pilot. The manner in which it attends the ſhark, according to M. Daubenton, may have given riſe to this name. It is ſaid to ſwim at the height of a foot and a half from the ſnout of this voracious animal, to follow and imitate all its movements, and to ſeize with addreſs every part of its prey which the ſhark allows to eſcape, and which is light enough to buoy up towards the ſurface of the water. When the ſhark, which has its mouth below, turns to ſeize any fiſh, the pilot-fiſh ſtarts away; but as ſoon as the ſhark recovers his ordinary ſituation, it returns to its former place. Barbut informs us, that theſe fiſhes propagate their ſpecies like the ſhark. He adds, that in the gulph of Guinea thoſe fiſhes follow ſhips for the ſake of the offals and human excrements; and hence the Dutch give them the name of *dung-fiſh*. It is remarkable, that though ſo ſmall they can keep pace with ſhips in their ſwifteſt courſe.

PILTEN, a diviſion of Courland, which lies in Courland properly ſo called, derives its name from the ancient caſtle or palace of Pilten, built by Valdemar II. king of Denmark about the year 1220, when he founded a biſhop's ſee in this country for the more effectual converſion of its Pagan inhabitants. This diſtrict afterwards ſucceſſively belonged to the Germans, then again to the king of Denmark, the duke of Courland, and to Poland; and by virtue of the inſtrument of regency drawn up for this diſtrict in the year 1717, the government is lodged in ſeven Poliſh ſenators or counſellors, from whom an appeal lies to the king. The biſhop of Samogitia alſo ſtyles himſelf biſhop of Pilten.

The moſt remarkable part of this diſtrict is the promontory of Domeſneſs, which projects northward into the gulph of Livonia. From this cape a ſand-bank runs four German miles further into the ſea, half of which lies under water, and cannot be diſcerned. To the eaſt of this promontory is an unfathomable abyſs, which is never obſerved to be agitated. For the ſafety of veſſels bound to Livonia, two ſquare beacons have been erected on the coaſt, near Domeſneſs church, oppoſite to the ſand-bank, and facing each other. One of theſe is twelve fathoms high, and the other eight; and a large fire is kept burning on them from the firſt of Auguſt to the firſt of January. When the mariners ſee theſe fires appear as one in a direct line, they may conclude that they are clear of the extremity of the ſand-bank, and conſequently out of danger; but if they ſee both beacons, they are in danger of running upon it. The diſtrict of Pilten contains ſeven pariſhes, but no towns worthy of notice. The inhabitants are chiefly of the Lutheran perſuaſion.

PILUM, a miſſive weapon uſed by the Roman ſoldiers, and in a charge darted upon the enemy. Its point, we are told by Polybius, was ſo long and ſmall, that after the firſt diſcharge it was generally ſo bent as to be rendered uſeleſs. The legionary ſoldiers made uſe of the pilum, and each man carried two. The pilum underwent many alterations and improvements, inſomuch that it is impoſſible with any preciſion to deſcribe it. Julius Scaliger laboured much to give an accurate account of it, and would have eſteemed ſucceſs on this head amongſt the greateſt bleſſings of his life. This weapon appears, however, to have been ſometimes round, but moſt commonly ſquare, to have been two cubits long in the ſtaff, and to have had an iron point of the ſame length hooked and jagged at the end. Marius made a material improvement in it; for, during the Cimbrian war, he ſo contrived it, that when it ſtuck in the enemies ſhield it ſhould bend down in an angle in the part where the wood was connected with the iron, and thus become uſeleſs to the perſon who received it.

PIMENTO, or, as Mr. Edwards writes, PIEMENTO, in botany, or JAMAICA PEPPER, or *Allſpice*, a ſpecies of the myrtus. See MYRTUS. "The pimento trees grow ſpontaneouſly, and in great abundance, in many parts of Jamaica, but more particularly on hilly ſituations near the ſea, on the northern ſide of that iſland; where they form the moſt delicious groves that can poſſibly be imagined; filling the air with fragrance, and giving reality, though in a very diſtant part of the globe, to our great poet's deſcription of thoſe balmy gales which convey to the delighted voyager '*Sabean odours from the ſpicy ſhore of* Araby *the bleſt.*'

"This tree is purely a child of nature, and ſeems to mock all the labours of man in his endeavours to extend or improve its growth: not one attempt in fifty to propagate the young plants, or to raiſe them from the ſeeds, in parts of the country where it is not found growing ſpontaneouſly, having ſucceeded. The uſual method of forming a new pimento plantation (in Jamaica it is called a *walk*) is nothing more than to appropriate a piece of woodland, in the neighbourhood of a plantation already exiſting, or in a country where the ſcattered trees are found in a native ſtate, the woods of which being fallen, the trees are ſuffered to remain on the ground till they become rotten and periſh. In the courſe of twelve months after the firſt ſeaſon, abundance of young pimento plants will be found growing vigorouſly in all parts of the land, being without doubt produced from ripe berries ſcattered there by the birds, while the fallen trees, &c. afford them both ſhelter and ſhade. At the end of two years it will be proper to give the land a thorough cleanſing, leaving ſuch only of the pimento trees as have a good appearance, which will then ſoon form ſuch groves as thoſe I have deſcribed, and, except perhaps for the firſt four or five years, require very little attention afterwards.

"Soon after the trees are in bloſſom, the berries become fit for gathering; the fruit not being ſuffered to ripen on the tree, as the pulp in that ſtate, being moiſt and glutinous, is difficult to cure, and when dry becomes black and taſteleſs. It is impoſſible, however, to prevent ſome of the ripe berries from mixing with the reſt; but if the proportion of them be great, the price of the commodity is conſiderably injured.

"It is gathered by the hand; one labourer on the tree, employed in gathering the ſmall branches, will give employment to three below (who are generally women and children) in picking the berries; and an induſtrious picker will fill a bag of 70lbs. in the day.

“ The returns from a pimento walk in a favourable ſeaſon are prodigious. A ſingle tree has been known to yield 150lbs. of the raw fruit, or one cwt. of the dried ſpice; there being commonly a loſs in weight of one third in curing; but this, like many other of the minor productions, is exceedingly uncertain, and perhaps a very plenteous crop occurs but once in five years.”

PIMPINELLA, BURNET SAXIFRAGE; a genus of the digynia order, belonging to the pentandria claſs of plants. There are ſeven ſpecies; the moſt remarkable of which are, 1. The major, or greater burnet ſaxifrage, growing naturally in chalky woods, and on the ſides of the banks near hedges, in ſeveral parts of England. The lower leaves of this ſort are winged; the lobes are deeply ſawed on their edges, and ſit cloſe to the midrib, of a dark green. The ſtalks are more than a foot high, dividing into four or five branches. The lower part of the ſtalk is garniſhed with winged leaves, ſhaped like thoſe at the bottom, but ſmaller: thoſe upon the branches are ſhort and trifid; the branches are terminated by ſmall umbels of white flowers, which are compoſed of ſmaller umbels or rays. The flowers have five heart-ſhaped petals, which turn inward, and are ſucceeded by two narrow, oblong, channelled ſeeds. 2. The aniſum or common aniſe, is an annual plant, which grows naturally in Egypt; but is cultivated in Malta and Spain, from whence the ſeeds are annually imported into Britain. The lower leaves of this plant are divided into three lobes, which are deeply cut on their edges; the ſtalk riſes a foot and a half high, dividing into ſeveral ſlender branches, garniſhed with narrow leaves, cut into three or four narrow ſegments, terminated by pretty large looſe umbels, compoſed of ſmaller umbels or rays, which ſtand on pretty long footſtalks. The flowers are ſmall, and of a yellowiſh white; the ſeeds are oblong and ſwelling. The former ſpecies requires no culture; the latter is too tender to be cultivated for profit in this country. However, the ſeeds will come up if ſown in the beginning of April on a warm border. When they come up, they ſhould be thinned, and kept clear of weeds, which is all the culture they require.

Both theſe ſpecies are uſed in medicine. The roots of pimpinella have a grateful, warm, very pungent taſte, which is entirely extracted by rectified ſpirit: in diſtillation the menſtruum ariſes, leaving all that it had taken up from the root united into a pungent aromatic reſin. This root promiſes, from its ſenſible qualities, to be a medicine of conſiderable utility, though little regarded in common practice: the only officinal compoſition in which it is an ingredient is the *pulvis ari compoſitus*. Stahl, Hoffman, and other German phyſicians, are extremely fond of it; and recommend it as an excellent ſtomachic, reſolvent, detergent, diuretic, diaphoretic, and alexipharmac. They frequently gave it, and not without ſucceſs, in ſcorbutic and cutaneous diſorders, foulneſs of the blood and juices, tumors and obſtructions of the glands, and diſeaſes proceeding from a deficiency of the fluid ſecretions in general. Boerhaave directs the uſe of this medicine in aſthmatic and hydropic caſes, where the ſtrongeſt reſolvents are indicated: the form he prefers is a watery infuſion; but the ſpirituous tincture poſſeſſes the virtues of the root in much greater perfection.

Aniſeeds have an aromatic ſmell, and a pleaſant warm taſte, accompanied with a degree of ſweetneſs. Water extracts very little of their flavour; rectified ſpirit the whole. Theſe ſeeds are in the number of the four greater hot ſeeds: their principal uſe is in cold flatulent diſorders, where tenacious phlegm abounds, and in the gripes to which young children are ſubject. Frederic Hoffman ſtrongly recommends them in weakneſs of the ſtomach, diarrhœas, and for ſtrengthening the tone of the viſcera in general; and thinks they well deſerve the appellation given them by Helmont, *inteſtinorum ſolamen*. The ſmaller kind of aniſeeds brought from Spain are preferred.

PIMPLE, in medicine, a ſmall puſtule ariſing on the face. By mixing equal quantities of the juice of houſe-leek, *ſedum minus*, paſſed through paper, and of ſpirit of wine rectified by itſelf, a white coagulum of a very volatile nature is formed, which Dr. Bughart commends for curing pimples of the face; and ſays, that the thin liquor ſeparated from it with ſugar-candy is an excellent remedy for thick viſcid phlegm in the breaſt.

PIN, in commerce, a little neceſſary inſtrument made of braſs-wire, chiefly uſed by women in adjuſting their dreſs. In the year 1543, by ſtatute 34 and 35 of Henry VIII. cap. vi. it was enacted, “ That no perſon ſhall put to ſale any pinnes but only ſuch as ſhall be double-headed, and have the heads ſoldered faſt to the ſhank of the pins, well ſmoothed, the ſhank well ſhapen, the points well and round filed, canted, and ſharpened.” From the above extract it ſhould appear that the art of pin-making was but of late invention, probably introduced from France; and that our manufactories ſince that period have wonderfully improved.

Though pins are apparently ſimple, their manufacture is, however, not a little curious and complex. We ſhall therefore give our readers an account of it from Ellis's *Campagna* of London.

“ When the braſs-wire, of which the pins are formed, is firſt received at the manufactory, it is generally too thick for the purpoſe of being cut into pins. The firſt operation therefore is that of winding it off from one wheel to another with great velocity, and cauſing it to paſs between the two, through a circle in a piece of iron of ſmaller diameter: the wire being thus reduced to its proper dimenſions, is ſtraightened by drawing it between iron pins, fixed in a board in a zig-zag manner, but ſo as to leave a ſtraight line between them: afterwards it is cut into lengths of three or four yards, and then into ſmaller ones, every length being ſufficient to make ſix pins; each end of theſe is ground to a point, which was performed, when I viewed the manufactory, by boys, who ſat each with two ſmall grinding-ſtones before him, turned by a wheel. Taking up a handful, he applies the ends to the coarſeſt of the two ſtones, being careful at the ſame time to keep each piece moving round between his fingers, ſo that the points may not become flat: he then gives them a ſmoother and ſharper point, by applying them to the other ſtone, and by that means a lad of 12 or 14 years of age is enabled to point about 16,000 pins in an hour. When the wire is thus pointed, a pin is taken off from each end, and this is repeated till it is cut into ſix pieces. The next operation is that of forming the heads, or, as they term it, *head-ſpinning*; which is done by means of a ſpinning wheel, one piece of wire being thus with aſtoniſhing rapidity wound round another, and the interior one being drawn out, leaves a hollow tube between the circumvolutions: it is then cut with ſheers; every two circumvolutions or turns of the wire forming one head: theſe are ſoftened by throwing them into iron pans, and placing them in a furnace till they are red hot. As ſoon as they are cold, they are diſtributed to children, who ſit with anvils and hammers before them, which they work with their feet, by means of a lathe; and taking up one of the lengths, they thruſt the blunt end into a quantity of the heads which lie before them; and catching one at the extremity, they apply them immediately to the anvil and hammer; and by a motion or two of the foot, the point and the head are fixed together in much leſs time than it can be deſcribed, and with a dexterity only to be acquired by practice; the ſpectator being in continual apprehenſion for the ſafety of their fingers ends. The pin is now finiſhed as to its form, but ſtill it is merely braſs; it is therefore thrown into a copper, containing a ſolution of tin and the leys of wine. Here it remains for ſome time; and when taken out aſſumes a white though dull appearance: in order therefore to give it a poliſh, it is put into a tub containing a quantity of bran, which is ſet in motion by turning a ſhaft that runs through its centre; and thus by means of friction it becomes perfectly bright. The pin being complete, nothing remains but to ſeparate it from the bran; which is performed by a mode exactly ſimilar to the winnowing of corn, the bran flying off, and leaving the pin behind fit for immediate ſale. I was the more pleaſed with this manufactory, as it appeared to afford employment to a number of children of both ſexes, who are thus not only prevented from acquiring the habits of idleneſs and vice, but are on the contrary initiated in their early years in thoſe of a beneficial and virtuous induſtry." See NEEDLES.

PINACIA, among the Athenians, were tablets of braſs inſcribed with the names of all thoſe citizens in each tribe who were duly qualified and willing to be judges of the court of Areopagus. Theſe tablets were caſt into a veſſel provided for the purpoſe, and the ſame number of beans, a hundred being white and all the reſt black, were thrown into another. Then the names of the candidates and the beans were drawn out one by one, and they whoſe names were drawn out together with the white beans were elected judges or ſenators. In Solon's time there were only four tribes, each of which choſe 100 ſenators; but the number of tribes afterwards increaſing, the number of ſenators, or judges, increaſed to ſo many hundreds more.

PINANG, the Chineſe name of the *Areca Catechu*, Lin. See ARICA.

PINCHBECK. See ZINC.

PINDAR, the prince of lyric poets, was born at Thebes, about 520 years B. C. He received his firſt muſical inſtructions from his father, who was a flute-player by profeſſion; after which, according to Suidas, he was placed under Myrtis, a lady of diſtinguiſhed abilities in lyric poetry. It was during this period that he became acquainted with the poeteſs Corinna, who was likewiſe a ſtudent under Myrtis. Plutarch tells us, that Pindar profited from the leſſons which Corinna, more advanced in her ſtudies, gave him at this ſchool. It is very natural to ſuppoſe, that the firſt poetical effuſions of a genius ſo full of fire and imagination as that of Pindar would be wild and luxuriant; and Lucian has preſerved ſix verſes, ſaid to have been the exordium of his firſt eſſay, in which he crowded almoſt all the ſubjects for ſong which ancient hiſtory and mythology then furniſhed. Upon communicating this attempt to Corinna, ſhe told him, ſmiling, that he ſhould ſow with the hand, and not empty his whole ſack at once. Pindar, however, ſoon quitted the leading-ſtrings of theſe ladies, his poetical nurſes, and became the diſciple of Simonides, now arrived at extreme old age: after which he ſoon ſurpaſſed all his maſters, and acquired great reputation over all Greece: but, like a true prophet, he was leſs honoured in his own country than elſewhere; for at Thebes he was frequently pronounced to be vanquiſhed, in the muſical and poetical conteſts, by candidates of inferior merit.

The cuſtom of having theſe public trials of ſkill in all the great cities of Greece was now ſo prevalent, that but little fame was to be acquired by a muſician or poet any other way than by entering the liſts; and we find, that both Myrtis and Corinna publicly diſputed the prize with him at Thebes. He obtained a victory over Myrtis, but was vanquiſhed five different times by Corinna. The judges, upon occaſions like theſe, have been frequently accuſed of partiality or ignorance, not only by the vanquiſhed, but by poſterity: and if the merit of Pindar was pronounced inferior to that of Corinna five ſeveral times, it was, ſays Pauſanias, becauſe the judges were more ſenſible to the charms of beauty than to thoſe of muſic and poetry *. Was it not ſtrange, ſaid the Scythian Anacharſis, that the Grecian artiſts were never judged by artiſts, their peers?

Pindar, before he quitted Thebes, had the vexation to ſee his Dithyrambics traduced, abuſed, and turned into ridicule, by the comic poets of his time; and Athenæus tells us, that he was ſeverely cenſured by his brother lyrics, for being a lipogrammatiſt, and compoſing an ode from which he had excommunicated the letter S. Whether theſe cenſures proceeded from envy or contempt cannot now be determined; but they were certainly uſeful to Pindar, and it was neceſſary that he ſhould be laſhed for ſuch puerilities. Thebes ſeems to have been the purgatory of our young bard: when he quitted that city, as his judgment was matured, he avoided moſt of the errors for which he had been chaſtiſed, and ſuddenly became the wonder and delight of all Greece. Every hero, prince, and potentate, deſirous of laſting fame, courted the muſe of Pindar.

He ſeems frequently to have been preſent at the four great feſtivals, of the Olympian, Pythian, Nemean, and Iſthmian games, as may be inferred from ſeveral circumſtances and expreſſions in the odes which he compoſed for the victors in them all. Thoſe at Olympia, who were ambitious of having their achievements celebrated by Pindar, applied to him for an ode, which was firſt ſung in the Prytaneum or town-hall of Olympia, where there was a banqueting-room ſet apart for the entertainment of the conquerors. Here the ode was rehearſed by a chorus, accompanied by inſtruments. It was afterwards performed in the ſame manner at the triumphal entry of the victor into his own country, in proceſſions, or at the ſacrifices that were made with great pomp and ſolemnity on the occaſion.

Pindar, in his ſecond Iſthmian ode, has apologized for the mercenary cuſtom among poets, of receiving money for their compoſitions. "The world (ſays he) is grown intereſted, and thinks in general with the Spartan philoſopher Ariſtodemus, that *money only makes the man*: a truth which this ſage himſelf experienced, having with his riches loſt all his friends." It is ſuppoſed that Pindar here alludes to the avarice of Simonides, who firſt allowed his muſe to ſell her favours to the higheſt bidder.

There is no great poet in antiquity whoſe moral character has been leſs cenſured than that of Pindar. Plutarch has preſerved a ſingle verſe of his *Epicedium* or *Dirge* that was ſung at his funeral; which, ſhort and ſimple as it is, implies great praiſe: *This man was pleaſing to ſtrangers, and dear to his fellow-citizens.* His works abound with precepts of the pureſt morality: and it does not appear that he ever traduced even his enemies; comforting himſelf, for their malignity, by a maxim which he inſerted in his firſt *Pythic*, and which afterwards became proverbial, *That it is better to be envied than pitied.*

Pauſanias ſays, that the character of poet was truly conſecrated, in the perſon of Pindar, by the god of verſe himſelf; who was pleaſed, by an expreſs oracle, to order the inhabitants of Delphos to ſet apart for Pindar one half of the firſt-fruit offerings brought by the religious to his ſhrine, and to allow him a conſpicuous place in his temple, where in an iron chair he uſed to ſit and ſing his hymns in honour of that god. This chair was remaining in the time of Pauſanias, ſeveral centuries after, and ſhown to him as a relick not unworthy of the ſanctity and magnificence of that place.

But though Pindar's muſe was penſioned at Delphos, and well paid by princes and potentates elſewhere, ſhe ſeems, however, ſometimes to have ſung the ſpontaneous ſtrains of pure friendſhip. Of this kind were, probably, the verſes beſtowed upon the muſician Midas, of Agrigentum in Sicily, who had twice obtained the palm of victory by his performance on the flute at the Pythic games[*]. It is in his 12th Pythic ode that Pindar celebrates the victory of Midas *over all Greece, upon that inſtrument which Minerva herſelf had invented*[†].

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* Pauſanias ſays, that Corinna was one of the moſt beautiful women of her time, as he judged by a picture of her which he ſaw at Tanagris at the place where the public exerciſes were performed. She was repreſented with her head ornamented by a riband, as a memorial of the victories ſhe had obtained over Pindar at Thebes.

Fabricius tells us that Pindar lived to the age of 90; and, according to the chronology of Dr. Blair, he died 435 years B. C. aged 86. His fellow-citizens erected a monument to him in the Hippodrome at Thebes, which was ſtill ſubſiſting in the time of Pauſanias; and his renown was ſo great after his death, that his poſterity derived very conſiderable honours and privileges from it. When Alexander the Great attacked the city of Thebes, he gave expreſs orders to his ſoldiers to ſpare the houſe and family of Pindar. The Lacedemonians had done the ſame before this period; for, when they ravaged Bœotia and burned the capital, the following words were written upon the door of the poet: *Forbear to burn this houſe, it was the dwelling of Pindar.* Reſpect for the memory of this great poet continued ſo long, that, even in Plutarch's time, the beſt part of the ſacred victim at the Theoxenian feſtival was appropriated to his deſcendants.

PINDARIC ODE, in poetry, an ode formed in imitation of the manner of Pindar. See POETRY.

PINDUS, (anc. geog.), not a ſingle mountain, but a chain of mountains, inhabited by different people of Epirus and Theſſaly; ſeparating Macedonia, Theſſaly, and Epirus: An extenſive chain, having Macedonia to the north, the Perrhœbi to the weſt, the Dolopes to the ſouth, and the mountain itſelf of Theſſaly (Strabo).

PINDUS, a Doric city of Ætolia, ſituated on the cognominal river, which falls into the Cephiſſus (Strabo).

PINE, in botany. See PINUS.

PINE-*Apple*. See BROMELIA.

PINEA, or PIGNE, in commerce, is a term uſed in Peru and Chili for a kind of light porous maſſes, or lumps, formed of a mixture of mercury and ſilver duſt from the mines. The ore, or mineral, of ſilver, when dug out of the veins of the mine, is firſt broken, and then ground in mills for the purpoſe, driven by water, with iron peſtles each of 200 pounds weight. The mineral, when thus pulveriſed, is next ſifted, and then worked up with water into a paſte; which, when half dry, is cut into pieces, called *cuerpos*, a foot long, weighing each about two thouſand five hundred pounds.

Each piece, or cuerpo, is again kneaded up with ſea-ſalt, which, diſſolving, incorporates with it. They then add mercury, from 10 to 20 pounds for each cuerpo, kneading the paſte afreſh until the mercury be incorporated therewith. This office, which is exceedingly dangerous on account of the noxious qualities of the mercury, is always made the lot of the poor Indians. This amalgamation is continued for eight or nine days; and ſome add lime, lead, or tin ore, &c. to forward it; and, in ſome mines, they are obliged to uſe fire. To try whether or no the mixture and amalgamation be ſufficient, they waſh a piece in water; and if the mercury be white, it is a proof that it has had its effect; if black, it muſt be ſtill further worked. When finiſhed, it is ſent to the lavatories, which are large baſons that empty ſucceſſively into one another. The paſte, &c. being laid in the uppermoſt of theſe, the earth is then waſhed from it into the reſt by a rivulet turned upon it; an Indian, all the while, ſtirring it with his feet, and two other Indians doing the like in the other baſons. When the water runs quite clear out of the baſons, the mercury and ſilver are found at bottom incorporated. This matter they call *pella*, and of this they form the pineas, by expreſſing as much of the mercury as they can; firſt, by putting it in woollen bags, and preſſing and beating it ſtrongly; then, by ſtamping it in a kind of wooden mould, of an octagonal form, at bottom whereof is a braſs plate pierced full of little holes. The matter, when taken out of the mould, is laid on a trivet, under which is a large veſſel full of water; and the whole being covered with an earthen head, a fire is made around it.

The mercury ſtill remains in the maſs, and is thus reduced into fumes; and, at length condenſing, it is precipitated into the water, leaving behind it a maſs of ſilver grains of different figures, which, only joining or touching at the extremes, render the matter very porous and light. This, therefore, is the pinea, or pigne, which the workmen endeavour to ſell ſecretly to veſſels trading to the South ſea; and from which thoſe who have ventured to engage in ſo dangerous a commerce have made ſuch vaſt gains. Indeed the traders herein muſt be very careful; for the Spaniſh miners are arrant knaves, and, to make the pignes weigh the more, they often fill the middle with ſand or iron.

PINEAL GLAND. See ANATOMY.

PINEAU (SEVERIN DU), who died at Paris in 1619, was a native of Chartres, and firſt ſurgeon to the king of France. He was very ſkilful in lithotomy; and has left behind him, 1. A Diſcourſe concerning the Extraction of the Stone in the Bladder, publiſhed in 1610 in 8vo. 2. A Treatiſe *De Virginitatis Notis*, printed at Leyden 1641, in 12mo. This laſt performance, however uſeful it may be to men of ſcience, we would not venture to recommend to the peruſal of young people, on account of ſome particulars which it was perhaps unneceſſary to expoſe to the eyes of the public.

PINEAU (Gabriel du), was born at Angers in 1573, where he followed the profeſſion of a lawyer with a reputation above his years. He went afterwards to Paris, and pleaded with eclat before the parliament and great council. Upon his return to Angers, he became a counſellor in the preſidial court. He was conſulted by all the neighbouring provinces, and had an active hand in all the great affairs of his time. Mary de Medicis conferred upon him the office of maſter of requeſts, and in her diſgrace wiſhed to ſupport herſelf by his credit and counſels; but Du Pineau, always attentive to what he owed on the one hand to the mother of his king, and on the other to the king himſelf, never ceaſed to inſpire that princeſs with ſentiments of peace.

In 1632, Louis XIII. by way of reward, appointed him mayor and captain-general of the city of Angers; a ſituation in which he merited the flattering title of *Father of the People*. He had no reſpect of perſons; for he was equally acceſſible to the poor and the great. This worthy citizen died the 15th of October 1644, at the age of 71. His houſe was a kind of academy, where regular conferences were held, and attended by young officers, advocates, and other literary characters.

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[*] This Midas is a very different perſonage from his long-eared majeſty of Phrygia, whoſe deciſion in favour of Pan had given ſuch offence to Apollo; as is manifeſt, indeed, from his having been cotemporary with Pindar.

[†] The moſt extraordinary part of this muſician's performance, that can be gathered from the ſcholiaſt upon Pindar, was his finiſhing the ſolo without a reed or mouth-piece, which broke accidentally while he was playing. The legendary account given by the poet in this ode, of the occaſion upon which the flute was invented by Minerva, is diverting: "It was (ſays he) to imitate the howling of the Gorgons, and the hiſſing of their ſnakes, which the goddeſs had heard when the head of Meduſa (one of theſe three anti-graces) was cut off by Perſeus."

In thoſe conferences every one freely ſtated the difficulties which occurred to him upon ſubjects either of law or hiſtory; and when Pineau ſpoke, all was made clear; but he was always the laſt in delivering his ſentiments, becauſe he perceived that too much deference was paid to his opinion. His writings are, 1. Latin notes, in addition to thoſe of Du Moulin, upon the canon law, and printed along with the works of that eminent lawyer by the care of Francis Pinſon. 2. Commentaries, obſervations, and conſultations, upon ſeveral important queſtions reſpecting the laws both of Anjou and of France, with ſome diſſertations upon different ſubjects, &c. reprinted in 1725 in 2 vols. fol. by the care of Livoniere, who has enriched them with very uſeful remarks. The editor ſays, that "Du Pineau is a little inferior to the celebrated Du Moulin on the civil law, but that he is more accurate than the other upon the canon law."—Menage made theſe two verſes upon his death:

Pinellus periit, Themidis pius ille ſacerdos,
In proprio judex limine perpetuus.

PINEDA (John), who was born at Seville of a noble family, entered into the ſociety of Jeſuits in 1572. He taught philoſophy and divinity in ſeveral colleges; and devoted his time to the ſtudy of the Holy Scriptures. That he might render that ſtudy the eaſier, he made himſelf maſter of the oriental languages. We have of his writings, 1. Two volumes of Commentaries upon the Book of Job, in folio. 2. Two upon Eccleſiaſtes. 3. A General Hiſtory of the Church, in Spaniſh, 4 vols. in folio. 4. A Hiſtory of Ferdinand III. in the ſame language, in folio. He died in 1637, much regretted by the members of his ſociety, and by the public in general.

PINELLI (John Vincent), born at Naples, was ſon of count Pinelli, a noble Genoeſe, who had ſettled in that city, and had acquired a handſome fortune in the way of trade. After receiving a liberal education he quitted the place of his nativity, and repaired to Padua, where he took up his reſidence at the age of 24. Being a great lover of ſcience, he gave a preference to that city on account of its famous univerſity, which brought to it a number of learned men. He had an excellent library, which conſiſted of a choice collection of books and manuſcripts, and which he continued to enrich till the hour of his death. His literary correſpondence, not only in Italy, but through the moſt of Europe, procured him all the new works which were worthy of a place in his collection. The authors themſelves were often forward to pay their reſpects to him. In many cities of Italy he had perſons employed to ſearch, at leaſt once a month, the ſtalls of thoſe artificers who make uſe of old parchments, ſuch as lute-makers, ſievewrights, and others; and by this means he had the good fortune often to ſave from deſtruction ſome valuable fragments. His paſſion for knowledge embraced all the ſciences; but hiſtory, medals, antiquities, natural hiſtory, and particularly botany, were his favourite ſtudies. He was conſulted from all quarters, and the extent of his acquaintance with the learned world was very great. He correſponded with Juſt. Lipſius, Joſeph Scaliger, Sigonius, Poſſevin, Peter Pithou, and a great many others, who have all paid the higheſt compliments to his erudition. Inſenſible to all the pleaſures of life, and acquainted only with thoſe of the mind, he had a great diſlike to plays, entertainments, ſhows, and every thing which moſt excites the curioſity of other men. During the ſpace of 43 years that he lived at Padua, he was never known to be out of the city but twice; once on occaſion of a plague which infeſted it; and afterwards on a voyage to Naples, which he made at the earneſt ſolicitation of his friends. In ſhort, Pinelli was generous, ſympathizing, and compaſſionate, particularly to men of letters, whoſe wants he often anticipated. His zeal for the progreſs and advancement of ſcience rendered him very communicative of his knowledge and of his books: but this was always done with judgment and diſcretion. He died in 1601, aged 68, without having publiſhed any work. Paul Gualdo, who has written Pinelli's Life, does not ſpecify the number of volumes of which his rich library conſiſted: he only informs us, that when it was tranſported by ſea to Naples, it was packed up in 130 cheſts, of which 14 contained manuſcripts; but it did not go wholly to his heirs. The ſenate of Venice cauſed their ſeal to be ſet upon the manuſcripts, and took away whatever concerned the affairs of the republic, to the number of 200 pieces.—"I compare (ſays Preſident de Thou) Pinelli to Titus Pomponius; for, as that illuſtrious Roman was called *Attick*, Pinelli alſo bore the title of *Venetian*, on account of the great affection which the republic of Venice had for him."

PINET (Antony du), lord of Noroy, lived in the 16th century, and was a native of Beſançon. He was ſtrongly attached to the Proteſtant religion, and a bitter enemy to the church of Rome. His book, entitled *La Conformité des Egliſes Reformées de France*, and *de l'Egliſe primitive*, printed at Lyons, 1564, in 8vo; and the notes which he added to the French tranſlation of the Fees of the Pope's Chancery, which was printed at Lyons, in 8vo, 1564, and reprinted at Amſterdam in 1700, in 12mo, plainly diſcover his ſentiments. He publiſhed the laſt-mentioned performance under this title: *Taxe des parties caſuelles de la boutique du Pape*, in Latin and French, with ſome notes taken from decrees, councils, and canons, in order to aſcertain the diſcipline anciently obſerved in the church. In the epiſtle dedicatory, he aſſumes the tone of a declared enemy to the court of Rome. He apologizes for having preſented this book "to a ſociety ſo holy as yours (the Proteſtants), in which are heard only hymns, pſalms, and praiſes, to the Lord our God; but it is proper to ſhow to the villain his villainy, and the fool his folly, leſt one ſhould be thought to reſemble them." We ſee, by this ſpecimen, that Pinet had no more politeneſs in his ſtyle than in his manners. His tranſlation of Pliny's Natural Hiſtory, printed at Lyons, in 2 vols. folio, 1566, and at Paris, 1608, was formerly much read. Though there are a good many errors in it, it is yet very uſeful at preſent, eſpecially for thoſe who underſtand Pliny's Latin, on account of the tranſlator's reſearches, and a great number of marginal notes. Pinet alſo publiſhed plans of the principal fortreſſes in the world, at Lyons, 1564, in folio.

PING-leang-fou, a city of China in the province of Chen-ſi. It is one of the moſt conſiderable cities of the weſtern part of the province, and is ſituated on the river Kin-ho. The air here is mild; and the agreeable views which the ſurrounding mountains preſent, added to the ſtreams which water the country, render it a very delightful reſidence. It has, under its juriſdiction three cities of the ſecond claſs and ſeven of the third. In this diſtrict is a valley ſo deep and narrow, that it is almoſt impervious to the light: a large highway, paved with ſquare ſtones, runs through it.

PINGUICULA, butterwort; a genus of the monogynia order, belonging to the diandria claſs of plants. There are four ſpecies, of which the moſt remarkable is the vulgaris, or common butterwort, growing commonly on bogs or low moiſt grounds in England and Scotland. Its leaves are covered with ſoft upright pellucid prickles, ſecreting a glutinous liquor. The flowers are pale red, purple, or deep violet colour, and hairy within. If the freſh gathered leaves of this plant are put into the ſtrainer through which warm milk from the cow is poured, and the milk ſet by for a day or two to become aceſcent, it acquires a conſiſtency and tenacity, and neither whey nor cream ſeparates from it. In this ſtate it is an extremely grateful food, and as ſuch is uſed by the inhabitants of the north of Sweden. There is no further occaſion to have recourſe to the leaves; for half a ſpoonful of this prepared milk, mixed with freſh warm milk, will convert it to its own nature, and this again will change another quantity of freſh milk, and ſo on without end. The juice of the leaves kills lice; and the common people uſe it to cure the cracks or chops in cows' udders. The plant is generally ſuppoſed injurious to ſheep, by occaſioning in them that diſeaſe called the *rot*; but from experiments made on purpoſe, and conducted with accuracy, it appears that neither ſheep, cows, goats, horſes, or ſwine, will feed upon this plant.

Wherever this plant, called alſo *Yorkſhire ſanicle*, is found, it is a certain indication of a boggy ſoil. From the idea that the country people have of its noxious operation on ſheep, this plant has been called the *white rot*; ſince, as they imagine, it gives them the rot whenever they eat it, which they will not do but from great neceſſity.

The Laplanders, like the Swedes with the milk of cows, receive that of the rein-deer upon the freſh leaves of this plant, which they immediately ſtrain off, and ſet it aſide till it becomes ſomewhat aceſcent; and the whole acquires in a day or two the conſiſtence of cream without ſeparating the ſerum, and thus becomes an agreeable food. When thus prepared, a ſmall quantity of the ſame has the property of rennet in producing the like change on freſh milk.

PINGUIN, or PENGUIN, in ornithology, a genus of birds of the order of palmipedes; diſtinguiſhed by Mr. Latham by the following characters:—The bill is ſtrong, ſtraight, more or leſs bending towards the point, and furrowed on the ſides: the noſtrils are linear, and placed in the furrows; the tongue is covered with ſtrong ſpines, pointing backwards; the wings are ſmall, very like fins, and covered with no longer feathers than the reſt of the body, and are uſeleſs in flight; the body is clothed with thick ſhort feathers, having broad ſhafts, and placed as compactly as the ſcales of fiſhes; the legs are ſhort, thick, and placed very near the vent; the toes are four, and are all placed forwards; the interior are looſe, and the reſt are webbed; the tail is very ſtiff, conſiſting of broad ſhafts ſcarcely webbed.

It is agreed that pinguins are inhabitants of ſouthern latitudes only; being, as far as is yet known, found only on the coaſts of South America, from Port Deſire to the Straits of Magellan; and Frezier ſays they are found on the weſtern ſhore as high as Conception. In Africa they ſeem to be unknown, except on a ſmall iſle near the Cape of Good Hope, which takes its name from them. They are found in vaſt numbers on land during the breeding ſeaſon; for they ſeldom come on ſhore but at that time: they form burrows under ground like rabbits; and the iſles they frequent are perfectly undermined by them.

Their attitude on land is quite erect, and on that account they have been compared by ſome to pigmies, by others to children with white bibs. They are very tame, and may be driven like a flock of ſheep. In water they are remarkably active, and ſwim with vaſt ſtrength, aſſiſted by their wings, which ſerve inſtead of fins; their food in general is fiſh; not but that they will eat graſs like geeſe.

Mr. Latham remarks, that this genus appears to hold the ſame place in the ſouthern diviſion of the earth that the awks do in the northern; and that, however authors may differ in opinion on this head, they ought not to be confounded with one another. The pinguin is never ſeen but in the temperate and frigid zones ſouth of the equator, while the awk only appears in the parallel latitudes north of the equator; for neither of theſe genera have yet been obſerved within the tropics. Forſter, in his Voyage (vol. i. page 92.), ſays, he ſaw one for the firſt time in lat. 48. ſouth, nor are they ever met with nearer than 40 degrees ſouth. *Id. Introd. Diſc. on Pinguins, Comment. Got.* vol. 3d.

The wings of the pinguin are ſcarcely any thing elſe than mere fins, while the awk has real wings and gills, though they be but ſmall. The former has four toes on each foot, the latter only three. While ſwimming, the pinguin ſinks wholly above the breaſt, the head and neck only appearing out of the water; while the awk, like moſt other birds, ſwims on the ſurface. There are ſeveral other peculiarities which ſerve to diſtinguiſh the two genera, but what we have mentioned are doubtleſs ſufficient.

"The bodies of the pinguin tribe (ſays our author) are commonly ſo well and cloſely covered with feathers that no wet can penetrate; and as they are in general exceſſively fat, theſe circumſtances united ſecure them from cold. They have often been found above 700 leagues from land, and frequently on the mountains of ice, on which they ſeem to aſcend without difficulty, as the ſoles of their feet are very rough, and ſuited to the purpoſe." Mr. Latham enumerates nine different ſpecies of this genus, beſides two varieties of the black-footed pinguin or diomedea.

1. The firſt, which is a very beautiful ſpecies, our author calls the *creſted* pinguin. The birds of this ſpecies are 23 inches long; the bill is three inches long, and of a red colour, with a dark furrow running along on each ſide to the tip; the upper mandible is curved at the end, the under is obtuſe; the irides are of a dull red; the head, neck, back, and ſides, are black. Over each eye there is a ſtripe of pale yellow feathers, which lengthens into a creſt behind, nearly four inches long; the feathers on each ſide of the head, above this ſtripe, are longer than the reſt, and ſtand upward, while thoſe of the creſt are decumbent, but can be erected on each ſide at pleaſure; the wings, or rather fins, are black on the outſide, edged with white; on the inſide they are white; the breaſt and all the under parts are alſo white; the legs are orange, and the claws are duſky. The female has a ſtreak of pale yellow over the eye, but it is not prolonged into a creſt behind as in the male.

This ſpecies inhabits Falkland's Iſlands, and was likewiſe met with in Kerguelen's Land, or Iſle of Deſolation, as well as at Van Diemen's Land, and New Holland, particularly in Adventure Bay. They are called *hopping pinguins* and *jumping jacks*, from their action of leaping quite out of the water, on meeting with the leaſt obſtacle, for three or four feet at leaſt; and indeed, without any ſeeming cauſe, they often do the ſame, appearing chiefly to advance by that means. This ſpecies ſeems to have a greater air of livelineſs in its countenance than others, yet is in fact a very ſtupid bird, ſo much ſo as to ſuffer itſelf to be knocked on the head with a ſtick when on land. Forſter ſays he found them difficult to kill; and when provoked, he adds, they ran at the ſailors in flocks, and pecked their legs, and ſpoiled their clothes. When angered too they erect their creſts in a beautiful manner. Theſe birds make their neſts among thoſe of the pelican tribe, living in tolerable harmony with them; and lay ſeldom more than one egg, which is white, and larger than that of a duck. They are moſtly ſeen by themſelves, ſeldom mixing with other pinguins, and often met with in great numbers on the outer ſhores, where they have been bred. They are frequently ſo regardleſs as to ſuffer themſelves to be taken by the hand. The females of this ſpecies lay their eggs in burrows, which they eaſily form of themſelves with their bills, throwing out the dirt with their feet. In theſe holes the eggs are depoſited on the bare earth. The general time of ſitting is in October; but ſome of the ſpecies, eſpecially in the colder parts, do not ſit till December, or even January. How long they ſit is not known.

2. The ſecond ſpecies mentioned by Latham is the *patagonian*. (See pl. 3.) It is diſtinguiſhed by this name not only becauſe it is found on that coaſt, but alſo becauſe it exceeds in bulk the common pinguins as much as the natives are ſaid to do the common race of men. It was firſt diſcovered by captain Macbride, who brought one of them from Falkland Iſlands, off the Straits of Magellan. The length of the ſtuffed ſkin of this particular bird meaſured four feet three inches, and the bulk of the body ſeemed to exceed that of a ſwan. The bill was four inches and a half long, ſlender, ſtraight, bending on the end of the upper mandible, with no noſtrils. The tongue half the length of the bill, and ſingularly armed with ſtrong ſharp ſpikes pointing backwards. The plumage is moſt remarkable, the feathers lying over one another with the compactneſs of the ſcales of a fiſh; their texture equally extraordinary; the ſhafts broad and very thin; the vanes unwebbed; the head, throat, and hind part of the neck, are of a deep brown colour: from each ſide of the head to the middle of the fore part of the neck are two lines of bright yellow, broad above, narrow beneath, and uniting half way down; thence the ſame colour widens towards the breaſt, fading away till it is loſt in pure white, of which colour is the whole under ſide of the body, a duſky line dividing it from the colour of the upper part. The whole back is of a very deep aſh-colour, almoſt duſky; but the end of each feather is marked with a blue ſpot, thoſe about the junction of the wings larger and paler than the others. The wings are in this ſpecies, as in all the others, extremely ſhort in reſpect to the ſize of the bird; hang down, and have the appearance of fins, whoſe office they perform; their length is only 14 inches; on the outſide they are duſky, and covered with ſcale-like feathers, or, at beſt, with ſuch whoſe ſhafts are ſo broad and flat as ſcarce to be diſtinguiſhed from ſcales; thoſe on the ridge of the wings conſiſting entirely of ſhaft; the larger, or quill-feathers, have ſome very ſhort webs. The tail conſiſts of 30 brown feathers, or rather thin ſhafts, reſembling ſplit whale-bone; flat on the upper ſide, concave on the under, and the webs ſhort, unconnected, and briſtly. From the knees to the end of the claws ſix inches, covered with ſtrong pentangular black ſcales; the fore toe ſcarce an inch long, and the others ſo remarkably ſhort as to evince the neceſſity of that ſtrength of the tail, which ſeems intended as a ſupport to the bird in its erect attitude, in the ſame manner as that of the woodpecker is when it clings to the ſides of trees: between the toes is a ſtrong ſemilunar membrane, continued up even part of the claws; the middle claw is near an inch long, and the inner edge very ſharp and thin; the interior toe is ſmall, and placed very high. The ſkin is extremely tough and thick; which, with the cloſeneſs of the feathers, guards it effectually in the element wherein it is ſo converſant.

This ſpecies, which was, as we have ſeen, firſt met with in Falkland Iſlands, has ſince been ſeen in Kerguelen's Land, New Georgia, and New Guinea. M. Bougainville caught one, which ſoon became ſo tame as to follow and know the perſon who had care of it; it fed on fleſh, fiſh, and bread; but after a time grew lean, pined away, and died. The chief food, when at large, is thought to be fiſh; the remains of which, as well as crabs, ſhell-fiſh, and moluſcæ, were found in the ſtomach. This ſpecies is the fatteſt of the tribe; and therefore moſt ſo in January, when they moult. They are ſuppoſed to lay and ſit in October. They are met with in the moſt deſerted places. Their fleſh is black, though not very unpalatable. This has been conſidered as a ſolitary ſpecies, but has now and then been met with in conſiderable flocks. They are found in the ſame places as the papuan pinguins, and not unfrequently mixed with them; but in general ſhow a diſpoſition of aſſociating with their own ſpecies.

3. The third ſpecies is denominated *papuan*. It is about $2\frac{1}{2}$ feet long, being a little bigger than that which is called the *Cape pinguin*. This ſpecies inhabits the iſle of Papos, or New Guinea; and has been met with at Falkland Iſles and Kerguelen's Land; it is often found among the patagonian pinguins.

4. The *antarctic* pinguin is about 25 inches long, and weighs about $11\frac{1}{2}$ pounds. The bill is upwards of $2\frac{3}{4}$ inches long; the upper parts of the body are black, the under are gloſſy white; beneath the chin there is a narrow ſtreak of a blackiſh colour, paſſing backward towards the hind head, a little bent about the region of the ears; the wings are much the ſame as in the other ſpecies; the tail is cuneiform; the feathers, or rather briſtles, of which it is compoſed, are black, and in number 32; the legs are of a fleſh-colour, and the ſoles of the feet are black.

" This ſpecies (ſays Latham) inhabits the South ſea, from 48 degrees to the antarctic circle; and is frequently found on the ice mountains and iſlands, on which it aſcends; it is a pretty numerous ſpecies. Our laſt voyagers found them in plenty in the Iſle of Deſolation. And it was obſerved, that in an iſland they touched at not greatly diſtant, the rocks were almoſt covered with pinguins and ſhags; the firſt moſt probably of this ſort."

5. For the black-footed pinguin, or *diomedea demerſa*, ſee Diomedea.

6. The *magellanic* ſpecies is about the ſize of the antarctic pinguin. They are about 2 feet and ſometimes $2\frac{1}{2}$ feet long, and weigh 11 pounds. The bill is black, having a tranſverſe band acroſs near its tip; the head and neck are black, except a few markings here and there; the upper parts of the body and wings are of the ſame colour; the under parts of both are white from the breaſt, except a narrow band of black paſſing at a little diſtance within the white on the breaſt, and downwards on each ſide, beneath the wings, quite to the thighs; the legs are of a reddiſh colour, irregularly ſpotted on the thighs; and the claws are black. This ſpecies, which is very numerous, inhabits the Straits of Magellan, Staten Land, Terra del Fuego, and Falkland Iſlands. Far from being timid, theſe birds will often attack a man and peck his legs. As food they are not at all unpalatable. They often mix with ſea-wolves among the ruſhes, burrowing in holes like a fox. They ſwim with prodigious ſwiftneſs. They lay their eggs in collective bodies, reſorting in incredible numbers to certain ſpots, which their long reſidence has freed from graſs, and to which were given the name of towns. Penroſe obſerves, that they compoſed their neſts of mud, a foot in height, and placed as near one another as may be. It is poſſible that they may have different ways of neſting, according to the places they inhabit; or perhaps the manners of this may be blended with thoſe of another. " Here, (ſays he, *i. e.* in the places they frequent), during the breeding ſeaſon, we were preſented with a ſight which conveyed a moſt dreary, and I may ſay awful, idea of the deſertion of theſe iſlands by the human ſpecies:—a generall ſtillneſs prevailed in theſe towns; and whenever we took our walks among them, in order to provide ourſelves with eggs, we were regarded indeed with ſide-long glances, but we carried no terror with us.

" The eggs are rather larger than thoſe of a gooſe, and laid in pairs. When we took them once, and ſometimes twice in a ſeaſon, they were as often replaced by the birds; but prudence would not permit us to plunder too far, leſt a future ſupply in the next year's brood might be prevented." They lay ſome time in November, driving away the albatroſſes, which have hatched their young in turn before them. The eggs were thought palatable food, and were preſerved good for three or four months.

7. The *collared* pinguin is very little leſs than the papuan, being 18 inches long. The bill, which is black, is ſimilar to that of the patagonian pinguin; the irides are black; the eye is ſurrounded with a bare ſkin of a blood-colour, of an oval ſhape, and three times as large as the eye itſelf; the head, throat, hind part of the neck, and ſides, back, wings, and tail, are all black; the fore part of the neck, breaſt, belly, and thighs, are white, extending round the neck, where the white begins, like a collar, except that it does not quite meet at the back part; the legs are black.

This ſpecies inhabits New Guinea. It was alſo ſeen by Dr. Forſter near Kerguelen's Land; and again on two iſles adjoining to the iſland of South Georgia.

8. For the red-footed pinguin, or *phaeton demerſus*, ſee Phaeton.

9. The *ſmall*, or, as Latham calls it, the *little pinguin*, is about the ſize of a teal, being 15 inches long. The bill, which is of a duſky colour, is about 1½ long, and ſhaped like that of the phaeton demerſus: the upper parts of the bird from the head to the tail appear to be of a cinereous blue colour, of which colour are the ends of the feathers; the baſe of them, however, is brown black, and the ſhafts of each are of the ſame colour; the under parts from chin to vent are white; the wings are duſky above and white beneath; the tail, which is exceedingly ſhort, conſiſts of 16 ſtiff feathers, which are ſcarcely perceptible; the legs are of a dull red colour; the webs are duſky, and the claws are black.

This ſpecies is pretty commonly found among the rocks on the ſouthern parts of New Zealand, but they are moſt frequent at Duſky Bay. They make deep burrows on the ſides of the hills, in which they lay their eggs: theſe holes are ſo thick in ſome parts, that a perſon is ſcarcely able to walk three or four ſteps without falling into one of them up to the knees. The inhabitants of Queen Charlotte's Sound kill them with ſticks, and, after ſkinning them, eſteem the fleſh as good food. They are known at New Zealand by the name of *korora*. "Theſe birds (ſays Latham) I have found to vary both in ſize and colour: ſome are much ſmaller than others, quite black above, and meaſure only 13 inches in length; others are rather larger, and of a plain lead colour on the upper parts, and the wings black, though all are white, or nearly ſo, beneath. The legs in theſe two laſt are marked with black at the ends of the toes; and the claws are black."

PINION, in mechanics, an arbor, or ſpindle, in the body whereof are ſeveral notches, which catch the teeth of a wheel that ſerves to turn it round; or it is a leſſer wheel that plays in the teeth of a larger.

PINK, a name given to a ſhip with a very narrow ſtern; whence all veſſels, however ſmall, whoſe ſterns are faſhioned in this manner, are called *pink ſterned*.

Pink, in botany. See Dianthus.

PINNA, in zoology; a genus belonging to the order of vermes teſtacea. See Plate 40, Vol. VII. and the article Mytilus. The animal is a ſlug. The ſhell is bivalve, fragile, and furniſhed with a beard; gapes at one end; the valves hinge without a tooth. They inhabit the coaſts of Provence, Italy, and the Indian ocean. The largeſt and moſt remarkable ſpecies inhabits the Mediterranean. It is blind, as are all of the genus; but furniſhed with very ſtrong calcareous valves. The cuttle-fiſh *(ſepia)*, an inhabitant of the ſame ſea, is a deadly foe to this animal: as ſoon as the pinna opens its ſhell, he ruſhes upon her like a lion; and would always devour her, but for another animal whom ſhe protects within her ſhell, and from whom in return ſhe receives very important ſervices. It is an animal of the crab kind (ſee Cancer), naked like the hermit, and very quickſighted. This cancer or crab the pinna receives into her covering, and, when ſhe opens her valves in queſt of food, lets him out to look for prey. During this the cuttle-fiſh approaches; the crab returns with the utmoſt ſpeed and anxiety to his hoſteſs, who being thus warned of the danger ſhuts her doors, and keeps out the enemy. That very ſagacious obſerver Dr. Haſſelquiſt, in his voyage towards Paleſtine, beheld this curious phenomenon, which though well known to the ancients had eſcaped the moderns. Ariſtotle (*Hiſt.* lib. 5. c. 15.) relates, that the pinna kept a guard to watch for her: that there grew to the mouth of the pinna a ſmall animal, having claws, and ſerving as a caterer, which was like a crab, and was called the *pinnophylax*. Pliny (lib. 9. 51.) ſays, the ſmalleſt of all the kinds is called the *pinnoteres*, and therefore liable to injury; this has the prudence to hide itſelf in the ſhells of oyſters. Again, lib. 9. 66. he ſays, the pinna is of the genus of ſhell-fiſh; it is produced in muddy waters, always erect, nor ever without a companion, which ſome call the *pinnoteres*, others the *pinnophylax*. This ſometimes is a ſmall ſquill, ſometimes a crab, that follows the pinna for the ſake of food. The pinna, upon opening its ſhell, expoſes itſelf as a prey to the ſmalleſt kind of fiſhes; for they immediately aſſault her, and, growing bolder upon finding no reſiſtance, venture in. The guard watching its time gives notice by a bite; upon which the pinna, cloſing its ſhell, ſhuts in, kills, and gives part of whatever happens to be there to its companion.

The pinnæ marinæ differ leſs from muſcles in the ſize of their ſhells than in the fineneſs and number of certain brown threads which attach them to the rocks, hold them in a fixed ſituation, ſecure them from the rolling of the waves, epecially in tempeſts, and aſſiſt them in laying hold of ſlime. See Mytilus. Theſe threads, ſays Rondelet, are as fine, compared with thoſe of muſcles, as the fineſt flax is compared with tow. M. de Reaumur ſays, that theſe threads are nearly as fine and beautiful as ſilk from the ſilk-worm, and hence he calls them the *ſilk-worms of the ſea*. Stuffs, and ſeveral kinds of beautiful manufacture, are made of theſe threads at Palermo; in many places they are the chief object of fiſhing, and become a ſilk proper for many purpoſes. It requires a conſiderable number of the pinnæ marinæ for one pair of ſtockings. Nothing can equal the delicacy of this ſingular thread. It is ſo fine, that a pair of ſtockings made of it can be eaſily contained in a ſnuff-box of an ordinary ſize. In 1754, a pair of gloves or ſtockings of theſe materials was preſented to pope Benedict XIV. which, notwithſtanding their extreme fineneſs, ſecured the leg both from cold and heat. A robe of the ſame ſingular materials was the gift of the Roman emperor to the Satrap of Armenia. See *Procopius de Edif.* lib. 3. c. 1. A great many manufacturers are employed in manufacturing theſe threads into various ſtuffs at Palermo and other places.

The men who are employed in fiſhing up the pinna marina inform us, that it is neceſſary to break the tuft of threads. They are fiſhed up at Toulon, from the depth of 15, 20, and ſometimes more than 30, feet, with an inſtrument called a cramp. This is a kind of fork of iron, of which the prongs are perpendicular with reſpect to the handle. Each of them is about eight feet in length, and there is a ſpace between them of about ſix inches; the length of the handle is in proportion to the depth of the water; the pinnæ are ſeized, ſeparated from the rock, and raiſed to the ſurface by means of this inſtrument. The tuft of ſilk iſſues directly from the body of the animal; it comes from the ſhell at the place where it opens, about four or five inches from the ſummit or point in the large pinnæ.

M. de Reaumur, *Mem. de l'Acad. des Sciences*, 1711, page 216, and 1717, page 177, conſiders the pinna as the moſt proper of all ſhell-fiſh to elucidate the formation of pearls. It produces many of them of different colours, as grey or lead-coloured, red, and ſome of a blackiſh colour, and in the form of a pear.

M. d'Argenville diſtinguiſhes three kinds of the pinnæ: 1*ſt*, The *large* kind, which are red within, and which have reddiſh mother of pearl, ſimilar to the ſubſtance of the ſhell itſelf. There are of thoſe ſhells which weigh near 15 pounds. This is the *aſtura* of the Venetians. 2*d*, The *ſmaller* kind. Some of theſe are ſlender, *papyraceous*, of the colour of horn, a little ſhaded with pale red. 3*d*, The kind called *perna*. Theſe are adorned with points in the channels of their ſhell; but, what is very ſingular, the edges of the ſhell are thicker at the openings than at the joining of the valves. The animal which lodges in the pinna marina rarely ſhows itſelf, becauſe the valves are ſeldom opened. Its head is below, its largeſt extremity oppoſite; it is kept in the ſhell by four vigorous muſcles, placed at the extremities of the valves; the ſhell has no hinges, but a flat and blackiſh ligament, which is equal in length to one-half of the ſhell. See Pinnoterus and Pearl.

PINNACE, a ſmall veſſel navigated with oars and ſails, and having generally two maſts, which are rigged like thoſe of a ſchooner. Pinnace is alſo a boat uſually rowed with eight oars. See the article Boat.

PINNACLE, in architecture, the top or roof of a houſe, terminating in a point. This kind of roof among the ancients was appropriated to temples; their ordinary roofs were all flat, or made in the platform way.

PINNATED leaves, in botany. See Botany.

PINNATIFID, *Ibid.*

PINNOTERUS, or Pinnophylax, is a kind of crab-fiſh, furniſhed with very good eyes. It is ſaid to be the companion of the pinna marina. They live and lodge together in the ſame ſhell, which belongs to the latter. When it has occaſion to eat, it opens its valves, and ſends out its faithful purveyor to procure food. If during their labour the pinnoterus perceives the polypus, it immediately returns to warn its blind friend of the danger, when, by ſhutting its valves, it eſcapes the rage of its enemy; but when the pinnoterus loads itſelf with booty without moleſtation, it makes a gentle noiſe at the opening of the ſhell, and when admitted the two friends feaſt on the fruits of its induſtry. See Pinna, &c.

PINT, *(pinta)*, a veſſel, or meaſure, uſed in eſtimating the quantity of liquids, and even ſometimes of dry things—Budæus derives the word from the Greek πινθα; others from the German *pint*, a little meaſure of wine; Nicod from the Greek πινειν, "to drink." The *Engliſh pint* is twofold; the one for wine-meaſure, the other for beer and ale-meaſure. See Measure.

PINTADA, a ſpecies of Procellaria.

PINTLES, certain pints or hooks faſtened upon the back-part of the rudder, with their points downwards, in order to enter into, and reſt upon, the *googings*, fixed in the ſtern-poſt, to hang the rudder. See Helm.

PINTOR (Peter), born at Valentia in Spain, in the year 1420, was phyſician to Alexander VI. whom he followed to Rome, where he practiſed with great ſucceſs. He has left behind him two performances of conſiderable merit, 1. *Aggregator Sententiarum Doctorum de Curatione in Peſtilentia*, printed at Rome 1499, in folio. 2. *De Morbo Fœdo & Occulto his Temporibus affligenti*, &c. printed at Rome, 1500, in 4to, black letter; a book extremely ſcarce, unknown to Luiſini and Aſtruc, and which traces the venereal diſeaſe to the year 1496. Pintor died at Rome in 1503, aged 83 years.

PINTURICCIO (Bernardino), a celebrated Italian painter, born at Perugia in 1454. He was the diſciple of Peter Perugino, under whom he became ſo good an artiſt, that he employed him on many occaſions as his aſſiſtant. He principally painted hiſtory and groteſque; but he alſo excelled in portraits, among which thoſe of pope Pius II. and Innocent VIII. of Giulia Farneſe, Cæſar Borgia, and queen Iſabella of Spain, are particularly diſtinguiſhed. The moſt memorable performance of Pinturiccio is the hiſtory of Pius II. painted in ten compartments in the Hiſtory of Siena; in which undertaking, Raphael, then a young man, and bred under the ſame maſter, aſſiſted him ſo far as to ſketch out cartoons of many parts of the compoſition. The ſtory of his death is worth relating, eſpecially as it illuſtrates his character. The laſt work he was engaged in was a *Nativity* for the monaſtery of St. Francis at Siena: the monks accommodated him with a chamber to work in, which they cleared of all the furniture, except one old trunk or cheſt that appeared too rotten to move; but Pinturiccio, naturally poſitive and peeviſh, inſiſting on its being taken away, the monks, willing to gratify him, complied. It was no ſooner ſtirred than one of the planks burſting, out tumbled 500 pieces of gold, which had been ſecreted there for many years. The monks were overjoyed at finding this treaſure, and the painter proportionably mortified at loſing his chance of the diſcovery by his indiſcreet obſtinacy: it affected his ſpirits ſo much that he ſurvived but a few months, and it was generally conſidered as the cauſe of his death.

PINUS, the Pine-tree; a genus of the monadelphia order, belonging to the monœcia claſs of plants. The pine-tree was well known to the ancients, and has been deſcribed and celebrated both by their philoſophers and poets. Pliny enumerates no leſs than ſix ſpecies of trees of this genus; and it is mentioned by Virgil both in his Eclogues, his Georgics, and his Æneid; by Horace in his Odes; by Ovid in his Metamorphoſes; by Statius; and by Catullus, &c. Macrobius relates a pleaſant anecdote concerning the cones of pine-trees, which in common language were called *poma pinea*, "pine apples." There lived in the Auguſtan age one Vatinius, who by ſome means had irritated the Roman people ſo much that they pelted him with ſtones. When he entertained them with gladiators, to ſave himſelf from ſuch treatment for the future, he procured an edict from the ædiles, that no perſon ſhould throw any thing but apples in the amphitheatre. It accidentally happened that at this time Caſcellius, eminent for his wit as well as knowledge of the law, was conſulted on the queſtion, whether a pine-apple (the cone of the pine) was legally included in the term *pomum*, "an apple?" It is an apple (ſaid he) if you intend to fling it at Vatinius. (*Saturn.* lib. 2. cap. 6.) A deciſion by which the edict in his favour did not much mend his ſituation: for Martial repreſents it dangerous to come under this tree, becauſe the cones in his time were of ſo great a ſize and weight, probably enlarged by cultivation for ages.

Nuces Pineæ.
Poma ſumus Cybeles: procul hinc diſcede, viator,
Ne cadat in miſerum noſtra ruina caput.
Lib. 13. Ep. 25.

There are generally reckoned 14 ſpecies of this genus; of which the moſt remarkable are theſe following:

1. The *pinea*, *pinaſter*, or wild pine, grows naturally on the mountains in Italy and the ſouth of France. It grows to the ſize of a large tree; the branches extend to a conſiderable diſtance; and while the trees are young, they are fully garniſhed with leaves, eſpecially where they are not ſo cloſe as to exclude the air from thoſe within; but as they advance in age, the branches appear naked, and all thoſe which are ſituated below become unſightly in a few years; for which reaſon they are now much leſs in eſteem than formerly.

2. The *pinus pinea*, or ſtone pine, is a tall ever green tree, native of Italy and Spain. It delights in a ſandy loam, though like moſt others it will grow well in almoſt any land. Reſpecting the uſes of this ſpecies, Hanbury tells us that "the kernels are eatable, and by many preferred to almonds. In Italy they are ſerved up at table in their deſerts.—They are exceeding

wholeſome, being good for coughs, colds, conſumptions, &c. on which account only this tree deſerves to be propagated." Hanbury continues: " It may be very proper here to take notice of a very great and dangerous miſtake Mr. Miller has committed, by ſaying, under this article of ſtone-pine, that ſeeds kept in the cones will be good and grow if they are ſown ten or twelve years after the cones have been gathered from the trees: whereas the ſeeds of this ſort, whether kept in the cones or taken out, are never good after the firſt year; and though ſometimes a few plants will come up from the ſeeds that are kept in the cones for two years before, yet this is but ſeldom; neither muſt a tenth part of a crop be expected. This caution is the more neceſſary, as ſeveral gentlemen who had cones, upon reading Mr. Miller's book, and finding the ſeeds would take no damage when kept there, deferred the work for a ſeaſon or two, when they thought they ſhould have more conveniency either of men or ground for their purpoſe, and were afterwards wholly diſappointed, no plants appearing, the ſeeds being by that time ſpoiled and worth nothing."

3. The *rubra*, commonly called the *Scots fir* or *pine*. It is common throughout Scotland, whence its name, though it is alſo found in moſt of the other countries of Europe. M. du Hamel, of the Royal Academy of Sciences, mentions his having received ſome ſeeds of it from St. Domingo in the Weſt Indies; and thence concludes, that it grows indifferently in the temperate, frigid, and torrid zones. The wood of this tree is the red or yellow deal, which is the moſt durable of any of the kinds yet known. The leaves of this tree are much ſhorter and broader than thoſe of the former ſort, of a greyiſh colour, growing two out of one ſheath; the cones are ſmall, pyramidal, and end in narrow points; they are of a light colour, and the ſeeds are ſmall.

4 The *pinus picea*, or yew-leaved fir, is a tall ever-green, and a native of Scotland, Sweden, and Germany. This ſpecies includes the ſilver fir and the balm of Gilead fir. The firſt of theſe is a noble upright tree. Mr. Marſham ſays, " The talleſt trees I have ſeen were ſpruce and ſilver firs in the valleys in Switzerland. I ſaw ſeveral firs in the dock-yards in Venice 40 yards long; and one of 39 yards was 18 inches diameter at the ſmall end. I was told they came from Switzerland."

The branches are not very numerous, and the bark is ſmooth and delicate. The leaves grow ſingly on the branches, and their ends are ſlightly indented. Their upper ſurface is of a fine ſtrong green colour, and their under has an ornament of two white lines running lengthwiſe on each ſide the midrib; on account of which ſilvery look this ſort is called the *ſilver fir*. The cones are large, and grow erect; and, when the warm weather comes on, they ſoon ſhed their ſeeds; which ſhould be a caution to all who wiſh to raiſe this plant, to gather the cones before that happens.

The balm of Gilead fir has of all the ſorts been moſt coveted, on account of the great fragrance of its leaves; though this is not its only good property: for it is a very beautiful tree, naturally of an upright growth, and the branches are ſo ornamented with their balmy leaves, as to exceed any of the other ſorts in beauty. The leaves, which are very cloſely ſet on the branches, are broad; and their ends are indented. Their upper ſurface, when healthy, is of a fine dark green colour, and their under has white lines on each ſide the mid-rib lengthwiſe, nearly like thoſe of the ſilver fir. Theſe leaves when bruiſed are very finely ſcented; and the buds, which ſwell in the autumn for the next year's ſhoot, are very ornamental all winter, being turgid, and of a fine brown colour: and from theſe alſo exudes a kind of fine turpentine, of the ſame kind of (though heightened) fragrancy. The tree being wounded in any part, emits plenty of this turpentine; and Hanbury ſays, " it is ſuppoſed by many to be the ſort from whence the balm of Gilead is taken, which occaſions this tree being ſo called. But this is a miſtake; for the true balm of Gilead is taken from a kind of terebinthus; though I am informed, that what has been collected from this tree has been ſent over to England from America (where it grows naturally), and often ſold in the ſhops for the true ſort."

The ſilver fir is very hardy, and will grow in any ſoil or ſituation, but always makes the greateſt progreſs in rich loamy earth. The balm of Gilead fir muſt be planted in deep, rich, good earth; nor will it live long in any other. The ſoil may be a black mould, or of a ſandy nature, if it be deep enough, and if the roots have room enough to ſtrike freely.

5. The *pinus abies*, or European ſpruce fir, a native of the northern parts of Europe and Aſia, includes the Norway ſpruce and long-coned Corniſh fir. The former of theſe is a tree of as much beauty while growing as its timber is valuable when propagated on that account. Its growth is naturally like the ſilver, upright: and the height it will aſpire to may be eaſily conceived, when we ſay that the white deal, ſo much coveted by the joiners, &c. is the wood of this tree; and it may perhaps ſatisfy the curious reader to know, that from this fir pitch is drawn. The leaves are of a dark-green colour; they ſtand ſingly on the branches, but the younger ſhoots are very cloſely garniſhed with them. They are very narrow; their ends are pointed; and they are poſſeſſed of ſuch beauties as to excite admiration. The cones are eight or ten inches long, and hang downwards.

The better the ſoil is, the faſter will the ſpruce fir grow, though it will thrive very well in moſt of our Engliſh lands. In ſtrong loamy earth it makes a ſurpriſing progreſs; and it delights in freſh land of all ſorts, which never has been worn out by ploughing, &c. though it be ever ſo poor. The long-coned Corniſh fir differs ſcarcely in any reſpect from the Norway ſpruce, except that the leaves and the cones are larger.

6. The *pinus Canadenſis*, American or Newfoundland ſpruce fir, a native of Canada, Pennſylvania, and other parts of North America, includes three varieties. The white Newfoundland ſpruce, the red Newfoundland ſpruce, and the black Newfoundland ſpruce. Theſe, however, differ ſo little, that one deſcription is common to them all. They are of a genteel upright growth, though they do not ſhoot ſo freely, or grow ſo faſt with us as the Norway ſpruce. The leaves are of the ſame green, and garniſh the branches in the ſame beautiful manner as thoſe of that ſpecies; only they are narrower, ſhorter, and ſtand cloſer. The greateſt difference is obſervable in the cones; for theſe are no more than about an inch in length, and the ſcales are cloſely placed. In the cones, indeed, conſiſts the difference of theſe three ſorts: thoſe of the white ſpecies are of a very light brown colour; thoſe of the red ſpecies more of a nut brown or reddiſh colour; and thoſe of the black ſpecies of a dark or blackiſh colour. Beſides this, there is ſcarcely any material difference; though it is obſervable, that this trifling variation ſeems to be pretty conſtant in the plants raiſed from the like ſeeds. Theſe ſorts will often flower, and produce cones when only about five or ſix feet high; and indeed look then very beautiful: but this is a ſign of weakneſs in the plant, which it does not often fairly get over.

7. The *pinus balſamea*, or hemlock-fir, a native of Virginia and Canada, poſſeſſes as little beauty as any of the fir tribe; though, being rather ſcarce in proportion, it is deemed valuable. It is called by ſome the *yew leaved fir*, from the reſemblance of the leaves to thoſe of the yew-tree. It is a tree of low growth, with but few branches: and theſe are long and ſlender, and ſpread abroad without order. The leaves do not garniſh the branches ſo plentifully as thoſe of any other ſort of fir. The cones are very ſmall and rounded; they are about half an inch long; and the ſcales are looſely arranged. We receive theſe cones from America, by which we raiſe the plants; though this caution ſhould be given to the planter, that this tree is fond

of moiſt rich ground, and in ſuch a kind of ſoil will make the greateſt progreſs.

8. The *pinus orientalis*, or oriental fir, a native of the Eaſt, is a low but elegant tree. The leaves are very ſhort, and nearly ſquare. The fruit is exceeding ſmall, and hangs downward; and the whole tree makes an agreeable variety with the other kinds.

9. The *ſtrobus*, lord Weymouth's pine, or North American white pine. This grows ſometimes to the height of 100 feet and upwards, and is highly valued on account of its beauty. The bark of the tree is very ſmooth and delicate, eſpecially when young; the leaves are long and ſlender, five growing out of one ſheath; the branches are pretty cloſely garniſhed with them, and thus make a fine appearance. The cones are long, ſlender, and very looſe, opening with the firſt warmth of the ſpring; ſo that, if they are not gathered in winter, the ſcales open and let out the ſeeds. The wood of this ſort is eſteemed for making maſts for ſhips. In queen Anne's time there was a law made for the preſervation of theſe trees, and for the encouragement of their growth in America. Within theſe laſt 50 years they have been propagated in Britain in conſiderable plenty.

With reſpect to the culture of this ſpecies, Mr. Hanbury, after ſome more general directions, continues thus: "I have known gentlemen, who, in attempting to raiſe theſe trees, have ſeen the young plants go off without perceiving the cauſe; and, the more watering and pains they have taken, have found the plants perſiſt in this way more and more, to their great mortification and aſtoniſhment. In the ſpring following theſe plants ſhould be pricked out in beds half a foot aſunder each way; and here they may ſtand two years, when they may be either finally planted out, or removed into the nurſery, at the diſtance of one foot aſunder, and two feet in the rows. If care has been taken of them in the nurſery, they may be removed at a conſiderable height with great aſſurance of ſucceſs; for it is much eaſier to make this pine grow than any of the other ſorts: ſo that, where they are wanted for ornament in parks, open places, &c. a ſhew of them may be made in a little time.

"The ſoil the Weymouth pine delights in moſt is a ſandy loam; but it likes other ſoils of an inferior nature: and although it is not generally to be planted on all lands like the Scotch fir, yet I have ſeen it luxuriant and healthy, making ſtrong ſhoots, on blue and red clays, and other ſorts of ſtrong ground. On ſtony and ſlaty ground, likewiſe, I have ſeen ſome very fine trees; ſo that, I believe, whoever is deſirous of having plantations of this pine need not be curious in the choice of his ground."

10. The *pinus tæda*, or ſwamp-pine, is a tall evergreen tree, a native of the ſwamps of Virginia and Canada. There are ſeveral varieties of this genus which Hanbury enumerates and deſcribes: ſuch as, 1ſt, The three-leaved American ſwamp-pine. 2d, The two-leaved American pine. 3d, The yellow American pine, the yellow tough pine, and the tough pine of the plains; among which there is but little variety. 4th, The baſtard pine. 5th, The frankincenſe pine. And 6th, The dwarf pine.

"There are many (continues our author) other ſorts of American pines, which we receive from thence with the like cant names of thoſe of the above, which I have choſen to retain, as they will probably be continued to be ſent over; and that the gardener receiving them as ſuch may beſt know what to do with them. In many of thoſe ſorts I ſee at preſent no material difference; ſo am induced to think they are the ſame, ſent over with different names. Some of the ſorts above mentioned differ in very few reſpects; but I have choſen to mention them, as a perſon may be ſupplied with the ſeeds from Pennſylvania, Jerſey, Virginia, Carolina, &c. where they all grow naturally: and having once obtained the ſeeds, and from them plants, they will become pleaſing objects of his niceſt obſervations."

11. The *pinus cedrus*, ranked by Tournefort and others under larix, famous for its duration, is that popularly called by us the *cedar of Lebanon*, by the ancients *cedrus magna* or the *great cedar*; alſo *cedrelate*, κεδρελάτη, and ſometimes the Phœnician or Syrian cedar, from the country where it grows in its greateſt perfection. It is a coniferous evergreen, of the bigger ſort, bearing large roundiſh cones of ſmooth ſcales, ſtanding erect, the leaves being ſmall, narrow, and thick ſet. They ſometimes counterfeit cedar, by dyeing wood of a reddiſh hue: but the ſmell diſcovers the cheat, that of true cedar being very aromatic. In ſome places, the wood of the cajou-tree paſſes under the name of cedar, on account of its reddiſh colour and its aromatic ſmell, which ſomewhat reſemble that of ſantal. Cedar-wood is reputed almoſt immortal and incorruptible; a prerogative which it owes chiefly to its bitter taſte, which the worms cannot endure. For this reaſon it was that the ancients uſed cedar tablets to write upon, eſpecially for things of importance, as appears from that expreſſion of Perſius, *Et cedra digna locutus*. A juice was alſo drawn from cedar, with which they ſmeared their books and writings, or other matters, to preſerve them from rotting; which is alluded to by Horace: by means of which it was, that Numa's books, written on papyrus, were preſerved entire to the year 535, as we are informed by Pliny.

Solomon's temple, as well as his palace, were both of this wood. That prince gave king Hiram ſeveral cities for the cedars he had furniſhed him on theſe occaſions. Cortes is ſaid to have erected a palace at Mexico, in which were 7000 beams of cedar, moſt of them 120 feet long, and twelve in circumference, as we are informed by Herrera. Some tell us of a cedar felled in Cyprus 130 feet long, and 18 in diameter. It was uſed for the main-maſt, in the galley of king Demetrius. Le Bruyn aſſures us, that the two biggeſt he ſaw on mount Lebanon meaſured, one of them 57 palms, and the other 47, in circumference. In the temple of Apollo at Utica, there were cedar trees near 2000 years old, which yet were nothing to that beam in an oratory of Diana at Seguntum in Spain, ſaid to have been brought thither 200 years before the deſtruction of Troy. Cedar is of ſo dry a nature, that it will not endure to be faſtened with iron nails, from which it uſually ſhrinks; ſo that they commonly faſten it with pins of the ſame wood.

"The ſtatue (ſays Hanbury) of the great godleſs at Epheſus was made of this material; and, if this tree abounded with us in great plenty, it might have a principal ſhare in our moſt ſuperb edifices. The effluvia conſtantly emitted from its wood are ſaid to purify the air, and make rooms wholeſome. Chapels and places ſet apart for religious duties being wainſcoted with this wood, inſpire the worſhippers with a more ſolemn awe. It is not obnoxious to worms; and emits an oil which will preſerve cloth or books from worms or corruption. The ſaw duſt will preſerve human bodies from putrefaction; and is therefore ſaid to be plentifully uſed in the rites of embalming, where practiſed."

It is remarkable that this tree is not to be found as a native in any other part of the world than mount Libanus, as far as hath yet been diſcovered. What we find mentioned in Scripture of the lofty cedars can be nowiſe applicable to the common growth of this tree; ſince, from the experience we have of thoſe now growing in England, as alſo from the teſtimony of ſeveral travellers who have viſited thoſe few remaining trees on mount Libanus, they are not inclined to grow very lofty, but on the contrary extend their branches very far; with which the alluſion made by the Pſalmiſt agrees very well, when he is deſcribing the flouriſhing ſtate of a people, and ſays, "They ſhall ſpread their branches like the cedar-tree."

Ranwolf, in his Travels, ſays, there were not at that time (i. e. anno 1574) upon mount Libanus more than 26 trees remaining, 24 of which ſtood in a circle; and the other two, which ſtood at a ſmall diſtance, had their branches almoſt conſumed with age; nor could he find any younger tree coming up to ſucceed them, though he looked about diligently for ſome. Theſe trees (he ſays) were growing at the foot of a ſmall hill, on the top of the mountains, and amongſt the ſnow. Theſe having very large branches, commonly bend the tree to one ſide, but are extended to a great length, and in ſo delicate and pleaſant order, as if they were trimmed and made even with great diligence; by which they are eaſily diſtinguiſhed, at a great diſtance, from fir-trees. The leaves (continues he) are very like to thoſe of the larch-tree, growing cloſe together in little bunches upon ſmall brown ſhoots.

Maundrel, in his Travels, ſays, there were but 16 large trees remaining when he viſited the mountain, ſome of which were of a prodigious bulk, but that there were many more young ones of a ſmaller ſize: he meaſured one of the largeſt, and found it to be 12 yards ſix inches in girth, and yet ſound, and 37 yards in the ſpread of its boughs. At about five or ſix yards from the ground it was divided into five limbs, each of which was equal to a great tree. What Maundrel hath related was confirmed by a gentleman who was there in the year 1720, with this difference only, viz. in the dimenſions of the branches of the largeſt tree, which he meaſured, and found to be 22 yards diameter. Now, whether Mr. Maundrel meant 37 yards in circumference of the ſpreading branches, or the diameter of them, cannot be determined by his words; yet either of them well agrees with this laſt account.

12. There is another ſpecies, viz. the *larch-tree*, which the old botaniſts ranked under larix, with deciduous leaves, and oval obtuſe cones. It grows naturally upon the Alps and Apennines, and of late has been very much propagated in Britain. It is of quick growth, and the trunk riſes to 50 feet or more; the branches are ſlender, their ends generally hanging downward, and are garniſhed with long narrow leaves which ariſe in cluſters from one point, ſpreading open above like the hairs of a painter's bruſh: they are of a light green, and fall away in autumn. In the month of April the male flowers appear, which are diſpoſed in form of ſmall cones; the female flowers are collected into oval obtuſe cones, which in ſome ſpecies have bright purple tops, and in others they are white: theſe differences are accidental; the cones are about an inch long, obtuſe at their points; the ſcales are ſmooth, and lie over each other: under each ſcale there are generally lodged two ſeeds, which have wings. There are two other varieties of this tree, one of which is a native of America, and the other of Siberia. The cones of the American kind which have been brought to Britain ſeem in general to be larger than thoſe of the common ſort.

"Many encomiums (ſays Hanbury when ſpeaking of this ſpecies) have been beſtowed on the timber of the larch: and we find ſuch a favourable account of it in ancient authors, as ſhould induce us to think it would be proper for almoſt any uſe. Evelyn recites a ſtory of Witſen, a Dutch writer, that a ſhip built of this timber and cypreſs had been found in the Numidian ſea, twelve fathoms under water, ſound and entire, and reduced to ſuch a hardneſs as to reſiſt the ſharpeſt tool, after it had lain ſubmerged above 1400 years. Certain it is this is an excellent wood for ſhip and houſe-building. At Venice this wood is frequently uſed in building their houſes, as well as in Switzerland, where theſe trees abound: ſo that, without all doubt, the larch excells for maſts for ſhips, or beams for houſes, doors, windows, &c. particularly as it is ſaid to reſiſt the worm.

"In Switzerland[*] their houſes are covered with boards of this wood cut out a foot ſquare; and, as it emits a reſinous ſubſtance, it ſo diffuſes itſelf into every joint and crevice, and becomes ſo compact and cloſe, as well as ſo hardened by the air, as to render the covering proof againſt all weather. But as ſuch covering for houſes would cauſe great devaſtation in caſe of fire, the buildings are confined to a limited diſtance by an order of police from the magiſtrates. The wood, when firſt laid on the houſes, is ſaid to be very white; but this colour in two or three years is changed, by means of the ſun and reſin, to a black, which appears like a ſmooth ſhining varniſh."

Of the common larch there are ſeveral varieties. The flowers which the commoneſt ſort exhibits early in the ſpring are of a delicate red colour; another ſort produces white flowers at the ſame ſeaſon, and theſe have a delightful effect among thoſe of the red ſort; whilſt another, called the *black Newfoundland larix*, increaſes the variety, though by an aſpect little differing from the others. There are alſo larches with greeniſh flowers, pale red, &c. all of which are accidental varieties from ſeeds. Theſe varieties are eaſily diſtinguiſhed, even when out of blow: the young ſhoots of the white-flowering larch are of the lighteſt green, and the cones when ripe are nearly white. The red flowering larch has its ſhoots of a reddiſh caſt, and the cones are of a brown colour; whilſt the cones and ſhoots of the black Newfoundland larch are in the ſame manner proportionally tinged. The cones, which are a very great ornament to ſeveral ſorts of the pines, are very little to theſe. Their chief beauty conſiſts in the manner of their growth, the nature and beauty of their pencilled leaves and fair flowers; for the cones that ſucceed them are ſmall, of a whitiſh, a reddiſh, or a blackiſh brown colour, and make no figure.

The pinus cedrus and pinus larix are propagated by ſowing in March on a bed of light earth expoſed to the morning ſun. The ſeed muſt be covered half an inch thick with fine light earth, and the beds watered at times when the weather is dry. In about ſix weeks the plants will appear; they muſt at this time be carefully guarded from the birds, ſhaded from the ſun and winds, and kept very clear of weeds. In the latter end of April the following year, they may be removed into beds of freſh earth, placing them at ten inches diſtance every way. They are to be kept here two years, and ſuch of them as ſeem to bend muſt be tied up to a ſtake to keep them upright. They may afterwards be planted in the places where they are to remain. They thrive well on the ſides of barren hills, and make a very pretty figure there.

Reſpecting the uſes of this tree, Dr. Pallas, in his *Flora Roſſica*, informs us, that if it is burnt, and the wood conſumed, the internal part of the wood diſtills copiouſly a drying reddiſh gum, a little leſs glutinous than gum arabic, ſomewhat of a reſinous taſte, but wholly ſoluble in water. At the inſtigation of M. Kinder, this gum has lately been ſold in the Ruſſian ſhops under the name of *gummi Orenburgenſis*, but which our author thinks ſhould be called *gummi uralienſe* or *laricis*. It is eaten by the Woguli as a dainty, and is ſaid to be nutritious and antiſcorbutic. Some manna was gathered from the green leaves, but it could never be condenſed. The Ruſſians uſe the boletus laricinus as an emetic in intermittents, and to check the leucorrhœa. At Batchir and Siberia the inhabitants ſprinkle the dry powder on the wounds of oxen and horſes, as a detergent and anthelmintic. The nuts of the pinus cembra, the ſame author aſſerts, are eaten as luxuries in Ruſſia, and are even exported with the ſame view. The unripe cones give a very fragrant oil, termed balſamic. The inhabitants of Siberia uſe the tender tops, and even the bark rubbed off in the ſpring, as an antiſcorbutic. The kernels of the nuts of the amygdalus nana give a very pleaſing flavour to brandy; and, when preſſed, afford a bitter oil in large quantities. The way of deſtroying the bitter is by digeſting it in the ſun with ſpirit of wine, and it then becomes ſweet and extremely agreeable.

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[*] "Between Bex and Devieux (ſays Coxe in his *Travels in Switzerland*), I obſerved the larch in great plenty. Painters, from the time of Pliny to that of Raphael, truſted their works to this wood, which the Roman naturaliſt ſtyles *immortale lignum*. The wood is reckoned excellent for all works which are to lie under water: and the borderers on the lake of Geneva prefer it for building their veſſels. In theſe parts I ſaw moſt beautiful woods of cheſnut. Haller ſays that they extend ſome leagues: he alſo informs us, that they are found in other parts of Switzerland, and even in deſert places in ſome of the tranſalpine parts. Accident muſt have brought them thither, as it appears from Pliny that theſe trees were firſt introduced into Europe from Sardis."

From the larch-tree is extracted what we erroneouſly call *Venice turpentine*. This ſubſtance, or natural balſam, flows at firſt without inciſion: when it has done dropping, the poor people who wait in the fir woods make inciſions at about two or three feet from the ground into the trunks of the trees, into which they fix narrow troughs about 20 inches long. The end of theſe troughs is hollowed like a ladle; and in the middle is a ſmall hole bored for the turpentine to run into the receiver which is placed below it. As the gummy ſubſtance runs from the trees, it paſſes along the ſloping gutter or trough to the ladle, and from thence runs through the holes into the receiver. The people who gather it viſit the trees morning and evening from the end of May to September, to collect the turpentine out of the receivers. When it flows out of the tree, Venice turpentine is clear like water, and of a yellowiſh white; but, as it grows older, it thickens and becomes of a citron colour. It is procured in the greateſt abundance in the neighbourhood of Lyons, and in the valley of St. Martin near St. Lucern in Switzerland.

Though we have already noticed the manner of cultivating ſome of the particular ſpecies of this genus, and have alſo remarked the uſes of ſome of them, we ſhall finiſh the article with a few general obſervations on the culture and uſes of the whole.

All the ſorts of pines are *propagated* by ſeeds produced in hard woody cones. The way to get the ſeeds out of theſe cones is to lay them before a gentle fire, which will cauſe the cells to open, and then the ſeeds may be eaſily taken out. If the cones are kept entire, the ſeeds will remain good for ſome years; ſo that the ſureſt way of preſerving them is to let them remain in the cones till the time for ſowing the ſeeds. If the cones are kept in a warm place in ſummer, they will open and emit the ſeeds: but if they are not expoſed to the heat, they will remain cloſe for a long time. The beſt ſeaſon for ſowing the pines is about the end of March. When the ſeeds are ſown, the place ſhould be covered with nets to keep off the birds; otherwiſe, when the plants begin to appear with the huſk of the ſeed on the top of them, the birds will peck off the tops, and thus deſtroy them.

From the firſt ſpecies is extracted the common turpentine, much uſed by farriers, and from which is drawn the oil of that name. The proceſs of making pitch, tar, reſin, and turpentine, from theſe trees is very familiar. In the ſpring time, when the ſap is moſt free in running, they pare off the bark of the pine tree, to make the ſap run down into a hole which they cut at the bottom to receive it. In the way, as it runs down, it leaves a white matter like cream, but a little thicker. This is very different from all the kinds of reſin and turpentine in uſe, and it is generally ſold to be uſed in the making of flambeaux inſtead of white bees wax. The matter that is received in the hole at the bottom is taken up with ladles, and put in a large baſket: a great part of this immediately runs through, and this is the common turpentine. This is received into ſtone or earthen pots, and is ready for ſale. The thicker matter, which remains in the baſket, they put into a common alembic, adding a large quantity of water. They diſtil this as long as any oil is ſeen ſwimming on the water. This oil they ſeparate from the ſurface in large quantities, and this is the common oil or ſpirit of turpentine. The remaining matter at the bottom of the ſtill is common yellow reſin. When they have thus obtained all that they can from the ſap of the tree, they cut it down; and, hewing the wood into billets, they fill a pit dug in the earth with theſe billets; and, ſetting them on fire, there runs from them, while they are burning, a black thick matter. This naturally falls to the bottom of the pit, and this is the tar. The top of the pit is covered with tiles, to keep in the heat; and there is at the bottom a little hole, out at which the tar runs like oil. If this hole be made too large, it ſets the whole quantity of the tar on fire; but, if ſmall enough, it runs quietly out.

The tar, being thus made, is put up in barrels; and if it be to be made into pitch, they put it into large boiling veſſels, without adding any thing to it. It is then ſuffered to boil a while, and, being then let out, is found when cold to be what we call pitch.

A decoction of the nuts or ſeeds of the firſt ſpecies in milk, or of the extremities of the branches pulled in ſpring, is ſaid, with a proper regimen, to cure the moſt inveterate ſcurvy. The wood of this ſpecies is not valued; but that of the Scots pine is ſuperior to any of the reſt. It is obſervable of the Scots pine, that when planted in bogs, or in a moiſt ſoil, though the plants make great progreſs, yet the wood is white, ſoft, and little eſteemed; but when planted in a dry ſoil, though the growth of the trees is there very ſlow, yet the wood is proportionally better. Few trees have been applied to more uſes than this. The talleſt and ſtraighteſt are formed by nature for maſts to our navy. The timber is reſinous, durable, and applicable to numberleſs domeſtic purpoſes, ſuch as flooring and wainſcoting of rooms, making of beds, cheſts, tables, boxes, &c. From the trunk and branches of this, as well as moſt others of the pine tribe, tar and pitch are obtained. By inciſion, barras, Burgundy pitch, and turpentine, are acquired and prepared. The reſinous roots are dug out of the ground in many parts of the Highlands, and, being divided into ſmall ſplinters, are uſed by the inhabitants to burn inſtead of candles. At Loch-Broom, in Roſs-ſhire, the fiſhermen make ropes of the inner bark; but hard neceſſity has taught the inhabitants of Sweden, Lapland, and Kamtſchatka, to convert the ſame into bread. To effect this, they, in the ſpring ſeaſon, make choice of the talleſt and faireſt trees; then ſtripping off carefully the outer bark, they collect the ſoft, white, ſucculent interior bark, and dry it in the ſhade. When they have occaſion to uſe it, they firſt toaſt it at the fire, then grind, and after ſteeping the flour in warm water to take off the reſinous taſte, they make it into thin cakes, which are baked for uſe. On this ſtrange food the poor inhabitants are ſometimes conſtrained to live for a whole year; and, we are told, through cuſtom, become at laſt even fond of it. Linnæus remarks, that this ſame bark bread will fatten ſwine; and humanity obliges us to wiſh, that men might never be reduced to the neceſſity of robbing them of ſuch a food. The interior bark, of which the above-mentioned bread is made, the Swediſh boys frequently peel off the trees in the ſpring, and eat raw with greedy appetite. From the cones of this tree is prepared a diuretic oil, like the oil of turpentine, and a reſinous extract, which has ſimilar virtues with the balſam of Peru. An infuſion or tea of the buds is highly commended as an antiſcorbutic. The farina, or yellow powder, of the male flowers, is ſometimes in the ſpring carried away by the winds, in ſuch quantities, where the trees abound, as to alarm the ignorant with the notion of its raining brimſtone. The tree lives to a great age; Linnæus affirms, to 400 years.

PIONEERS, in the art of war, are ſuch as are commanded in from the country, to march with an army for mending the ways, for working on intrenchments and fortifications, and for making mines and approaches. The ſoldiers are likewiſe employed for all theſe purpoſes. Moſt of the foreign regiments of artillery have half a company of pioneers, well inſtructed in that important branch of duty. Our regiments of infantry and cavalry have three or four pioneers each, provided with aprons, hatchets, ſaws, ſpades, and pick-axes. Each pioneer muſt have an ax, a ſaw, and an apron; a cap with a leather crown, and a black bear-ſkin front, on which is to be the king's creſt in white, on a red ground; and the number of the regiment is to be on the back part of it.

PIP, or Pep, a diſeaſe among poultry, conſiſting of a white ſkin, or film, that grows under the tip of the tongue, and hinders their feeding. It uſually ariſes from want of water, or from the drinking puddle-water, or eating filthy meat. It is cured by pulling off the film with the fingers, and rubbing the tongue with ſalt. Hawks are particularly liable to this diſeaſe, eſpecially from feeding on ſtinking fleſh.

PIPE, in building, &c. a canal, or conduit, for the conveyance of water and other liquids. Pipes for water, water-engines, &c. are uſually of lead, iron, earth, or wood: the latter are uſually made of oak or elder. Thoſe of iron are caſt in forges; their uſual length is about two feet and a half: ſeveral of theſe are commonly faſtened together by means of four ſcrews at each end, with leather or old hat between them, to ſtop the water. Thoſe of earth are made by the potters; theſe are fitted into one another, one end being always made wider than the other. To join them the cloſer, and prevent their breaking, they are covered with tow and pitch: their length is uſually about that of the iron pipes. The wooden pipes are trees bored with large iron augers, of different ſizes, beginning with a leſs, and then proceeding with a larger ſucceſſively; the firſt being pointed, the reſt being formed like ſpoons, increaſing in diameter, from one to ſix inches or more: they are fitted into the extremities of each other (as repreſented in pl. 2. fig. 2.), and are ſold by the foot.

Wooden pipes are bored as follows. The machine repreſented fig. 1. is put in motion by the wheel A, which is moved by a current of water: upon the axle of this wheel is a cog-wheel B, which cauſes the lanterns C, D, to turn horizontally, whoſe common axis is conſequently in a perpendicular direction. The lantern D turns at the ſame time two cog-wheels, E and F: the firſt, E, which is vertical, turns the auger which bores the wood; and the ſecond, F, which is horizontal, cauſes the carriage bearing the piece to advance by means of the arms H, I, which take hold of the notches in the wheel K. The firſt, H, by means of the notches, draws the wheel towards F; and the other, I, puſhes the under-poſt of the wheel in an oppoſite direction; both which motions tend to draw the carriage towards F, and conſequently cauſe the auger to pierce the wood. The auger being from 9 to 12 feet in length, and of a proportionable bigneſs, it will be neceſſary to have two pieces, as L, L, to ſupport its weight, and cauſe it to enter the piece to be bored with the ſame uniformity.

For the conſtruction of leaden pipes, ſee PLUMBERY.

Air-PIPES. See AIR-*Pipes*.

PIPES *of an Organ*. See ORGAN.

Bag-PIPE. See BAG-*Pipe*.

Horn-PIPE. See HORNPIPE.

Tobacco-PIPE, a machine uſed in the ſmoking of tobacco, conſiſting of a long tube, made of earth or clay, having at one end a little caſe, or furnace, called the *bowl*, for the reception of the tobacco, the fumes whereof are drawn by the mouth through the other end. Tobacco-pipes are made of various faſhions; long, ſhort, plain, worked, white, varniſhed, unvarniſhed, and of various colours, &c. The Turks uſe pipes three or four feet long, made of ruſhes, or of wood bored, at the end whereof they fix a kind of a pot of baked earth, which ſerves as a bowl, and which they take off after ſmoking.

PIPE, alſo denotes a veſſel or meaſure for wine, and things meaſured by wine-meaſure. See BARREL and MEASURE.

PIPE, in mining, is where the ore runs forward endwiſe in a hole, and doth not ſink downwards or in a vein.

PIPE, *Pipa*, in law, is a roll in the exchequer, called alſo the *great roll*. See the next article.

PIPE *Office*, is an office wherein a perſon called the *clerk of the pipe* makes out leaſes of crown lands, by warrant from the lord treaſurer, or commiſſioners of the treaſury, or chancellor of the exchequer. The clerk of the pipe makes out alſo all accounts of ſheriffs, &c. and gives the accountants their *quietus eſt*. To this office are brought all accounts which paſs the remembrancer's office, and remain there, that if any ſtated debt be due from any perſon, the ſame may be drawn down into the great roll of the pipe: upon which the comptroller iſſues out a writ, called the *ſummons of the pipe*, for recovery thereof; and if there be no goods or chattels, the clerk then draws down the debts to the lord treaſurer's remembrancer, to write eſtreats againſt their lands. All tallies which vouch the payment of any ſum contained in ſuch accounts are examined and allowed by the chief ſecondary of the pipe. Beſides the chief clerk in this office, there are eight attorneys or ſworn clerks, and a comptroller.

PIPE *Fiſh*, in ichthyology. See SYNGNATHUS.

Sea PIPES, in zoology, are univalve ſhells, of an oblong figure, terminating in a point, ſometimes a little bending, and ſometimes ſtraight. Sea ears, figures of which we have given along with the ſea-pipes, are alſo univalve flat ſhells, reſembling in ſhape the ear of a man. In ſea ears it is not uncommon to find ſmall pearls, the ſeeds of which are often found in the middle of their cavities, which are of the fineſt naker or mother-of-pearl colour. There are ridges on both ſides; thoſe without form a kind of volute or ſpire, terminating in an eye. In theſe ſhells there is a row of round holes, ſix of which generally go quite through.

There is a ſhell of this kind, which is longer in proportion to its width, and much leſs common, for it is never found in our ſeas. There is yet another, very fine and thin, of a dirty grey colour, neither nakered nor perforated as the others are; the inner rim is ſpiral, and at ſome diſtance from the outer.

The ſea-pipes are diſtinguiſhed from ſea-worms by having their pipes ſingle; whereas the others form an aſſemblage of pipes joined together. The ſea worms, from the number and junction of their parts, are multivalves. The ſhells of pipes called *dentales* and *antales* are diſtinguiſhed from each other only by their ſize, the antales being much the leaſt. The *ſea pencil*, or *watering-ſpout*, is the moſt remarkable ſhell of this tribe, and muſt be conſidered as having a ſpecific character, either by its form, which is ſtraight, or the ſingularity of its ſuperior extremity, which is perforated like the ſpout of a watering-pot.

In plate 40, Vol. VII. the ſhell, fig. 1. pierced with many holes, is found with its natural covering in our ſeas. It is finely nakered within, and in the middle of its hollow or cavity contains many ſmall pearls. Fig. 2. is placed on its upper ſide to ſhew its ſpots, which are red upon a ground of the pureſt white; the ridges are prominent; the rim and the eye are irregular and notched. Fig. 4. the ſingularity of this ſhell conſiſts in its being neither nakered nor perforated, and in turning very much up near the eye of its ſpire or contour. Fig. 5. is a pencil or watering-ſpout; at the head is a kind of ruff, and within it is formed like the end of a watering-ſpout, perforated with many holes, which, when the fiſh is alive, are filled with very fine threads, like the hairs of a painter's pencil. Fig. 6. are called dentals, from their reſemblance of elephants' teeth; the point or apex is white, and the other extremity green. They are both ribbed and nakered, and are diſtinguiſhed from each other only by ſome excreſcences which appear on the uppermoſt. Fig. 7. are two ſmall ſhells of the dental figure, called for diftinction antales. They are perfectly ſmooth; one is white, and the other reddiſh.

PIPER, in ichthyology. See Trigla.

Piper, *Pepper*; a genus of the trigynia order, belonging to the diandria claſs of plants. There are 20 ſpecies, of which the moſt remarkable is the ſiriboa, with oval, heart-ſhaped, nerved leaves, and reflexed ſpikes. This is the plant which produces the pepper ſo much uſed in food. It is a ſhrub whoſe root is ſmall, fibrous, and flexible; it riſes into a ſtem, which requires a tree or prop to ſupport it. Its wood has the ſame ſort of knots as the vine; and when it is dry, it exactly reſembles the vine-branch. The leaves, which have a ſtrong ſmell and a pungent taſte, are of an oval ſhape; but they diminiſh towards the extremity, and terminate in a point. From the flower-buds, which are white, and are ſometimes placed in the middle and ſometimes at the extremity of the branches, are produced ſmall berries reſembling thoſe of the currant tree. Each of theſe contains between 20 and 30 corns of pepper; they are commonly gathered in October, and expoſed to the ſun ſeven or eight days. The fruit, which was green at firſt, and afterwards red, when ſtripped of its covering aſſumes the appearance it has when we ſee it. The largeſt, heavieſt, and leaſt ſhrivelled, is the beſt.

The pepper plant flouriſhes in the iſlands of Java, Sumatra*, and Ceylon, and more particularly on the Malabar coaſt. It is not ſown, but planted; and great nicety is required in the choice of the ſhoots. It produces no fruit till the end of three years; but bears ſo plentifully the three ſucceeding years, that ſome plants yield between ſix and ſeven pounds of pepper. The bark then begins to ſhrink; and the ſhrub declines ſo faſt, that in 12 years time it ceaſes bearing.

The culture of pepper is not difficult: it is ſufficient to plant it in a rich ſoil, and carefully to pull up the weeds that grow in great abundance round its roots, eſpecially the three firſt years. As the ſun is highly neceſſary to the growth of the pepper plant, when it is ready to bear, the trees that ſupport it muſt be lopped to prevent their ſhade from injuring the fruit. When the ſeaſon is over, it is proper to crop the head of the plant. Without this precaution, there would be too much wood, and little fruit.

The pepper exported from Malabar, which was formerly entirely in the hands of the Portugueſe, and is at preſent divided between the Dutch, Britiſh, and French, amounts to about 10,000,000 weight. Betel, or betle, is a ſpecies of this genus. See Betel. It is a creeping and climbing plant like the ivy; and its leaves a good deal reſemble thoſe of the citron, though they are longer, and narrower at the extremity. It grows in all parts of India, but thrives beſt in moiſt places. The natives cultivate it as we do the vine, placing props for it to run and climb upon; and it is a common practice to plant it againſt the tree which bears the areca-nut.

At all times of the day, and even in the night, the Indians chew the leaves of the betel, the bitterneſs of which is corrected by the areca that is wrapped up in them. There is conſtantly mixed with it the chinam, a kind of burnt lime made of ſhells. The rich frequently add perſumes, either to gratiſy their vanity or their ſenſuality.

It would be thought a breach of politeneſs among the Indians to take leave for any long time, without preſenting each other with a purſe of betel. It is a pledge of friendſhip that relieves the pain of abſence. No one dares to ſpeak to a ſuperior unleſs his mouth is perſumed with betel; it would even be rude to neglect this precaution with an equal. The women of gallantry are the moſt laviſh in the uſe of betel, as being a powerful incentive to love. Betel is taken after meals; it is chewed during a viſit; it is offered when you meet, and when you ſeparate; in ſhort, nothing is to be done without betel. If it is prejudicial to the teeth, it aſſiſts and ſtrengthens the ſtomach. At leaſt, it is a general faſhion that prevails throughout India.

The *piper amalago*, or black pepper, and the *piper inequale*, or long pepper of Jamaica, with ſome other ſpecies, are indigenous, and known by the names of *joint wood*, or *peppery elders*. The firſt bears a ſmall ſpike, on which are attached a number of ſmall ſeeds of the ſize of muſtard. The whole of the plant has the exact taſte of the Eaſt India black pepper. The long pepper buſh grows taller than the amalago. The leaves are broad, ſmooth, and ſhining. The fruit is ſimilar to the long pepper of the ſhops, but ſmaller. The common people in Jamaica ſeaſon their meſſes with the black pepper. To preſerve both, the fruit may be ſlightly ſcalded when green, then dried, and wrapped in paper. Perhaps hereafter they may be deemed worthy of attention.

PIPRA, in ornithology; a genus of birds of the order of *paſſeres*. Latham gives it the name of *manakin*, and ſo does Buffon, who informs us that it was beſtowed upon them by the Dutch ſettlers in Surinam. Latham deſcribes 25 different ſpecies, and five varieties. The general character of the genus is, that the bill is ſhort, ſtrong, hard, and ſlightly incurvated, and the noſtrils are naked. The middle toe is connected to the outer as far as the third joint: this character, however, is not altogether univerſal, ſome of the ſpecies differing in this particular. The tail is ſhort. This genus has a conſiderable reſemblance to the genus *parus*, or *titmouſe*. They are ſuppoſed to inhabit South America only; but this is not true, for Mr. Latham aſſures us that he has ſeen many of thoſe ſpecies which he has deſcribed which came from other parts, but which nevertheleſs certainly belong to this genus. Buffon differs widely in his arrangement from Mr. Latham, and only enumerates ſix diſtinct ſpecies. Without particularizing thoſe differences, however, we ſhall give from Buffon the following elegant account of the genus in general: "The natural habits common to them all were not known, and the obſervations which have been made are ſtill inſufficient to admit an exact detail. We ſhall only relate the remarks communicated to us by Sonnini of Manoncour, who ſaw many of theſe birds in their native climates. They inhabit the immenſe foreſts in the warm parts of America, and never emerge from their receſſes to viſit the cleared grounds or the vicinity of the plantations. They fly with conſiderable ſwiftneſs, but always at a ſmall height, and to ſhort diſtances; they never perch on the ſummits of trees, but on the middle branches; they feed upon ſmall wild fruits, and alſo eat inſects. They generally occur in ſmall bodies of eight or ten of the ſame ſpecies, and ſometimes intermingled with other flocks of the ſame genus, or even of a different genus, ſuch as the Cayenne warblers, &c. It is commonly in the morning that they are found thus aſſembled, and then ſeem to be joyous, and warble their delicate little notes. The freſhneſs of the air ſeems to inſpire the ſong; for they are ſilent during the burning heat of the day, and diſperſe and retire to the ſhade of the thickeſt parts of the foreſt. This habit is obſerved, indeed, in many kinds of birds, and even in thoſe of the woods of France, where they collect to ſing in the morning and evening; but the manakins never aſſemble in the evening, and continue together only from ſun-riſe to nine or ten o'clock in the forenoon, and remain ſeparate during the reſt of the day and the ſucceeding night. In general they prefer a cool humid ſituation, though they never frequent marſhes or the margins of lakes."

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* See a copious account of the mode of cultivating pepper in Sumatra, in Mr. Marſden's *Hiſtory of Sumatra*, or in the *New Annual Regiſter* for 1783, p. 147.

1. The *pipra rupicola*, or creſted manakin, is about the ſize of a ſmall pigeon, being about 10 or 12 inches long. The bill is about an inch and a quarter long, and of a yellowiſh colour. The head is furniſhed with a double round creſt; the general colour of the plumage is orange, inclining to ſaffron; the wing coverts are looſe and fringed; the quills are partly white and partly brown; the tail feathers are in number 12; the baſe half of the ten middle ones is of an orange colour, from thence to the ends they are brown; the outer feathers are brown, and the baſe half of the inner web is orange; all of them are ſimilarly fringed; the upper tail coverts are very long, looſely webbed, and ſquare at the ends; the legs and claws are yellow. The female is altogether brown, except the under wing coverts, which are of a rufous orange; the creſt is neither ſo complete nor rounded as that of the male. Both males and females are at firſt grey, or of a very pale yellow, inclining to brown. The male does not acquire the orange colour till the ſecond year, neither does the female the full brown.

“This beautiful ſpecies (ſays Latham) inhabits various parts of Surinam, Cayenne, and Guiana, in rocky ſituations; but is nowhere ſo frequent as in the mountain Luca, near the river Oyapoc, and in the mountain Courouaye, near the river Aprouack, where they build in the cavernous hollows and the darkeſt receſſes. They lay two round white eggs, the ſize of thoſe of a pigeon, and make the neſt of a few dry bits of ſticks. They are in general very ſhy, but have been frequently tamed, inſomuch as to run at large among the poultry. It is ſaid that the female, after ſhe has laid eggs for ſome years, and ceaſes ſo to do more, becomes at the enſuing moult of the ſame colour as the male, and may be miſtaken for him; in this imitating the females of various kinds of poultry, ſuch as the peacock, pheaſant, &c. (See PAVO, &c.) A moſt complete pair is in the Leverian Muſeum.” Our author deſcribes a variety of this ſpecies, which he calls the *Peruvian manakin*. It is longer than the preceding, eſpecially in the tail, and the upper coverts of it are not truncated at the ends; the wing coverts are not fringed, as in the rock manakin, and the creſt is not ſo well defined as in that bird; the general colour of the plumage inclines much to red: the ſecond coverts and rump are of an aſh colour; the wings and tail are black; the bill and legs as in the laſt deſcribed. It is an inhabitant of Peru, from whence its name.

2. The next and laſt ſpecies which we ſhall deſcribe (for it would be impoſſible to enumerate them all) Mr. Latham calls the *tuneful manakin*. Its length is four inches; the bill is duſky, the forehead yellow, and the crown and nape blue; the chin, ſides of the head below the eyes, and the throat, are black; the upper part of the back, the wings, and the tail, are duſky black; the tail is very ſhort; the lower part of the back and rump, the breaſt, belly, vent, and thighs, are orange coloured; the legs are duſky. It is a native of St. Domingo, where it has gained the name of *organiſte* from its note, forming the complete octave in the moſt agreeable manner, one note ſucceſſively after another. It is ſaid not to be uncommon, but not eaſy to be ſhot, as, like the creeper, it perpetually ſhifts to the oppoſite part of the branch from the ſpectator's eye, ſo as to elude his vigilance. It is moſt likely the very bird mentioned by Du Pratz, above quoted, whoſe notes, he ſays, are ſo varied and ſweet, and which warbles ſo tenderly, that thoſe who have heard it value much leſs the ſong of the nightingale. It is ſaid to ſing for near two hours without ſcarce taking breath, and after a reſpite of about the ſame time begins again. Du Pratz, who himſelf has heard it, ſays that it ſung perched on an oak near the houſe he was then in.

PIQUET, or PICKET, a celebrated game at cards, much in uſe throughout the polite world. It is played between two perſons with only 32 cards; all the duces, threes, fours, fives, and ſixes, being ſet aſide. In reckoning at this game, every card goes for the number it bears, as a ten for ten; only all court cards go for ten, and the ace for eleven: and the uſual game is one hundred up. In playing, the ace wins the king, the king the queen, and ſo down.

Twelve cards are dealt round, uſually by two and two which done, the remainder are laid in the middle: if one of the gameſters finds he has not a court-card in his hand, he is to declare he has *carte-blanche*, and tell how many cards he will lay out, and deſire the other to diſcard, that he may ſhow his game, and ſatisfy his antagoniſt that the carte blanche is real; for which he reckons ten.

Each perſon diſcards, *i. e.* lays aſide a certain number of his cards, and takes in a like number from the ſtock. The firſt of the eight cards may take three, four, or five; the dealer all the remainder, if he pleaſes.

After diſcarding, the eldeſt hand examines what ſuit he has moſt cards of; and reckoning how many points he has in that ſuit, if the other have not ſo many in that or any other ſuit, he tells one for every ten of that ſuit. He who thus reckons moſt is ſaid to win the point.

The point being over, each examines what *ſequences* he has of the ſame ſuit, *viz.* how many tierces, or ſequences of three, quartes or fours, quintes or fives, ſixiemes or ſixes, &c. For a tierce they reckon three points, for a quarte four, for a quinte 15, for a ſixieme 16, &c. And the ſeveral ſequences are diſtinguiſhed in dignity by the cards they begin from: thus ace, king, and queen, are called *tierce major*; king, queen, and knave, *tierce to a king*; knave, ten, and nine, *tierce to a knave, &c.* and the beſt tierce, quarte, or quinte, *i. e.* that which takes its deſcent from the beſt card, prevails, ſo as to make all the others in that hand good, and deſtroy all thoſe in the other hand. In like manner, a quarte in one hand ſets aſide a tierce in the other.

The ſequences over, they proceed to examine how many aces, kings, queens, knaves, and tens, each holds; reckoning for every three of any ſort, three: but here too, as in ſequences, he that with the ſame number of threes has one that is higher than any the other has, *e. gr.* three aces, has all his others made good hereby, and his adverſary's all ſet aſide. But four of any ſort, which is called a *quatorze*, always ſets aſide three.

All the game in hand being thus reckoned, the eldeſt proceeds to play, reckoning one for every card he plays above a nine, and the other follows him in the ſuit; and the higheſt card of the ſuit wins the trick. Note, unleſs a trick be won with a card above a nine (except the laſt trick), nothing is reckoned for it; though the trick ſerves afterwards towards winning the cards; and that he who plays laſt does not reckon for his cards unleſs he wins the trick.

The cards being played out, he that has moſt tricks reckons ten for winning the cards. If they have tricks alike, neither reckons any thing. The deal being finiſhed, and each having marked up his game, they proceed to deal again as before, cutting afreſh each time for the deal.

If both parties be within a few points of being up, the carte-blanche is the firſt thing that reckons, then the point, then the ſequences, then the quatorzes or threes, then the tenth cards.

He that can reckon 30 in hand by carte-blanche, points, quintes, &c. without playing, ere the other has reckoned any thing, reckons 90 for them; and this is called a *repique*. If he reckons above 30, he reckons ſo many above 90. If he can make up 30, part in hand and part play, ere the other has told any thing, he reckons for them 60. And this is called a *pique*. Whence the name of the game. He that wins all the tricks, inſtead of ten, which is his right for winning the cards, reckons 40. And this is called a *capot*.

Mr. de Moivre, who has made this game the object of mathematical inveſtigations, has propoſed and ſolved the following problems: 1. To find at piquet the probability which the dealer has for taking one ace or more in three cards, he having none in his hand. He concludes from his computation, that it is 29 to 28 that the dealer takes one ace or more. 2. To find at piquet the probability which the eldeſt has of taking an ace or more in five cards, he having no ace in his hand. Anſwer; 232 to 91, or 5 to 2, nearly. 3. To find at piquet the probability which the eldeſt hand has of taking an ace and a king in five cards, he having none in his hand. Anſwer; the odds againſt the eldeſt hand taking an ace and a king are 331 to 315, or 21 to 20 nearly. 4. To find at piquet the probability of having 12 cards dealt to, without king, queen, or knave, which caſe is commonly called *cartes-blanches*. Anſwer; the odds againſt cartes-blanches are 1791 to 1 nearly. 5. To find how many different ſets, eſſentially different from one another, one may have at piquet before taking in. Anſwer; 28,967,278. This number falls ſhort of the ſum of all the diſtinct combinations, whereby 12 cards may be taken out of 32, this number being 225,792,840; but it muſt be conſidered that in that number ſeveral ſets of the ſame import, but differing in ſuit, might be taken, which would not introduce an eſſential difference among the ſets. The ſame author gives alſo ſome other obſervations on this game, which he had from an experienced player. See *Doctrine of Chances*, p. 179, &c. M. de Monmort has treated of piquet in his *Analyſe des Jeux de Hazard*, p. 162.

PIRA, is a name by which a variety of foreign fiſhes are diſtinguiſhed. The *pira-aca* is a little horned fiſh of the Weſt Indies, called by Cluſius and others the *monoceros* or *unicorn-fiſh*. The *pira-acangata* is the name of a Braſilian fiſh, which reſembles the perch both in ſize and ſhape. It ſeldom exceeds four or five inches in length; its mouth is ſmall; its tail forked. On the back it has only one long fin, which is ſupported by rigid and prickly ſpines. This fin it can depreſs at pleaſure, and ſink within a cavity made for it in the back. Its ſcales are of a ſilvery white colour; it is wholeſome and well taſted. *Pira bebe* is the name of the milvus, or kite fiſh. *Pira coaba* is an American fiſh of the truttaceous kind, of a very delicate flavour. It grows to the length of 12 inches; its noſe is pointed, and its mouth large, but without teeth; the upper jaw is longer than the under one, and hangs over like a cartilaginous prominence; its eyes are very large, and its tail is forked: under each of the gill fins there is a beard made of ſix white filaments, and covered with ſilvery ſcales. *Pira jurumenbeca* is a Braſilian fiſh, otherwiſe called *boſca melle*. It lives in the muddy bottom of the American ſeas, and is a long-bodied not flatted fiſh. It grows to a great ſize, being found nine, and ſometimes even ten or eleven feet long, and two feet and a half thick. It has one long fin on the back, the anterior part of which is thin and pellucid. There is alſo a cavity on the back, as in the pira-acangata, into which the fin can be depreſſed at pleaſure; the tail is not forked, and the ſcales are all of a ſilvery colour and brightneſs. The fiſh is very well taſted; the *pira pixanga* is another Braſilian fiſh of the turdus or wraſſe kind, and called by ſome the *gat-viſch*. It is generally about four or five inches long; its mouth is pretty large, and furniſhed with very ſmall and very ſharp teeth; its head is ſmall, but its eyes are large and prominent, the pupil being of a fine turquoiſe colour, and the iris yellow and red in a variety of ſhades. The coverings of the gills end in a triangular figure, and are terminated by a ſhort ſpine or prickle; its ſcales are very ſmall, and ſo evenly arranged, and cloſely laid on the fleſh, that it is very ſmooth to the touch; its tail is rounded at the end; its whole body, head, tail, and fins, are of a pale yellow colour, variegated all over with very beautiful blood-coloured ſpots; theſe are round, and of the bigneſs of hemp-ſeed on the back and ſides, and ſomething larger on the belly; the fins are all ſpotted in the ſame manner, and are all marked with an edge of red. It is caught among the rocks, and about the ſhores, and is a very well taſted fiſh. *Piranba* is an American fiſh, more generally known by the name *piraya*. *Piraquiba*, or *Ipiraquiba*, is the name of a fiſh originally Braſilian, which ſome writers apply to the *remora* or *ſucking fiſh*.

PIRÆUS portus, (anc. geog.), a celebrated port to the weſt of Athens, conſiſting naturally of three harbours or baſons, (Thucydides); which lay neglected, till Themiſtocles put the Athenians on making it a commodious port, (Nepos); the Phalerus, a ſmall port, and not far from the city, being what they uſed before that time, (Pauſanias, Nepos). Piræus was originally a village of Attica, (Pauſanias); an iſland, (Strabo); and, though diſtant 40 ſtadia from Athens, was joined to it by two long walls, (Thucydides), and itſelf locked or walled round, (Nepos): A very commodious and ſafe harbour. The whole of its compaſs was 60 ſtadia, including the Munychia. Not far from the Piræus ſtood the ſepulchre of Themiſtocles; whither his friends conveyed his bones from Magneſia, into the Hither Aſia, (Cicero, Plutarch, Pauſanias). The entrance of the Piræus is narrow, and formed by two rocky points, one belonging to the promontory of Eetion, the other to that of Alcimus. Within were three ſtations for ſhipping; Kantharus, ſo named from a hero; Aphrodiſium, from a temple of Venus; and Zea, the reſort of veſſels laden with grain. By it was a demos or borough town of the ſame name before the time of Themiſtocles, who recommended the exchanging its triple harbour for the ſingle one of Phalerum, both as more capacious and as better ſituated for navigators. The wall was begun by him when archon, in the ſecond year of the 75th Olympiad, 477 years before Chriſt; and afterwards he urged the Athenians to complete it as the importance of the place deſerved. This whole fortification was of hewn ſtone, without cement or other material, except lead and iron, which were uſed to hold together the exterior ranges or facings. It was ſo wide that the loaded carts could paſs on it in different directions, and it was 40 cubits high; which was about half what he had deſigned.

The Piræus, as Athens flouriſhed, became the common emporium of all Greece. Hippodamus an architect, celebrated, beſides other monuments of his genius, as the inventor of many improvements in houſe-building, was employed to lay out the ground. Five porticoes, which uniting formed the *Long Portico*, were erected by the ports. Here was an *agora* or market-place, and, farther from the ſea, another called *Hippodamia*. By the veſſels were dwellings for the mariners. A theatre was opened, temples were raiſed, and the Piræus, which ſurpaſſed the city in utility, began to equal it in dignity. The cavities and windings of Munychia, natural and artificial, were filled with houſes; and the whole ſettlement, comprehending Phalerum and the ports of the Piræus, with the arſenals, the ſtore-houſes, the famous armoury of which Philo was the architect, and the ſheds for 300, and afterwards 400, triremes, reſembled the city of Rhodes, which had been planned by the ſame Hippodamus. The ports, on the commencement of the Peloponneſian war, were ſecured with chains. Sentinels were ſtationed, and the Piræus was carefully guarded.

The Piræus was reduced with great difficulty by Sylla, who demoliſhed the walls, and ſet fire to the armoury and arſenals. In the civil war it was in a defenceleſs condition. Calenus, lieutenant to Cæſar, ſeized it, inveſted Athens, and ravaged the territory. Strabo, who lived under the emperors Auguſtus and Tiberius, obſerves, that the many wars had deſtroyed the long walls, with the fortreſs of Munychia, and had contracted the Piræus into a ſmall ſettlement by the ports and the temple of Jupiter Saviour. This fabric was then adorned with wonderful pictures, the works of illuſtrious artiſts, and on the outſide with ſtatues. In the ſecond century, beſides houſes for triremes, the temple of Jupiter and Minerva remained, with their images in braſs, and a temple of Venus, a portico, and the tomb of Themiſtocles.

The port of the Piræus has been named *Porto Lione*, from the marble lion ſeen in the chart, and alſo *Porto Draco*. The lion has been deſcribed as a piece of admirable ſculpture, 10 feet high, and as repoſing on its hinder parts. It was pierced, and, as ſome have conjectured, had belonged to a fountain. Near Athens, in the way to Eleuſis, was another, the poſture couchant; probably its companion. Both theſe were removed to Venice by the famous general Moroſini, and are to be ſeen there before the arſenal. At the mouth of the port are two ruined piers. A few veſſels, moſtly ſmall craft, frequent it. Some low land at the head ſeems an encroachment on the water. The buildings are a mean cuſtomhouſe, with a few ſheds; and by the ſhore on the eaſt ſide, a warehouſe belonging to the French; and a Greek monaſtery dedicated to St. Spiridion. On the oppoſite ſide is a rocky ridge, on which are remnants of the ancient wall, and of a gateway towards Athens. By the water-edge are veſtiges of building; and, going from the cuſtomhouſe to the city on the right hand, traces of a ſmall theatre in the ſide of the hill of Munychia.

PIRACY, the crime of robbery and depredation upon the high ſeas. By the ancient common law, piracy, if committed by a ſubject, was held to be a ſpecies of treaſon, being contrary to his natural allegiance; and by an alien, to be felony only: but now, ſince the ſtatute of treaſons, 25 Edw. III. c. 2. it is held to be only felony in a ſubject. Formerly it was only cognizable by the admiralty courts, which proceed by the rules of the civil law. But, it being inconſiſtent with the liberties of the nation, that any man's life ſhould be taken away, unleſs by the judgment of his peers, or the common law of the land, the ſtatute 28 Hen. VIII. c. 15. eſtabliſhed a new juriſdiction for this purpoſe; which proceeds according to the courſe of the common law.

The offence of piracy, by common law, conſiſts in committing thoſe acts of robbery and depredation upon the high ſeas, which, if committed upon land, would have amounted to felony there. But, by ſtatute, ſome other offences are made piracy alſo: as, by ſtatute 11 and 12 W. III. c. 7. if any natural-born ſubject commits any act of hoſtility upon the high ſeas, againſt others of his majeſty's ſubjects, under colour of a commiſſion from any foreign power; this, though it would only be an act of war in an alien, ſhall be conſtrued piracy in a ſubject. And farther, any commander, or other ſeafaring perſon, betraying his truſt, and running away with any ſhip, boat, ordnance, ammunition, or goods; or yielding them up voluntarily to a pirate; or conſpiring to do theſe acts; or any perſon aſſaulting the commander of a veſſel, to hinder him from fighting in defence of his ſhip; or confining him, or cauſing or endeavouring to cauſe a revolt on board; ſhall, for each of theſe offences, be adjudged a pirate, felon, and robber, and ſhall ſuffer death, whether he be principal, or merely acceſſory by ſetting forth ſuch pirates, or abetting them before the fact, or receiving or concealing them or their goods after it. And the ſtatute 4 Geo. I. c. 11. expreſsly excludes the principals from the benefit of clergy. By the ſtatute 8 Geo. I. c. 24. the trading with known pirates, or furniſhing them with ammunition, or fitting out any veſſel for that purpoſe, or in anywiſe conſulting, combining, confederating, or correſponding with them; or the forcibly boarding any merchant veſſel, though without ſeizing or carrying her off, and deſtroying or throwing any of the goods overboard; ſhall be deemed piracy: and ſuch acceſſories to piracy as are deſcribed by the ſtatute of king William are declared to be principal pirates; and all pirates convicted by virtue of this act are made felons without benefit of clergy. By the ſame ſtatutes alſo, (to encourage the defence of merchant veſſels againſt pirates), the commanders or ſeamen wounded, and the widows of ſuch ſeamen as are ſlain, in any piratical engagement, ſhall be entitled to a bounty to be divided among them, not exceeding one-fiftieth part of the value of the cargo on board: and ſuch wounded ſeamen ſhall be entitled to the penſion of Greenwich hoſpital; which no other ſeamen are, except only ſuch as have ſerved in a ſhip of war. And if the commander ſhall behave cowardly, by not defending the ſhip, if ſhe carries guns or arms; or ſhall diſcharge the mariners from fighting, ſo that the ſhip falls into the hands of pirates; ſuch commander ſhall forfeit all his wages, and ſuffer ſix months impriſonment. Laſtly, by ſtatute 18 Geo. II. c. 30. any natural-born ſubject or denizen, who in time of war ſhall commit hoſtilities at ſea againſt any of his fellow-ſubjects, or ſhall aſſiſt an enemy on that element, is liable to be tried and convicted as a pirate.

PIRATE, (πειρατης, Gr.); a ſea-robber, or an armed ſhip that roams the ſeas without any legal commiſſion, and ſeizes or plunders every veſſel ſhe meets indiſcriminately, whether friends or enemies.

The colours uſually diſplayed by pirates are ſaid to be a black field, with a death's head, a battle-axe, and hour-glaſs. The laſt inſtrument is generally ſuppoſed to determine the time allowed to the priſoners, whom they take, to conſider whether they will join the pirates in their felonious combination, or be put to death; which is often perpetrated in the moſt cruel manner.

Amongſt the moſt celebrated pirates of the north is recorded Alvilda, daughter of a king of the Goths named *Sypardus*. She embraced this occupation to deliver herſelf from the violence impoſed on her inclination, by a marriage with Alf, ſon of Sigarus king of Denmark. She dreſſed herſelf as a man; and compoſed her band of rowers, and the reſt of her crew, of a number of young women attired in the ſame manner. Amongſt the firſt of her cruizes, ſhe touched at a place where a company of pirates bewailed the death of their captain. The ſtrangers were captivated with the agreeable manners of Alvilda, and choſe her for their chief. By this reinforcement ſhe became ſo formidable upon the ſea, that prince Alf came to engage her. She ſuſtained his attacks for a conſiderable time: but, in a vigorous action, Alf boarded her veſſel, and, having killed the greateſt part of her crew, ſeized the captain, namely herſelf; whom nevertheleſs he knew not, becauſe the princeſs had a caſque which covered her viſage. Being maſter of her perſon, he removed the caſque; and, in ſpite of her diſguiſe, inſtantly recognized her, and offered her his hand in wedlock.

PIRENE, (Pliny); a fountain ſacred to the Muſes, ſpringing below the top of the Acrocorinthus, a high and ſteep mountain which hangs over Corinth. Its waters were agreeable to drink, (Pauſanias); extremely clear, (Strabo); very light, (Athenæus); and pale, (Perſius): having relation either to the grief of Pirene, mother of Cenchrea, from whoſe tears this fountain aroſe, (Pauſanias); or to the paleneſs brought on by the too eager purſuits of the Muſes.

PIROMALLI (Paul), a Dominican of Calabria, was ſent a miſſionary into the Eaſt. He remained a long time in Armenia, where he had the happineſs to bring back to the church many ſchiſmatics and Eutycheans, and the patriarch himſelf, who had before thrown every obſtacle in his way. He afterwards paſſed into Georgia and Perſia, then into Poland, in quality of pope Urban VIII.'s nuncio, in order to appeaſe the diſturbances which had been occaſioned there by the diſputes of the Armenians, who were very numerous in that country. Piromalli reunited them in the profeſſion of the ſame faith, and obſervance of the ſame ceremonies. In his return to Italy, he was taken by ſome corſairs, who carried him priſoner to Tunis. As ſoon as he was ranſomed he went to Rome, and gave an account of his miſſion to the pope, who conferred upon him ſome ſignal marks of his eſteem. His holineſs entruſted him with the reviſal of an Armenian Bible, and ſent him again into the Eaſt, where he was promoted, in 1665, to the biſhopric of Naſlivan. After having governed that church for nine years, he returned to Italy, and took the charge of the church of Baſignano, where he died three years after in 1667. His charity, his zeal, and other virtues did honour to the epiſcopal office. There are extant of his writings, 1. Some works of Controverſy and Theology. 2. Two Dictionaries; the one a Latin-Perſian, and the other an Armenian-Latin. 3. An Armenian Grammar. 4. A Directory, which is of great uſe in correcting Armenian books. All theſe works equally diſtinguiſh him for virtue and for learning.

PIRON (Alexis), whoſe father was an apothecary, was born at Dijon the 9th of July 1689, where he paſſed more than 30 years in the idle and deſtructive diſſipation too common to young men. He was at length obliged to quit the place of his nativity, in order to avoid the reproaches of his fellow citizens, on account of an ode which he had written, and which gave great offence. His relations not being able to give him much aſſiſtance, he ſupported himſelf at Paris by means of his pen, the ſtrokes of which were as beautiful and fair as thoſe of an engraver. He lived in the houſe of M. de Belliſle as his ſecretary, and afterwards with a financier, who did not know that he had a man of genius under his roof. His reputation as a writer commenced with ſome pieces which he publiſhed for the entertainment of the populace, and which ſhowed ſtrong marks of original invention; but what fully eſtabliſhed his character in this way was his comedy entitled *Metromany*, which was the beſt that had appeared in France ſince Regnard's Gameſter. This performance, in five acts, well conducted, replete with genius, wit, and humour, was acted with the greateſt ſucceſs upon the French ſtage in 1738. The author met with every attention in the capital which was due to a man of real genius, and whoſe flaſhes of wit were inexhauſtible. We ſhall inſert a few anecdotes of him, which will ſerve to ſhew his character and turn of mind. In Burgundy the inhabitants of Beaune are called the *Aſſes of Beaune.* Piron often indulged his ſatirical diſpoſition at their expence. One day as he was taking a walk in the neighbourhood of that city, he diverted himſelf with cutting down all the thiſtles which he met with. When a friend aſked him his reaſon for doing ſo, he replied, *J'ai à me plaindre des Beaunois; je leur coupe les vivres*, i. e. " I am ſorry indeed for the Beaunians; for I am cutting down their food." Being told again that theſe people would certainly be revenged of him,

Allez, (ſays he) *allez: je ne crains point leur impuiſſant couroux;*
Et, quand je ſerois ſeul, je les batterois tous.

" Get you gone, get you gone: I fear not their feeble revenge; for, though alone, I ſhould beat them all." Going into a theatre one time where a play was acting, he aſked what it was? " The Cheats of Scapin," gravely replied a young Beaunian. " Ah! Sir, (ſays Piron, after thanking him,) I took it to be the Cheats of Oreſtes." In the time of the play, ſomebody addreſſes the company with " Silence there, gentlemen, we don't hear." " It is not at leaſt (cried Piron) for want of ears." A biſhop one day aſked Piron, during the diſputes about Janſeniſm, " Did you read my mandate, Mr. Piron?" " No, my lord; and you—" The converſation turning very warm, the biſhop reminded him of the diſtance which birth and rank had put between them. " Sir (ſays Piron), I have plainly the ſuperiority over you at this moment; for I am in the right, and you are in the wrong." Voltaire's Semiramis did not meet with a very favourable reception the firſt time it was acted. The author finding Piron behind the ſcenes, aſked him what he thought of his performance? " I think (replied he) you would have been pleaſed that I had been the author of it." The performer of the character Ferdinand Cortez (the title of one of Piron's tragedies) having requeſted ſome corrections to be made on the play the firſt time it was acted, Piron fired at the word *corrections*. The player, who was deputed to wait upon the author with this requeſt, cited the example of Voltaire, who corrected ſome of his pieces in order to gratify the taſte of the public. " The caſes are widely different (replied Piron); Voltaire works in chequer-work, and I caſt in braſs." If this anſwer be not very modeſt, we muſt allow that it does not want wit. He thought himſelf, if not ſuperior, at leaſt equal to Voltaire. Some perſon congratulating him on having compoſed the beſt comedy of this age, he anſwered, with more frankneſs than modeſty, " Add too, and the beſt tragedy." The following verſes are well known, in which he ſays:

En deux mots voulez vous diſtinguer & connoître
Le rimeur Dijonnois & le Pariſien?
Le premier ne fut rien, & ne voulut rien être;
L'autre voulut tout être, & ne fut preſque rien.

We ſee by theſe different traits that Piron had a ſufficient ſtock of ſelf conceit. What helped to increaſe it, and make him fancy himſelf ſuperior to the moſt celebrated of his contemporaries, was, that his company, on account of his original humour, of which he had an uncommon ſhare, was more courted than that of Voltaire, who was otherwiſe too lively, too captious, and crabbed. But thoſe who have favoured us with an account of his many witticiſms in converſation, would have done more honour to his memory if they had paſſed over ſuch as were either indecent or inſipid. A thing often pleaſes over a glaſs of wine, which will not give the ſame ſatisfaction when it is repeated, eſpecially if, in repeating it, you want to make it appear of ſome importance. Be that as it may, Piron's miſchievous ingenuity was partly the cauſe which excluded him from the French Academy. " I could not (ſaid he) make thirty-nine people think as I do, and I could ſtill leſs think as thirty-nine do." He called that celebrated ſociety very unjuſtly *les invalides du bel eſprit*, " the invalids of wit;" and yet he often endeavoured to be one of thoſe invalids. His death was haſtened by a fall which he got a little before. He died the 21ſt of January 1773, at the age of 83. He had prepared for himſelf the following epitaph, in the way of an epigram:

Ci gît Piron, qui ne fut rien,
Pas même académicien.

" Here lies Piron, who was nothing, not even an academician."

His wife, Maria Thereſa Quenaudon, who died in 1751, he deſcribes as a ſweet and moſt agreeable companion. They lived together for ſeveral years; and no huſband ever diſcharged his duty with more fidelity and attention.

A collection of his works appeared in 1776, in 7 vols. 8vo. and 9 vols. 12mo. The principal pieces are, The School of Fathers; a comedy acted in 1728 under the title of Ungrateful Sons. Calliſthenes; a tragedy, the ſubject of which is taken from Juſtin. The Myſterious Lover, a comedy. Guſtavus, and Ferdinand Cortez, two tragedies; ſome ſcenes of which diſcover an original genius, but the verſification neither pleaſes the ear nor affects the heart. Metromany, a comedy. The Courſes of Tempe, an ingenious paſtoral, in which the manners both of the town and country are pleaſantly drawn. Some odes, poems, fables, and epigrams. In this laſt kind of poetry he was very ſucceſsful, and he may be placed after Marot and Rouſſeau. There was no occaſion for loading the public with 7 vols. of his works; the half of that number might have ſufficed. For, excepting Metromany, Guſtavus, the Courſes of Tempe, ſome odes, about 20 epigrams. three or four fables, and ſome epiſtles, the reſt are but indifferent, and have no claim to any extraordinary merit.

PISA, an ancient and large city of Tuſcany, capital of the Piſano, with a univerſity, an archbiſhop's ſee, and three forts. The river Arno runs through Piſa, and over it are three bridges, one of which is conſtructed of marble. This city is ſo far from having as many inhabitants as it can contain, that graſs grows in the principal ſtreets. The cathedral is a magnificent ſtructure, and on the right ſide of the choir is a leaning tower, much talked of. In the great ſquare, before St. Stephen's church, is a white marble ſtatue of duke Coſmo the Great. The grand duke's palace, and the magnificent exchange, are worth notice. Piſa is ſeated in a fertile plain, at a ſmall diſtance from the Mediterranean, 10 miles N. of Leghorn, and 42 W. of Florence. E. lon. 10. 17. N. lat. 43. 43.

PISCARY, in our ancient ſtatutes, the liberty of fiſhing in another man's waters.

PISCES, in aſtronomy, the 12th ſign or conſtellation of the zodiac. See ASTRONOMY.

PISCIDIA, a genus of the decandria order, belonging to the diadelphia claſs of plants. There are two ſpecies, *viz.* 1. The *erythrina*, or dog-wood tree. This grows plentifully in Jamaica, where it riſes to the height of 25 feet or more; the ſtem is almoſt as large as a man's body, covered with a light-coloured ſmooth bark, and ſending out ſeveral branches at the top without order; the leaves are about two inches long, winged, with oval lobes. The flowers are of the butterfly kind, and of a dirty white colour; they are ſucceeded by oblong pods, with four longitudinal wings, and jointed between the cells which contain the ſeeds. 2. The *Carthaginienſis*, with oblong oval leaves, is alſo a native of the Weſt Indies. It differs from the former only in the ſhape and conſiſtence of the leaves, which are more oblong and ſtiffer; but in other reſpects they are very ſimilar. Both ſpecies are eaſily propagated by ſeeds; but require artificial heat to preſerve them in this country. The negroes in the Weſt Indies make uſe of the bark of the firſt ſpecies to intoxicate fiſh. When any number of gentlemen have an inclination to divert themſelves with fiſhing, or, more properly ſpeaking, with fiſh-hunting, they ſend each of them a negro-ſlave to the woods, in order to fetch ſome of the bark of the dog-wood tree. This bark is next morning pounded very ſmall with ſtones, put into old ſacks, carried into rocky parts of the ſea, ſteeped till thoroughly ſoaked with ſalt-water, and then well ſqueezed by the negroes to expreſs the juice. This juice immediately colours the ſea with a reddiſh hue; and, being of a poiſonous nature, will in an hour's time make the fiſhes, ſuch as groopers, rock-fiſh, old wives, Welchmen, &c. ſo drunk or intoxicated, as to ſwim on the ſurface of the water, quite heedleſs of the danger: the gentlemen then ſend in their negroes, who purſue, both ſwimming and diving, the poor inebriated fiſhes, till they catch them with their hands; their maſters in the mean time ſtanding by, on high rocks, to ſee the paſtime.

It is remarkable, that though this poiſon kills millions of the ſmall fry, it has never been known to impart any bad quality to the fiſh which have been caught in conſequence of the intoxication.

The wood of this tree, although pretty hard, is only fit for fuel; and even for this purpoſe the negroes very ſeldom, if ever, employ it, on account of its ſingular quality juſt mentioned. The bark is rough, brown, and thick; the tree ſends forth a conſiderable number of branches, and is well clothed with leaves, which reſemble thoſe of the pea, are thick, cottony, and of a deep green. The bark uſed for the above-mentioned purpoſe is chiefly that of the roots.

PISCINA, in antiquity, a large baſon in a public place or ſquare, where the Roman youth learned to ſwim; and which was ſurrounded with a high wall, to prevent filth from being thrown into it. This word is alſo uſed for a lavatory among the Turks, placed in the middle court of a moſque or temple, where the Muſſulmen waſh themſelves before they offer their prayers.

PISISTRATUS, an Athenian who early diſtinguiſhed himſelf by his valour in the field, and by his addreſs and eloquence at home. After he had rendered himſelf the favourite of the populace by his liberality, and by the intrepidity with which he had fought their battles, particularly near Salamis, he reſolved to make himſelf maſter of his country. Every thing ſeemed favourable to his ambitious views; but Solon alone, who was then at the head of affairs, and who had lately enforced his celebrated laws, oppoſed him, and diſcovered his duplicity and artful behaviour before the public aſſembly. Piſiſtratus was not diſheartened by the meaſures of his relation Solon, but he had recourſe to artifice. In returning from his country-houſe, he cut himſelf in various places; and after he had expoſed his mangled body to the eyes of the populace, deplored his misfortunes, and accuſed his enemies of attempts upon his life, becauſe he was the friend of the people, the guardian of the poor, and the reliever of the oppreſſed, he claimed a choſen body of 50 men from the populace to defend his perſon in future from the malevolence and the cruelty of his enemies. The unſuſpecting people unanimouſly granted his requeſt, though Solon oppoſed it with all his influence; and Piſiſtratus had no ſooner received an armed band on whoſe fidelity and attachment he could rely, than he ſeized the citadel of Athens, and made himſelf abſolute. The people too late perceived their credulity: yet, though the tyrant was popular, two of the citizens, Megacles and Lycurgus, conſpired together againſt him, and by their means he was forcibly ejected from the city. His houſe and all his effects were expoſed to ſale; but there was found in Athens only one man who would buy them. The private diſſenſions of the friends of liberty proved favourable to the expelled tyrant; and Megacles, who was jealous of Lycurgus, ſecretly promiſed to reſtore Piſiſtratus to all his rights and privileges in Athens, if he would marry his daughter. Piſiſtratus conſented; and by the aſſiſtance of his father-in-law he was ſoon enabled to expel Lycurgus, and to re-eſtabliſh himſelf. By means of a woman called *Phya*, whoſe ſhape was tall, whoſe features were noble and commanding, he impoſed upon the people, and created himſelf adherents even among his enemies. Phya was conducted through the ſtreets of the city; and ſhowing herſelf ſubſervient to the artifice of Piſiſtratus, ſhe was announced as Minerva, the Goddeſs of Wiſdom, and the patroneſs of Athens, who was come down from heaven to re-eſtabliſh her favourite Piſiſtratus in a power which was ſanctioned by the will of Heaven, and favoured by the affection of the people. In the midſt of his triumph, however, Piſiſtratus found himſelf unſupported; and ſome time after, when he repudiated the daughter of Megacles, he found that not only the citizens, but even his very troops, were alienated from him by the influence, the intrigues, and the bribery of his father-in-law. He fled from Athens, where he no longer could maintain his power, and retired to Eubœa. Eleven years after he was drawn from his obſcure retreat, by means of his ſon Hippias, and was a third time received by the people of Athens as their maſter and ſovereign. Upon this he ſacrificed to his reſentment the friends of Megacles; but he did not loſe ſight of the public good, and, while he ſought the agrandizement of his family, did not neglect the dignity and the honour of the Athenian name. He died about 528 years before the Chriſtian era, after he had enjoyed the ſovereign power at Athens for 33 years, and was ſucceeded by his ſon Hipparchus. Piſiſtratus claims our admiration for his juſtice, his liberality, and his moderation. If he was dreaded and deteſted as a tyrant, the Athenians loved and reſpected his private virtues and his patriotiſm as a fellow-citizen; and the opprobrium which generally falls on his head may be attributed not to the ſeverity of his adminiſtration, but to the republican principles of the Athenians, who hated and exclaimed againſt the moderation and equity of the mildeſt ſovereign, while they flattered the pride and gratified the guilty deſires of the moſt tyrannical of their fellow-ſubjects. Piſiſtratus often refuſed to puniſh the inſolence of his enemies; and when he had one day been virulently accuſed of murder, rather than inflict immediate puniſhment upon the man who had criminated him, he went to the areopagus, and there convinced the Athenians that the accuſations of his enemies were groundleſs, and that his life was irreproachable. It is to his labours that we are indebted for the preſervation of the poems of Homer; and he was the firſt, according to Cicero, who introduced them at Athens in the order in which they now ſtand. He alſo eſtabliſhed a public library at Athens; and the valuable books which he had diligently collected were carried into Perſia when Xerxes made himſelf maſter of the capital of Attica. Hipparchus and Hippias, the ſons of Piſiſtratus, who have received the name of *Piſiſtratidæ*, rendered themſelves as illuſtrious as their father; but the flames of liberty were too powerful to be extinguiſhed. The Piſiſtratidæ governed with great moderation; but the name of tyrant or ſovereign was inſupportable to the Athenians. Two of the moſt reſpectable of the citizens, called *Harmodius* and *Ariſtogiton*, conſpired againſt them, and Hipparchus was diſpatched in a public aſſembly. This murder was not, however, attended with any advantages: and though the two leaders of the conſpiracy, who have been celebrated through every age for their patriotiſm, were ſupported by the people, yet Hippias quelled the tumult by his uncommon firmneſs and prudence, and for a while preſerved that peace in Athens which his father had often been unable to command. This was not long to continue. Hippias was at laſt expelled by the united efforts of the Athenians and of their allies, and he left Attica, when he found himſelf unable to maintain his power and independence. The reſt of the family of Piſiſtratus followed him in his baniſhment; and after they had refuſed to accept the liberal offers of the princes of Theſſaly, and the king of Macedonia, who wiſhed them to ſettle in their reſpective territories, the Piſiſtratidæ retired to Sigæum, which their father had in the ſummit of his power conquered, and bequeathed to his poſterity. After the baniſhment of the Piſiſtratidæ, the Athenians became more than commonly jealous of their liberty, and often ſacrificed the moſt powerful of their citizens, apprehenſive of the influence which popularity and a well-directed liberality might gain among a fickle and unſettled populace. The Piſiſtratidæ were baniſhed from Athens about 18 years after the death of Piſiſtratus.

PISMIRES, a vulgar name given to the Ant. A large kind of theſe inſects are very common in Africa. They deſtroy not only the fruits of the ground, but even men and beaſts, in ſo little a time as one ſingle night; and would, without all doubt, prove more fatally deſtructive to the inhabitants, were they not ſo happily deſtroyed by a proportionable number of monkeys, who greedily ferret and devour them. For a further account of theſe, and ſome other grievous plagues with which the far greater part of the vaſt continent of Africa is afflicted, particularly that moſt horrid viſitation of locuſts, which ſeldom fail a year of laying waſte ſome of the provinces, ſee Gryllus.

PISO (Lucius Calpurnius), ſurnamed *Frugi* on account of his frugality, was deſcended of the illuſtrious family of the Piſos, which gave ſo many great men to the Roman republic. He was tribune of the people in the year 149 before Chriſt, and afterwards conſul. During his tribuneſhip, he publiſhed a law againſt the crime of concuſſion or extortion, entitled *Lex Calpurnia de pecuniis repetundis*. He happily ended the war in Sicily. To reward the ſervices of one of his ſons, who had diſtinguiſhed himſelf in that expedition, he left him by his will a golden crown, weighing 20 pounds. Piſo joined to the qualities of a good citizen the talents of a lawyer, an orator, and hiſtorian.

Piso (Caius Calpurnius), a Roman conſul in the year 67 before Chriſt, was author of the law which forbade canvaſſing for public offices, entitled *Lex Calpurnia de ambitu*. He diſplayed all the firmneſs worthy of a conſul in one of the moſt ſtormy periods of the republic. The Roman people, deceived by the flattery of Marcus Palicanus, a turbulent and ſeditious fellow, were on the eve of loading themſelves with the greateſt diſgrace, by putting the ſupreme authority into the hands of this man, who deſerved puniſhment rather than honours. The tribunes of the people, by their harangues, inflamed the blind fury of the multitude, already ſufficiently mutinous of themſelves. In this ſituation, Piſo mounted the roſtrum; and being aſked if he would declare Palicanus conſul, in caſe the ſuffrages of the people ſhould concur in the nomination, he inſtantly replied, that "he did not think the republic was yet involved in ſuch darkneſs and deſpair as to be capable of committing ſo infamous an action." Being afterwards ſtrongly and repeatedly called upon to ſay, "what he would do, if the thing ſhould happen?" his anſwer was, "No, I would not name him." By this firm and laconic anſwer he deprived Palicanus of the dignity to which he aſpired. Piſo, according to Cicero, was not poſſeſſed of a quick conception; but he thought maturely, and with judgment, and by a proper firmneſs he appeared to be an abler man than he really was.

Piso (Cneius Calpurnius), was conſul in the reign of Auguſtus, and governor of Syria under Tiberius, whoſe confident he was. It is ſaid, that by the order of this emperor he cauſed Germanicus to be poiſoned. Being accuſed of that crime, and ſeeing himſelf abandoned by every body, he laid violent hands on himſelf in the 20th year of our Lord. He was a man of inſupportable pride and exceſſive violence. Some inſtances of his wicked cruelty have been handed down to us. Having given orders in the heat of his paſſion to conduct to puniſhment a ſoldier, as guilty of the death of one of his companions, becauſe he had gone out of the camp with him and returned without him, no prayers or entreaty could prevail with Piſo to ſuſpend the execution of this ſentence until the affair ſhould be properly inveſtigated. The ſoldier was led without the entrenchments, and had already preſented his head to receive the fatal ſtroke, when his companion whom he was accuſed of having killed, made his appearance again. Whereupon the centurion, whoſe office it was to ſee the ſentence executed, ordered the executioner to put up his ſword into the ſcabbard. Thoſe two companions, after embracing each other, are conducted to Piſo, amidſt the acclamations of the whole army, and a prodigious crowd of people. Piſo, foaming with rage, aſcends his tribune, and pronounces the ſame ſentence of death againſt the whole three, without excepting the centurion who had brought back the condemned ſoldier, in theſe terms: "You I order to be put to death becauſe you have been already condemned; you, becauſe you have been the cauſe of the condemnation of your comrade; and you, becauſe, having got orders to put that ſoldier to death, you have not obeyed your prince."

PISSASPHALTUM, earth-pitch; a fluid, opaque, mineral body, of a thick conſiſtence, ſtrong ſmell, readily inflammable, but leaving a reſiduum of greyiſh aſhes after burning. It ariſes out of the cracks of the rocks, in ſeveral places in the iſland of Sumatra, and ſome other places in the Eaſt Indies, where it is much eſteemed in paralytic diſorders. There is a remarkable mine of it in the iſland of Bua, (ſee Bua,) of which the following curious deſcription is given us by the Abbé Fortis: "The iſland is divided into two promontories between the north and weſt: croſſing over the top of the latter, which is not half a mile broad, and deſcending in a right line towards the ſea, one is conducted to a hole well known to the inhabitants. This hole extends not much above 12 feet, and from its bottom, above 25 feet perpendicular, ariſe the marble ſtrata which ſuſtain the irregular maſſes that ſurround the top of the mountain.

“ The place ſeemed to me (continues our author) ſo worthy of obſervation, that I cauſed a drawing of it to be taken. The hole AAA, Plate 3. is dug out of an irregular ſtratum of argillaceous ſandy earth, in ſome parts whitiſh, and in others of a greeniſh colour; part of it is half petrified, and full of numiſmales of the largeſt kind, lenticulares, and fragments, with here and there a ſmall branch of madreporites, and frequently of thoſe other foſſil bodies called by Geſner *cornua ammonis candida, minima*, &c. The maſs B is fallen from the height of the rock, and lies iſolated. The excavation, made by ſome poor man in the ſofter matter, reaches a little below the extremity CC of the ſtratum DD. This is ſeparated by the line EE from the ſtratum FF, which is of hard common marble, with marine bodies without flints. The upper part *a a* is of hard lenticular ſtone, interſperſed with flints full of lenticulares. The maſs H does not diſcover the diviſions of its ſtrata on the outſide, and tranſpires very ſmall drops of piſſaſphaltum, ſcarcely diſcernible; but the tears I I I of the ſame matter, which flow from the fiſſures and chinks of the whitiſh ſtratum DD, are very obſervable. They come out moſt abundantly when the ſun falls on the marble rock in the heat of the day. This piſſaſphaltum is of the moſt perfect quality, black and ſhining like the *bitumen Judaicum*; very pure, odorous, and coheſive. It comes out almoſt liquid, but hardens in large drops when the ſun ſets. On breaking many of theſe drops on the ſpot, I found that almoſt every one of them had an inner cavity full of very clear water.

“ The greateſt breadth of the tears that I ſaw was two inches, and the common breadth is half an inch. The chinks and fiſſures of the marble, from whence this bituminous pitch tranſudes, are not more than the thickneſs of a thread; and for the moſt part are ſo imperceptible, that were it not for the pitch itſelf, whereby they are blackened, they could not by any means be diſtinguiſhed by the naked eye. To the narrowneſs of theſe paſſages is, no doubt, in part owing the ſmall quantity of piſſaſphaltum that tranſpires.”

After ſome conjectures about the origin of this mine, our author proceeds to inform us that the piſſaſphaltum of Bua is correſpondent to that foſſil production which by Haſſelquiſt, in his Travels, is called *mumia minerale*, and *mumia nativa Perſiana* by Kempfer, which the Egyptians made uſe of to embalm their kings[*]. It is found in a cave of mount Caucaſus, which is kept ſhut, and carefully guarded by order of the king of Perſia. One of the qualities aſſigned by M. Linnæus to the fineſt bitumen is to ſmoke when laid on the fire, as ours does, emitting a ſmell of pitch not diſagreeable. He believes it would be very good for wounds, as the oriental mumia is, and like the pitch of Caſtro, which is frequently uſed by the Roman chirurgeons for fractures, contuſions, and in many external applications. See MINERALOGY.

PISSELÆUM INDICUM, *Barbadoes Tar*; a mineral fluid of the nature of the thicker bitumens, and of all others the moſt approaching, in appearance, colour, and conſiſtence, to the true piſſaſphaltum, but differing from it in other reſpects. It is very frequent in many parts of America, where it is found trickling down the ſides of mountains in large quantities, and ſometimes floating on the ſurface of the waters. It has been greatly recommended internally in coughs and other diſorders of the breaſt and lungs.

PISTACIA, TURPENTINE-TREE, *Piſtachia-nut* and *Maſtich-tree*; a genus of the pentandria order, belonging to the diœcia claſs of plants. There are nine ſpecies; of which the moſt remarkable are, 1. The terebinthus, or piſtachia-tree. This grows naturally in Arabia, Perſia, and Syria, whence the nuts are annually brought to Europe. In thoſe countries it grows to the height of 25 or 30 feet: the bark of the ſtem and old branches is of a dark ruſſet colour, but that of the young branches is of a light brown. Theſe are garniſhed with winged leaves, compoſed ſometimes of two, at other times of three, pairs of lobes, terminated by an odd one: theſe lobes approach towards an oval ſhape, and their edges are turned backward; and theſe, when bruiſed, emit a ſmell ſimilar to that of the ſhell of the nut. Some of theſe trees produce male and others female flowers, and ſome have both male and female on the ſame tree. The male flowers come out from the ſides of the branches in looſe bunches or catkins. They have no petals, but five ſmall ſtamina crowned by large four-cornered ſummits filled with farina; and when this is diſcharged, the flowers fall off. The female flowers come out in cluſters from the ſides of the branches: they have no petals, but a large oval germen ſupporting three reflexed ſtyles, and are ſucceeded by oval nuts. 2. The lentiſcus, or common maſtich-tree, grows naturally in Portugal, Spain, and Italy. Being an evergreen, it has been preſerved in this country in order to adorn the green-houſes. In the countries where it is a native, it riſes to the height of 18 or 20 feet, covered with a grey bark on the ſtem; but the branches, which are very numerous, are covered with a reddiſh-brown bark, and are garniſhed with winged leaves, compoſed of three or four pair of ſmall ſpear-ſhaped lobes, without an odd one at the end. 3. The orientalis, or true maſtich-tree of the Levant, from which the maſtich is gathered, has been confounded by moſt botanical writers with the lentiſcus, or common maſtich tree, above deſcribed, though there are conſiderable differences between them. The bark of the tree is brown; the leaves are compoſed of two or three pair of ſpear-ſhaped lobes, terminated by an odd one: the outer lobes are the largeſt; the others gradually diminiſh, the innermoſt being the leaſt. Theſe turn of a browniſh colour towards the autumn, when the plants are expoſed to the open air; but if they are under glaſſes, they keep green. The leaves continue all the year, but are not ſo thick as thoſe of the common ſort, nor are the plants ſo hardy.

The firſt ſpecies is *propagated* by its nuts; which ſhould be planted in pots filled with light kitchen-garden earth, and plunged into a moderate hot-bed to bring up the plants: when theſe appear, they ſhould have a large ſhare of air admitted to them, and by degrees they ſhould be expoſed to the open air, which at laſt they will bear in all ſeaſons, though not without

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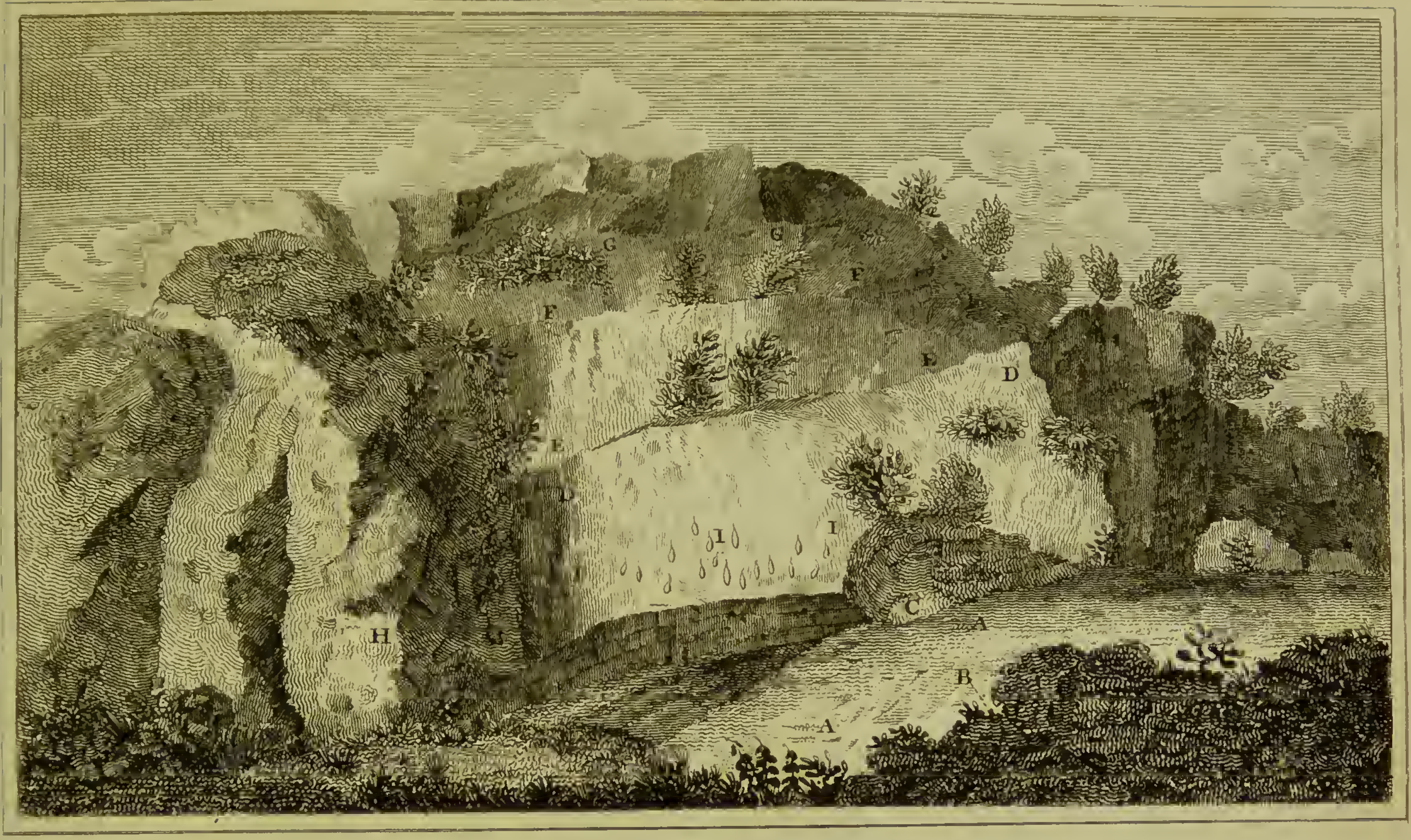
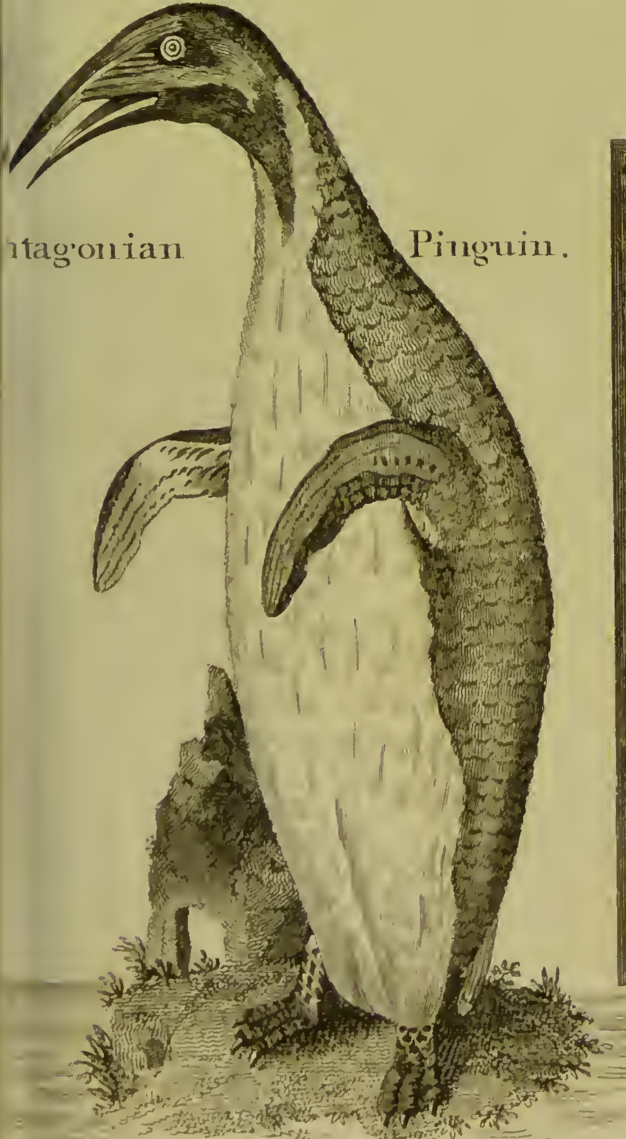
[*] “ Mumiahi, or native Perſian mummy. It proceeds from a hard rock in very ſmall quantity. It is a bituminous juice, that tranſudes from the ſtony ſuperficies of the hill, reſembling in appearance coarſe ſhoemakers wax, as well in its colour as in its denſity and ductility. While adherent to the rock it is leſs ſolid, but is formed by the warmth of the hands. It is eaſily united with oil, but repels water; it is quite void of ſmell, and very like in ſubſtance to the Egyptian mummy. When laid on burning coals, it has the ſmell of ſulphur tempered a little with that of naphtha, not diſagreeable. There are two kinds of this mummy; the one is valuable for its ſcarcity and great activity. The native place of the beſt mummy is far from the acceſs of men, from habitations, and from ſprings of water, in the province of Daraab. It is found in a narrow cave, not above two fathoms deep, cut like a well out of the maſs, at the foot of the ragged mountain Caucaſus.——*Kempfer. Amœn. Perſ.* This deſcription agrees perfectly with the piſſaſphaltum or foſſil mummy of Bua, differing only in the privation of ſmell, which it is difficult to imagine is totally wanting in the Perſian mummy.

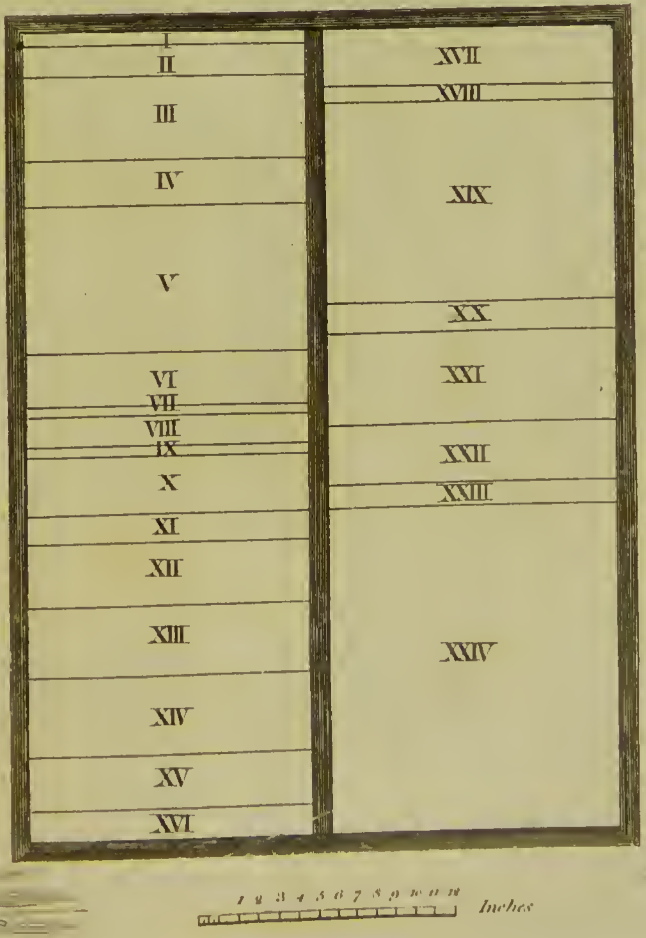
The Mines of Piſsasphaltum in the Island of Bua.



ntagonian Pinguin.



Vegetable Cabinet.



Platalea or Spoonbill.

Barlow sculp.

great danger of being deſtroyed in ſevere winters. The ſecond ſort is commonly propagated by laying down the branches, though it may alſo be raiſed from the ſeed in the manner already directed for the piſtachia-nut tree: and in this manner alſo may the true maſtich-tree be raiſed. But this, being more tender than any of the other ſorts, requires to be conſtantly ſheltered in winter, and to have a warm ſituation in ſummer.

Piſtachia-nuts are moderately large, containing a kernel of a pale greeniſh colour, covered with a reddiſh ſkin. They have a pleaſant, ſweet, unctuous taſte, reſembling that of almonds; and they abound with a ſweet and well-taſted oil, which they yield in great abundance on being preſſed after bruiſing them: they are reckoned amongſt the analeptics, and are wholeſome and nutritive, and are by ſome eſteemed very proper to be preſcribed by way of reſtoratives, eaten in ſmall quantity, to people emaciated by long illneſs.

PISTIL, among botaniſts, the little upright column which is generally found in the centre of every flower. According to the Linnæan ſyſtem, it is the female part of generation, whoſe office is to receive and ſecrete the pollen, and produce the fruit. It conſiſts of three parts, viz. germen, ſtylus, and ſtigma. See BOTANY.

PISTOIA is a city of Italy, in the duchy of Tuſcany, ſituated on the river Stella, in a beautiful plain near the foot of the Apennine mountains. By Pliny it is called *Piſtorium*, and is ſaid to have been once a Roman colony. At preſent it is a biſhop's ſee, ſuffragan of Florence. The ſtreets are broad and regular, the houſes tolerably well built, but poorly inhabited for want of trade. Formerly it was an independent republic; but ſince it was ſubdued by the Florentines in 1200, it has been in a declining condition. The cathedral has a very handſome cupola, and a magnificent ſtaircaſe to aſcend to it. In the chapel dedicated to St. James, where his relics are preſerved, the walls are almoſt covered with plates of ſilver. Here are four marble ſtatues of very good workmanſhip. The marble pulpit, the baſſo-relievos, the veſſel that holds the holy water, and the ſquare ſteeple, are the work of John Piſano. The Jeſuits have a very fine college, and the Franciſcans, Dominicans, and Auguſtinians, good churches. In the church of Madonna dell' Umilta there are two ſtatues, one of Leo X. and the other of Clement VII. The public palace, ſituated in a large ſquare, is a handſome building; ſeveral of the nobility have alſo very good houſes. In the neighbouring mountains, called by the name of Piſtoia, there are many large villages, the chief of which is that of S. Marcello, belonging to the family of Cartoli. Theſe mountains are a part of the Apennines, and border on the territory of Bologna and the county of Vernio; higher up is the ſource of the river Reno. The country about Piſtoia, eſpecially towards Florence, is exceeding fertile and delightful, covered with all ſorts of fruits, corn, wine, &c. and containing a vaſt number of little towns, wealthy villages, and country ſeats, ſo as to be reckoned the richeſt and moſt beautiful in all Tuſcany. It is about 20 miles N. W. of Florence, and 30 N. E. of Piſa. E. lon. 11. 29. N. lat. 43. 55

PISTOL, the ſmalleſt piece of fire-arms, borne at the ſaddle-bow, on the girdle, and in the pocket.

PISTOLE, a gold coin, ſtruck in Spain and in ſeveral parts of Italy, Switzerland, &c. The piſtole has its augmentations and diminutions, which are quadruple piſtoles, double piſtoles, and half piſtoles. See MONEY-*Table*.

PISTON, in pump-work, is a ſhort cylinder of metal or other ſolid ſubſtance, fitted exactly to the cavity of the barrel or body of the pump. See HYDROSTATICS.

PISTORIUS (JOHN), born at Nidda in 1546, applied himſelf at firſt to the ſtudy of medicine, and was admitted a doctor with applauſe; but his preſcriptions not being attended with all the ſucceſs which he expected, he quitted that profeſſion, and ſtudied the law. His merit procured him the appointment of counſellor to Erneſt Frederick margrave of Baden-Dourlach. He had embraced the Proteſtant religion; but ſome time after he changed his opinion, and returned to the communion of the church of Rome. He became afterwards a doctor of divinity, one of the emperor's counſellors, provoſt of the cathedral of Breſlaw, and domeſtic prelate to the abbot of Fulda. We have of his writings, 1. Several Controverſial Tracts againſt the Lutherans. 2. *Artis Cabaliſticæ Scriptores*, printed at Bale 1587; a ſcarce and curious collection. 3. *Scriptores rerum Polonicarum*. 4. *Scriptores de rebus Germanicis*, in 3 vols. folio, from 1603 to 1613. This is a curious and ſcarce performance, but might have been better digeſted. The author died in 1608, at the age of 52.

PISUM, PEASE; a genus of the decandria order, belonging to the diadelphia claſs of plants. The ſpecies are, 1. The ſativum, or greater garden pea, whoſe lower ſtipulæ are roundiſh, indented, with taper foot-ſtalks, and many flowers on a foot-ſtalk. 2. The humile, or dwarf pea, with an erect branching ſtalk, and leaves having two pair of round lobes. 3. The umbellatum, roſe, or crown-pea, with four pointed acute ſtipuli, and foot-ſtalks bearing many flowers, which terminate the ſtalks. 4. The maritimum, or ſea-pea, with foot-ſtalks which are plain on their upper ſide, an angular ſtalk, arrow-pointed ſtipulæ, and foot-ſtalks bearing many flowers. 5. The Americanum, commonly called *Cape-Horn pea*, with an angular trailing ſtalk, whoſe lower leaves are ſpear-ſhaped, ſharply indented, and thoſe at the top arrow-pointed. 6. The ochrus, with membranaceous running foot-ſtalks, having two leaves and one flower upon a foot-ſtalk.

There is a great variety of garden-peaſe now cultivated in Britain, which are diſtinguiſhed by the gardeners and ſeedſmen, and have their different titles: but as great part of theſe have been ſeminal variations; ſo, if they are not very carefully managed, by taking away all thoſe plants which have a tendency to alter before the ſeeds are formed, they will degenerate into their original ſtate: therefore all thoſe perſons who are curious in the choice of their ſeeds, look carefully over thoſe which they deſign for ſeeds at the time when they begin to flower, and draw out all the plants which they diſlike from the other. This is what they call *roguing their peaſe*; meaning hereby the taking out all the bad plants from the good, that the farina of the former may not impregnate the latter; to prevent which, they always do it before the flowers open. By thus diligently drawing out the bad, reſerving thoſe which come earlieſt to flower, they have greatly improved their peaſe of late years, and are conſtantly endeavouring to get forwarder varieties; ſo that it would be to little purpoſe in this place to attempt giving a particular account of all the varieties now cultivated: therefore we ſhall only mention the names by which they are commonly known, placing them according to their time of coming to the table, or gathering for uſe.

The golden hotſpur.
The Charlton.
The Reading hotſpur.
Maſter's hotſpur.
Eſſex hotſpur.
The dwarf pea.
The ſugar pea
Spaniſh Morotto.
Nonpareil.
Sugar dwarf.
Sickle pea.
Marrowfat.
Roſe or crown pea.
Rouncival pea.
Gray pea.
Pig pea.

To theſe may be added ſome others.

The Engliſh ſea-pea is found wild upon the ſhore in Suſſex and ſeveral other counties in England, and is undoubtedly a different ſpecies from the common pea.

The fifth ſpecies hath a biennial root, which continues two years. This was brought from Cape Horn by lord Anſon's cook, when he paſſed that cape, where theſe peaſe were a great relief to the ſailors. It is kept here as a curioſity, but the peaſe are not ſo good for eating as the worſt ſort now cultivated in Britain. It is a low trailing plant; the leaves have two lobes on each foot-ſtalk: thoſe below are ſpear-ſhaped, and ſharply indented on their edges; but the upper leaves are ſmall, and arrow-pointed. The flowers are blue, each foot-ſtalk ſuſtaining four or five flowers; the pods are taper, near three inches long; and the ſeeds are round, about the ſize of tares.

The ſixth ſort is annual. This grows naturally among the corn in Sicily and ſome parts of Italy, but is here preſerved in botanic gardens for the ſake of variety. It hath an angular ſtalk, riſing near three feet high; the leaves ſtand upon winged foot-ſtalks, each ſuſtaining two oblong lobes. The flowers are of a pale yellow colour, ſhaped like thoſe of the other ſort of pea, but are ſmall, each foot-ſtalk ſuſtaining one flower; theſe are ſucceeded by pods about two inches long, containing five or ſix roundiſh ſeeds, which are a little compreſſed on their ſides. Theſe are by ſome perſons eaten green; but unleſs they are gathered very young, they are coarſe, and at beſt not ſo good as the common pea. It may be ſown and managed in the ſame way as the garden pea.

We ſhall now proceed to ſet down the method of cultivating the ſeveral ſorts of garden peaſe, ſo as to continue them throughout the ſeaſon.

It is a common practice with the gardeners near London to raiſe peaſe upon hot-beds, to have them very early in the ſpring; in order to which, they ſow their peaſe upon warm borders, under walls or hedges, about the middle of October; and when the plants come up, they draw the earth up gently to their ſtems with a hoe, the better to protect them from froſt. In theſe places they let them remain until the latter end of January, or the beginning of February, obſerving to earth them up from time to time as the plants advance in height (for the reaſons before given); as alſo to cover them in very hard froſt with peaſe-haulm, ſtraw, or ſome other light covering, to preſerve them from being deſtroyed; they then make a hot-bed (in proportion to the quantity of peaſe intended), which muſt be made of good hot dung, well prepared and properly mixed together, that the heat may not be too great. The dung ſhould be laid for two or three feet thick, according as the beds are made earlier or later in the ſeaſon: when the dung is equally levelled, then the earth (which ſhould be light and freſh, but not over rich) muſt be laid thereon about ſix or eight inches thick, laying it equally all over the bed. This being done, the frames (which ſhould be two feet high on the back ſide, and about 14 inches in front) muſt be put on, and covered with glaſſes; after which it ſhould remain three or four days, to let the ſteam of the bed paſs off before you put the plants therein, obſerving every day to raiſe the glaſſes to give vent for the riſing ſteam to paſs off: then, when you find the bed of a moderate temperature for heat, you ſhould, with a trowel, or ſome other inſtrument, take up the plants as carefully as poſſible to preſerve the earth to their roots, and plant them in the hot-bed in rows about two feet aſunder, and the plants about an inch diſtant from each other in the rows, obſerving to water and ſhade them until they have taken root; after which you muſt be careful to give them air at all times when the ſeaſon is favourable, otherwiſe they will draw up very weak, and be ſubject to grow mouldy and decay. You ſhould alſo draw the earth up to the ſhanks of the plants as they advance in height, and keep them always clear from weeds. The water they ſhould have muſt be given them ſparingly; for, if they are too much watered, it will cauſe them to grow too rank, and ſometimes rot off the plants at their ſhanks juſt above ground. When the weather is very hot, you ſhould cover the glaſſes with mats in the heat of the day, to ſcreen them from the violence of the heat of the ſun, which is then too great for them: but when the plants begin to fruit, they ſhould be watered oftener, and in greater plenty than before; for by that time the plants will have nearly done growing, and the often refreſhing them will occaſion their producing a greater plenty of fruit.

The ſort of pea which is generally uſed for this purpoſe is the dwarf; for all the other ſorts ramble too much to be kept in frames: the reaſon for ſowing them in the common ground, and afterwards tranſplanting them on a hot-bed, is to check their growth, and cauſe them to bear in leſs compaſs; for, if the ſeeds were ſown upon a hot-bed, and the plants continued thereon, they would produce ſuch luxuriant plants as could not be contained in the frames, and would bear but little fruit.

The next ſort of pea which is ſown to ſucceed thoſe on the hot-bed is the hotſpur; of which there are reckoned ſeveral varieties, as the golden hotſpur, the Charlton hotſpur, the Maſter's hotſpur, the Reading hotſpur, and ſome others; which are very little differing from each other, except in their early bearing, for which the golden and Charlton hotſpurs are chiefly preferred; though, if either of theſe ſorts are cultivated in the ſame place for three or four years, they are apt to degenerate, and be later in fruiting; for which reaſon, moſt curious perſons procure their ſeeds annually from ſome diſtant place; and in the choice of theſe ſeeds, if they could be obtained from a colder ſituation and a poorer ſoil than that in which they are to be ſown, it will be much better than on the contrary, and they will come earlier in the ſpring.

Theſe muſt alſo be ſown on warm borders, towards the latter end of October; and when the plants are come up you ſhould draw the earth up to their ſhanks, and treat them in every other reſpect as above directed.

In the ſpring you muſt carefully clear them from weeds, and draw ſome freſh earth up to their ſtems; but do not raiſe it too high up to the plants, leſt by burying their leaves you ſhould rot their ſtems, as is ſometimes the caſe, eſpecially in wet ſeaſons. You ſhould alſo obſerve to keep them free from vermin, which if permitted to remain amongſt the plants, will increaſe ſo plentifully as to devour the greateſt part of them. The chief of the vermin which infeſt peaſe are ſlugs, which lie all the day in the ſmall hollows of the earth, near the ſtems of the plants, and in the night-time come out and make terrible deſtruction of the peaſe; and theſe chiefly abound in wet ſoils, or where a garden is neglected and over-run with weeds: therefore you ſhould make the ground clear every way round the peaſe, to deſtroy their harbours; and afterwards in a fine mild morning very early, when theſe vermin are got abroad from their holes, you ſhould ſlake a quantity of lime, which ſhould be ſtrewed over the ground pretty thick, which will deſtroy the vermin wherever it happens to fall upon them, but will do very little injury to the peaſe, provided it be not ſcattered too thick upon them.

If this crop of peaſe ſucceeds, it will immediately follow thoſe on the hot-bed; but for fear this ſhould miſcarry, it will be proper to ſow two more crops at about a fortnight or three weeks diſtance from each other, ſo that there may be the more chances to ſucceed. This will be ſufficient till the ſpring of the year, when you may ſow ſeveral more crops of theſe peaſe at a fortnight diſtance from each other. The late ſowings will be ſufficient to continue the early ſort of peaſe through the ſeaſon; but it will be proper to have ſome of the large ſort to ſucceed them for the uſe of the family: in order to which, you ſhould ſow ſome of the Spaniſh Morotto, which is a great bearer and a hardy ſort of pea, about the middle of February, upon a clear open ſpot of ground. Theſe muſt be ſown in rows about four feet aſunder, and the peaſe ſhould be dropped in the drills about an inch diſtance, covering them about two inches deep with earth, being very careful that none of them lie uncovered, which will draw the mice, pigeons, or rooks, to attack the whole ſpot; and it often happens, by this neglect, that a whole plantation is devoured by theſe creatures; whereas, when there are none of the peaſe left in ſight, they do not eaſily find them out.

About a fortnight after this you ſhould ſow another ſpot, either of this ſort or any other large ſort of pea, to ſucceed theſe; and then continue to repeat ſowing once a fortnight, till the middle or latter end of May; only obſerving to allow the marrowfats, and other very large ſorts of peaſe, at leaſt four feet and a half between row and row; and the roſe-pea ſhould be allowed at leaſt eight or ten inches diſtance plant from plant in the rows: for theſe grow very large; and if they have not room allowed them, they will ſpoil each other by drawing them up very tall, and will produce no fruit.

When the plants come up, the earth ſhould be drawn up to their ſhanks (as was before directed), and the ground kept entirely clear from weeds; and when the plants are grown eight or ten inches high, you ſhould ſtick ſome bruſhwood into the ground cloſe to the peaſe for them to ramp upon; which will ſupport them from trailing upon the ground, which is very apt to rot the growing ſorts of peaſe, eſpecially in wet ſeaſons: beſides, by thus ſupporting them, the air can freely paſs between them, which will preſerve the bloſſoms from falling off before their time, and occaſion them to bear much better than if permitted to lie upon the ground, and there will be room to paſs between the rows to gather the peaſe when they are ripe.

The dwarf ſort of peaſe may be ſown much cloſer together than thoſe before mentioned; for theſe ſeldom riſe above a foot high, and rarely ſpread above half a foot in width, ſo that theſe need not have more room than two feet row from row, and not above an inch aſunder in the rows. Theſe will produce a good quantity of peaſe, provided the ſeaſon be not over dry; but they ſeldom continue long in bearing, ſo that they are not ſo proper to ſow for the main crop when a quantity of peaſe is expected for the table, their chief excellency being for hot-beds, where they will produce a greater quantity of peaſe (provided they are well managed) than if expoſed to the open air, where the heat of the ſun ſoon dries them up.

The large-growing ſorts may be cultivated for the common uſe of the family, becauſe theſe will produce in greater quantities than the other, and will endure the drought better; but the early kind are by far the ſweeter-taſted peaſe.

The beſt of all the large kinds is the marrowfat, which, if gathered young, is a well-taſted pea; and this will continue good through the month of Auguſt, if planted on a ſtrong ſoil.

The gray and other large winter peaſe are ſeldom cultivated in gardens, becauſe they require a great deal of room, but are uſually ſown in fields. For the proper method of managing them, ſee AGRICULTURE.

In the *Muſeum Ruſticum*, Vol. I. p. 109, we find the following method of preparing peaſe for hog-meat, which we ſhall give in the words of the ingenious farmer who communicated it:

" A few years ago (ſays he), I had a plentiful crop of peaſe on a ten acre piece, which lies near my houſe: when they were full podded and nearly ripe, I had them hooked in the uſual manner; but before I could get them in, there came a heavy ſhower of rain which wetted them through and through; and the dull heavy weather, with frequent ſhowers which followed, prevented their drying for a conſiderable time.

" I cauſed the wads to be from time to time turned, to prevent the haulm from rotting; and at length a few days ſunſhine dried them enough to be inned; for, as they lay hollow, the wind was greatly aſſiſtant to the operation.

" Before I got them in, on examining ſome of the pods, I found that the peaſe were all ſprouted to a conſiderable length: this was what I had expected, and I gave my crop over for loſt, till after a little recollection, as the weather ſtill continued fine, I determined to threſh them in the field.

" This was accordingly done; and the corn, after it was caſt and riddled to ſeparate it from the rubbiſh, was dried on my malt kiln.

" When this operation was over, I began to reflect in what manner I ſhould diſpoſe of my peaſe, being ſenſible that they could not be proper for ſeed, and ſtanding no chance of diſpoſing of them to any advantage in the market.

" At length, as it was then a time of war, and of courſe there was a great demand for pork for the uſe of the navy, I determined to buy a conſiderable number of lean hogs, that I might by their means conſume this crop on my own premiſes, and in that manner make the moſt of it.

" My expectations were more than anſwered; for I found, by repeated experience, that three buſhels of the peaſe I have mentioned went nearly as far in fattening the hogs I bought, as four buſhels got in dry and hard in the manner uſually practiſed.

" This diſcovery I made ſeveral years ago, and it has turned out to my advantage; for ſince that time I have been quite indifferent as to the weather in which my peaſe are hooked, being rather better pleaſed, as far as relates to them, with wet than dry weather; but if the weather happens to be dry at the time they are ripe, I always cauſe as many as I want for feeding my hogs, which are not a few in a year, to be regularly malted in the ſame manner nearly as my barley: this management has of late ſucceeded very well with me, and I therefore intend to continue it.

" Beſides feeding my hogs with theſe malted peaſe, I have often given them to my horſes, with which they agree very well, and are heartening food.

" Turkeys will fatten apace on them alſo, and be fine meat.

" I have applied my malted peaſe to many other uſes, which I have not at preſent time to enumerate: but were they only uſed for feeding hogs and horſes, it is ſtill worth while to prepare ſome in this manner every year."

PIT-COAL, or STONE-COAL. See COAL and LITHANTHRAX. Mr. Bertrand, in his *Oryctologic Dictionary*, reduces all kinds of coals to ſix general claſſes, *viz.* 1. Lithanthrax ligneus; 2. Petroſus; 3. Terreſtris; 4. Piceus; 5. Fiſſilis; 6. Mineraliſatus. He ſays, that the Scots coals are heavier, and burn not ſo well as thoſe of Newcaſtle; that thoſe of Liege burn quicker; and thoſe from Braſſac in Auvergne, and from La Foſſe, burn with a more agreeable flame, &c. But Mr. Morand, in his *Nomenclature Raiſonnée*, diſtributes all ſorts of pit-coals into four claſſes: In the firſt he places nine varieties, beginning with the *gagas* or *ſuccinum nigrum*, to the variegated lithanthrax; in the ſecond he reckons ſeven varieties, beginning with the *lithanthrax eleganti ſtructura*, to that *facie granulata*: and he forms the fourth claſs with the earthy and poorer kinds of foſſil coals. He ſeems, however, to have been puzzled with the ſlaty coals, as he ranges them in a ſeparate claſs, perhaps to ſhelter himſelf from the critical objections of thoſe numerous ſuperficial naturaliſts, who only look for the apparent configuration, without almoſt any regard to the component parts of foſſils.

The coal-trade is of infinite importance to Great Britain, which never could have arrived at its preſent commercial eminence without it; and this eminence it will be impoſſible to retain if coal ſhould ever become ſcarce. This we truſt is not likely to be the caſe, though Mr. Williams expreſſes great fears for it, and informs us, that at Newcaſtle and in many parts of Scotland the mines near the ſea are already waſted, the firſt conſequence of which muſt be an enormous riſe in the price. See his obſervations on this ſubject in his *Natural Hiſtory of the Mineral Kingdom*, p. 156, &c. This author ſays, that coal was not diſcovered till between the middle of the 12th and beginning of the 13th centuries: it is therefore, according to him, 400 years ſince it was firſt diſcovered in Britain, but they have not been in common uſe for more than 200 years. The ſame author gives us many pertinent obſervations on the appearances and indications of coal, inſtructions about ſearching for it, remarks on falſe and doubtful ſymptoms of coal: for all which, together with his obſervations on the different kinds of Scots coal, we ſhall refer our readers to the work itſelf; the firſt part of which, occupying the largeſt proportion of the firſt volume, is upon the *ſtrata of coal*, and on the *concomitant ſtrata*. See alſo our article COALERY.

PITAHAYA (*Cactus Pitajaya*, Lin. *Syſt. Vegetabilium. Jacquin Amer.* 151. ed. 2. p. 75. M. *E. Carthagena*), a ſhrub peculiar to California, is a kind of beech, the fruit of which forms the greateſt harveſt of the natives. Its branches are finely fluted, and riſe vertically from the ſtem, ſo as to form a very beautiful top. The fruit is like a horſe cheſnut; in ſome white, in others yellow, and in others red, but always exquiſitely delicious, being a rich ſweet, tempered with a grateful acid. See CACTUS.

PITCAITHLY. See PITKEATHLY.

PITCH, a tenacious oily ſubſtance, drawn chiefly from pines and firs, and uſed in ſhipping, medicine, and various arts: or it is more properly tar inſpiſſated by boiling it over a ſlow fire. See TAR.

Foſſil PITCH. See PETROLEUM.

PITCHING, in ſea affairs, may be defined the vertical vibration which the length of a ſhip makes about her centre of gravity; or the movement by which ſhe plunges her head and after-part alternately into the hollow of the ſea. This motion may proceed from two cauſes: the waves which agitate the veſſel; and the wind upon the ſails, which makes her ſtoop to every blaſt thereof. The firſt abſolutely depends upon the agitation of the ſea, and is not ſuſceptible of inquiry; and the ſecond is occaſioned by the inclination of the maſts, and may be ſubmitted to certain eſtabliſhed maxims.

When the wind acts upon the ſails, the maſt yields to its effort, with an inclination which increaſes in proportion to the length of the maſt, to the augmentation of the wind, and to the comparative weight and diſtribution of the ſhip's lading.

The repulſion of the water, to the effort of gravity, oppoſes itſelf to this inclination, or at leaſt ſuſtains it, by as much as the repulſion exceeds the momentum, or abſolute effort of the maſt, upon which the wind operates. At the end of each blaſt, when the wind ſuſpends its action, this repulſion lifts the veſſel; and theſe ſucceſſive inclinations and repulſions produce the movement of pitching, which is very inconvenient; and, when it is conſiderable, will greatly retard the courſe, as well as endanger the maſt, and ſtrain the veſſel.

PITH, in vegetation, the ſoft ſpongy ſubſtance contained in the central parts of plants and trees. See PLANT.

PITHO, (fab. hiſt.) the goddeſs of perſuaſion among the Romans. She was ſuppoſed to be the daughter of Mercury and Venus, and was repreſented with a diadem on her head, to intimate her influence over the hearts of men. One of her arms appeared raiſed as in the attitude of an orator haranguing in a public aſſembly; and with the other ſhe holds a thunderbolt and fetters, made with flowers, to ſignify the powers of reaſoning and the attractions of eloquence. A caduceus, as a ſymbol of perſuaſion, appears at her feet, with the writings of Demoſthenes and Cicero, the two moſt celebrated among the ancients, who underſtood how to command the attention of their audience, and to rouſe and animate their various paſſions. —A Roman courtezan. She received this name on account of the allurements which her charms poſſeſſed, and of her winning expreſſions.

PITHOM, one of the cities that the children of Iſrael built for Pharaoh in Egypt (Exod. i. 11.) during the time of their ſervitude. This is probably the ſame city with Pathumos mentioned by Herodotus, which he places upon the canal made by the kings Necho and Darius to join the Red Sea with the Nile, and by that means with the Mediterranean. We find alſo in the ancient geographers, that there was an arm of the Nile called *Pathmeticus*, *Phatmicus*, *Phatnicus*, or *Phatniticus*. Bochart ſays, that Pithom and Raamſes are about five leagues above the diviſion of the Nile, and beyond this river: but this aſſertion has no proof from antiquity. This author contents himſelf with relating what was ſaid of Egypt in his own time. Marſham will have Pithom to be the ſame as Peluſium or Damietta.

PITHOU or PITHŒUS (Peter), a Frenchman of great literary eminence, was deſcended from an ancient and noble family in Normandy, and born at Troyes in 1539. His taſte for literature appeared very early, and his father cultivated it to the utmoſt. He firſt ſtudied at Troyes, and was afterwards ſent to Paris, where he became firſt the ſcholar, and then the friend, of Turnebus. Having finiſhed his purſuits in languages and the belles lettres, he was removed to Bourges, and placed under Cujacius in order to ſtudy civil law. His father was well ſkilled in this profeſſion, and has left no inconſiderable ſpecimen of his judgment in the advice he gave his ſon with regard to acquiring a knowledge of it; which was, not to ſpend his time and pains upon voluminous and barren commentators, but to confine his reading chiefly to original writers. He made ſo rapid a progreſs, that at ſeventeen he was able to ſpeak extempore upon the moſt difficult queſtions; and his maſter was not aſhamed to own, that even himſelf had learned ſome things of him. Cujacius afterwards removed to Valence; and Pithœus followed him, and continued to profit by his lectures till the year 1560. He then returned to Paris, and frequented the bar of the parliament there, in order to join practical forms and uſages to his theoretic knowledge.

In 1565, being then 24, he publiſhed *Adverſaria Subſeciva*, a work highly applauded by Turnebus, Lipſius, and other learned men; and which laid the foundation of that great and extenſive fame he afterwards acquired. Soon after this, Henry III. advanced him to ſome conſiderable poſts; in which, as well as at the bar, he acquitted himſelf moſt honourably. Pithœus being a proteſtant, it was next to a miracle that he was not involved in the terrible maſſacre of St. Bartholomew in 1572; for he was at Paris where it was committed, and in the ſame lodgings with ſeveral Huguenots, who were all killed. It ſeems indeed to have frightened him out of his religion; which having, according to the cuſtom of converts, examined and found to be erroneous, he ſoon abjured, and openly embraced the Catholic faith. He afterwards attended the duke of Montmorency into England; and on his return, from his great wiſdom, good nature, and amiable manners, he became a kind of oracle to his countrymen, and even to foreigners, who conſulted him on all important occaſions: an inſtance of which we have in Ferdinand the Grand Duke of Tuſcany, who not only conſulted him, but even ſubmitted to his determination in a point contrary to his intereſts. Henry III. and IV. were greatly obliged to him for combating the League in the moſt intrepid manner, and for many other ſervices, in which he had recourſe to his pen as well as to other means.

Pithœus died upon his birth-day in 1596, leaving behind him a wife whom he had married in 1579, and ſome children. Thuanus ſays he was the moſt excellent and accompliſhed man of the age in which he lived; and all the learned have agreed to ſpeak well of him. He collected a very valuable library, containing a variety of rare manuſcripts, as well as printed books; and he took many precautions to hinder its being diſperſed after his death, but in vain. He publiſhed a great number of works upon law, hiſtory, and claſſical literature; and he gave ſeveral new and correct editions of ancient writers. He was the firſt who made the world acquainted with the Fables of Phædrus; which, together with the name of their author, were utterly unknown and unheard of till publiſhed from a manuſcript of his.

PITISCUS (Samuel), a learned antiquary, born at Zutphen, was rector of the college of that city, and afterwards of St. Jerome at Utrecht, where he died on the firſt of February 1717, aged 90. He wrote, 1. *Lexicon Antiquitatum Romanorum*, in two volumes folio; a work which is eſteemed. 2. Editions of many Latin authors, with notes; and other works.

PITKEATHLY, or Pitcaithly, is the name of an eſtate in Strathern in Scotland, famous for a mineral ſpring. An intelligent traveller (Heron) gives the following account of it: "The ſituation of the mineral ſpring at Pitcaithly, the efficacy with which its waters are ſaid to operate in the cure of the diſeaſes for which they are uſed, and the accommodations which the neighbourhood affords, are all of a nature to invite equally the ſick and the healthy. Two or three houſes are kept in the ſtyle of hotels for the reception of ſtrangers. There is no long-room at the well; but there are pleaſing walks through the adjoining fields. Good roads afford eaſy acceſs to all the circumjacent country. This delightful tract of Lower Strathern is filled with houſes and gardens, and ſtations from which wide and delightful proſpects may be enjoyed; all of which offer agreeable points to which the company at the well may direct their forenoon excurſions; converſation, muſic, dances, whiſt, and that beſt friend to elegant, lively, and ſocial converſe, the tea-table, are ſufficient to prevent the afternoons from becoming languid: and in the evenings nothing can be ſo delightful as a walk when the ſetting ſun ſheds a ſoft ſlanting light, and the dew has juſt not begun to moiſten the graſs. Thus is Pitcaithly truly a rural watering place. The company cannot be at any one time more in number than two or three families. The amuſements of the place are ſimply ſuch as a ſingle family might enjoy in an agreeable ſituation in the country; only the ſociety is more diverſified by the continual change and fluctuation of the company."

PITOT (Henry), of a noble family in Languedoc, was born at Aramont in the dioceſe of Uſez, on the 29th of May 1695, and died there on the 27th of December, 1771, aged 76. He learned the mathematics without a maſter, and went to Paris in 1718, where he formed a cloſe friendſhip with the illuſtrious Reaumur. In 1724, he was admitted a member of the Royal Academy of Sciences at Paris, and in a few years roſe to the degree of a penſioner. Beſides a vaſt number of memoirs printed in the collection of that ſociety, he publiſhed in 1731 the Theory of the Working of Ships, in one volume 4to; a work of conſiderable merit, which was tranſlated into Engliſh, and made the author be admitted into the Royal Society of London. In 1740, the ſtates-general of Languedoc made choice of him for their chief engineer, and gave him at the ſame time the appointment of inſpector general of the canal which unites the two ſeas. That province is indebted to him for ſeveral monuments of his genius, which will tranſmit his name with luſtre to poſterity. The city of Montpellier being in want of water, Pitot brought from the diſtance of three leagues two ſprings which furniſh a plentiful ſupply of that neceſſary article. They are brought to the magnificent Place du Peyron, and thence are diſtributed through the city. This aſtoniſhing work is the admiration of all ſtrangers. The illuſtrious marſhal de Saxe was the great patron and friend of Pitot, who had taught this hero the mathematics. In 1754, he was honoured with the order of St. Michael. In 1735 he had married Maria-Leonina Pharambier de Sabballoua, deſcended from a very ancient noble family of Navarre. By this marriage he had only one ſon, who was firſt Advocate-general of the Court of Accounts, Aids, and Finances of Montpellier. Pitot was a practical philoſopher, and a man of uncommon probity and candour. He was alſo a member of the Royal Society of Sciences of Montpellier; and his eulogium was pronounced in 1772 by M. de Ratte perpetual ſecrĕtary, in preſence of the ſtates of Languedoc; as it likewiſe was at the Royal Academy of Sciences at Paris by Abbé de Fouchi, who was then ſecretary.

PITS (John), the biographer, was born in 1560, at Alton in Hampſhire, and educated at Wykeham's ſchool near Wincheſter, till he was about 18 years of age; when he was ſent to New-college in Oxford, and admitted probationer fellow. Having continued in that univerſity not quite two years, he left the kingdom as a voluntary Romiſh exile, and retired to Douay; thence he went to the Engliſh college at Rheims, where he remained about a year; and then proceeded to Rome, where he continued a member of the Engliſh college near ſeven years, and was made a prieſt. In 1589 he returned to Rheims; and there, during two years, taught rhetoric and the Greek language. He now quitted Rheims on account of the civil war in France; and retired to Pont à Mouſſon in Lorrain, where he took the degrees of maſter of arts and bachelor in divinity. Hence he travelled into Germany, and reſided a year and a half at Triers, where he commenced licentiate in his faculty. From Triers he viſited ſeveral of the principal cities in Germany; and, continuing three years at Ingoldſtadt in Bavaria, took the degree of doctor in divinity. Thence having made the tour of Italy, he returned once more to Lorrain; where he was patroniſed by the cardinal of that duchy, who preferred him to a canonry of Verdun; and about two years after he became confeſſor to the ducheſs of Cleves, daughter to the duke of Lorrain. During the leiſure he enjoyed in this employment, he wrote in Latin the lives of the kings, biſhops, apoſtolical men, and writers of England. The laſt of theſe, commonly known and quoted by this title, *De illuſtribus Angliæ ſcriptoribus*, was publiſhed after his death. The three firſt remain ſtill in manuſcript among the archives of the collegiate church of Liverdun. The duke of Cleves dying after Pits had been about twelve years confeſſor to the ducheſs, ſhe returned to Lorrain, attended by our author, who was promoted to the deanery of Liverdun, which, with a canonry and officialſhip, he enjoyed to the end of his life. He died in 1616, and was buried in the collegiate church. Pits was undoubtedly a ſcholar, and not an inelegant writer; but he is juſtly accuſed of ingratitude to Bale, from whom he borrowed his materials without acknowledgment. He quotes Leland with great familiarity, without ever having ſeen his book: his errors are innumerable, and his partiality to the Romiſh writers moſt obvious; nevertheleſs we are obliged to him for his account of ſeveral popiſh authors, who lived abroad at the beginning of the Reformation.

PITT (Christopher), an eminent Engliſh poet, celebrated for his excellent tranſlation of Virgil's Æneid, was born in the year 1699. Having ſtudied four years at New-college, Oxford, he was preſented to the living of Pimperne in Dorſetſhire, which he held during the remainder of his life. He had ſo poetical a turn, that while he was a ſchool-boy he wrote two large folios of manuſcript poems, one of which contained an entire tranſlation of Lucan. He was much eſteemed while at the univerſity; particularly by the celebrated Dr. Young, who uſed familiarly to call him his *ſon*. Next to his fine tranſlation of Virgil, Mr. Pitt gained the greateſt reputation by his excellent Engliſh tranſlation of Vida's Art of poetry. This amiable poet died in the year 1648, without leaving, it is ſaid, one enemy behind him.

Pitt (William), earl of Chatham, a moſt celebrated Britiſh ſtateſman and patriot, was born in November 1708. He was the youngeſt ſon of Robert Pitt, Eſq. of Boconnock in Cornwall; and grandſon of Thomas Pitt, Eſq. governor of Fort St. George in the Eaſt Indies in the reign of queen Anne, who ſold an extraordinary fine diamond to the king of France for 135,000l. and thus obtained the name of *Diamond Pitt*. His intellectual faculties and powers of elocution very ſoon made a diſtinguiſhed appearance; but at the age of 16 he felt the attacks of an hereditary and incurable gout, by which he was tormented at times during the reſt of his life.

His lordſhip entered early into the army, and ſerved in a regiment of dragoons. Through the intereſt of the ducheſs of Marlborough he obtained a ſeat in parliament before he was 21 years of age. His firſt appearance in the houſe was as repreſentative of the borough of Old Sarum, in the ninth parliament of Great Britain. In the 10th he repreſented Seaford, Aldborough in the 11th, and the city of Bath in the 12th; where he continued till he was called up to the houſe of peers in 1766. The intention of the ducheſs in bringing him thus early into parliament was to oppoſe Sir Robert Walpole, whom he kept in awe by the force of his eloquence. At her death the ducheſs left him 10,000l. on condition, as was then reported, that he never ſhould receive a place in adminiſtration. However, if any ſuch condition was made, it certainly was not kept on his lordſhip's part. In 1746 he was appointed vice-treaſurer of Ireland, and ſoon after paymaſter general of the forces, and ſworn a privy-counſellor. He diſcharged the office of paymaſter with ſuch honour and inflexible integrity, refuſing even many of the perquiſites of his office, that his bittereſt enemies could lay nothing to his charge, and he ſoon became the darling of the people. In 1755 he reſigned the office of paymaſter, on ſeeing Mr. Fox preferred to him. The people were alarmed at this reſignation; and being diſguſted with the unſucceſsful beginning of the war, complained ſo loudly, that, on the 4th of December 1756, Mr. Pitt was appointed ſecretary of ſtate in the room of Mr. Fox afterwards lord Holland; and other promotions were made in order to ſecond his plans. He then took ſuch meaſures as were neceſſary for the honour and intereſt of the nation; but in the month of February 1757, having refuſed to aſſent to the carrying on a war in Germany for the ſake of his majeſty's dominions on the continent, he was deprived of the ſeals on the 5th of April following. Upon this the complaints of the people again became ſo violent, that on the 29th of June he was again appointed ſecretary, and his friends filled other important offices. The ſucceſs with which the war was now conducted is univerſally known; yet on the 5th of October 1761 Mr. Pitt, to the aſtoniſhment of almoſt the whole kingdom, reſigned the ſeals into his majeſty's own hands. The reaſon of this was, that Mr. Pitt, having received certain intelligence that the family-compact was ſigned between France and Spain, and that the latter was about to join France againſt us, thought it neceſſary to prevent her by commencing hoſtilities firſt. Having communicated this opinion in the privy-council, the other miniſters urged that they would think twice before they declared war againſt that kingdom. "I will not give them leave to think (replied Mr. Pitt); this is the time, let us cruſh the whole houſe of Bourbon. But if the members of this board are of a different opinion, this is the laſt time I ſhall ever mix in its councils. I was called into the miniſtry by the voice of the people, and to them I hold myſelf anſwerable for my conduct. I am to thank the miniſters of the late king for their ſupport; I have ſerved my country with ſucceſs; but I will not be reſponſible for the conduct of the war any longer than while I have the direction of it." To this bold declaration, the lord who then preſided in council made the following reply: "I find the gentleman is determined to leave us; nor can I ſay that I am ſorry for it, ſince he would otherwiſe have certainly compelled us to leave him. But if he is reſolved to aſſume the right of adviſing his majeſty, and directing the operations of the war, to what purpoſe are we called to this council? When he talks of being reſponſible to the people, he talks the language of the houſe of commons, and forgets that at this board he is reſponſible only to the king. However, though he may poſſibly have convinced himſelf of his infallibility, ſtill it remains that we ſhould be equally convinced before we can reſign our underſtandings to his direction, or join with him in the meaſure he propoſes."

This converſation, which was followed by Mr. Pitt's reſignation, is ſufficient to ſhow the haughtineſs and imperious temper of our miniſter. However, theſe very qualities were ſometimes productive of great and good conſequences, as appears from the following anecdote.—Preparatory to one of the ſecret expeditions during the war which ended in 1763, the miniſter had given orders to the different preſiding officers in the military, navy, and ordnance departments, to prepare a large body of forces, a certain number of ſhips, and a proportionable quantity of ſtores, &c. and to have them all ready againſt a certain day. To theſe orders he received an anſwer from each of the officers, declaring the total impoſſibility of a compliance with them. Notwithſtanding it was then at a very late hour, he ſent immediately for his ſecretary; and after expreſſing his reſentment at the ignorance or negligence of his majeſty's ſervants, he gave the following commands:—"I deſire, Mr. Wood, that you will immediately go to lord Anſon; you need not trouble yourſelf to ſearch the admiralty, he is not to be found there; you muſt purſue him to the gaming-houſe, and tell him from me, that if he does not obey the orders of government which he has received at my hands, I will moſt aſſuredly impeach him. Proceed from him to lord Ligonier; and though he ſhould be bolſtered with harlots, undraw his curtains, and repeat the ſame meſſage. Then direct your courſe to Sir Charles Frederick, and aſſure him, that if his majeſty's orders are not obeyed, they ſhall be the laſt which he ſhall receive from me." In conſequence of theſe commands, Mr. Wood proceeded to White's, and told his errand to the firſt lord of the admiralty; who inſiſted that the ſecretary of ſtate was out of his ſenſes, and it was impoſſible to comply with his wiſhes: "however, (added he,) as madmen muſt be anſwered, tell him that I will do my utmoſt to ſatisfy him." From thence he went to the commander in chief of the forces, and delivered the ſame meſſage. He alſo ſaid that it was an impoſſible buſineſs; "and the ſecretary knows it, (added the old lord:) nevertheleſs, he is in the right to make us do what we can; and what is poſſible to do, inform him, ſhall be done." The ſurveyor general of the ordnance was next informed of Mr. Pitt's reſolution; and, after ſome little conſideration, he began to think that the orders might be completed within the time preſcribed. The conſequence at laſt was, that every thing, in ſpite of impoſſibilities themſelves, was ready at the time appointed.

After his reſignation in 1761, Mr. Pitt never had any ſhare in adminiſtration. He received a penſion of 3000l. a-year, to be continued after his deceaſe, during the ſurvivancy of his lady and ſon; and this gratuity was dignified with the title of *Baroneſs of Chatham* to his lady, and that of *Baron* to her heirs-male. Mr. Pitt at that time declined a title of nobility; but in 1766 accepted of a peerage under the title of *Baron Pynſent and Earl of Chatham*, and at the ſame time he was appointed lord privy-ſeal.

This acceptance of a peerage proved very prejudicial to his lordſhip's character. However, he continued ſtedfaſt in his oppoſition to the meaſures of adminiſtration. His laſt appearance in the houſe of lords was on the 2d of April 1778. He was then very ill and much debilitated: but the queſtion was important, being a motion of the duke of Richmond to addreſs his majeſty to remove the miniſters, and to make peace with America on any terms. His lordſhip made a long ſpeech, which had certainly overcome his ſpirits: for, attempting to riſe a ſecond time, he fell down in a convulſive fit; and though he recovered for that time, his diſorder continued to increaſe till the 11th of May, when he died at his ſeat at Hayes. His death was lamented as a national loſs. As ſoon as the news reached the houſe of commons, which was then ſitting, colonel Barré made a motion, that an addreſs ſhould be preſented to his majeſty, requeſting that the earl of Chatham ſhould be buried at the public expence. But Mr. Rigby having propoſed the erecting of a ſtatue to his memory, as more likely to perpetuate the ſenſe of his great merits entertained by the public, this was unanimouſly carried. A bill was ſoon after paſſed, by which 4000l. a-year was ſettled upon John, now earl of Chatham, and the heirs of the late earl to whom that title may deſcend.—His lordſhip was married in 1754 to lady Heſter, ſiſter to the earl of Temple; by whom he had three ſons and two daughters.

Never perhaps was any life ſo multifarious as that of lord Chatham; never did any compriſe ſuch a number of intereſting ſituations. To bring the ſcattered features of ſuch a character into one point of view, is an arduous taſk. The author of the hiſtory of his life has attempted to do it; and with the outlines of what he has ſaid in ſumming up his character, we ſhall finiſh our biographical ſketch of this wonderful man.

"One of the firſt things that ſtrikes us, in the recollection of Chatham's life, is the ſuperior figure he makes among his contemporaries. Men of genius and attraction, a Carteret, a Townſhend, and I had almoſt ſaid a Mansfield, however pleaſing in a limited view, appear evidently in this compariſon to ſhrink into narrower dimenſions, and walk a humbler circle. All that deſerves to arreſt the attention, in taking a general ſurvey of the age in which he lived, is compriſed in the hiſtory of Chatham. No character ever bore the more undiſputed ſtamp of originality. Unreſembled and himſelf, he was not born to accommodate to the genius of his age. While all around him were depreſſed by the uniformity of faſhion, or the contagion of venality, he ſtood aloof. He conſulted no judgment but his own; and he acted from the untainted dictates of a comprehenſive ſoul.

"The native royalty of his mind is eminently conſpicuous. He felt himſelf born to command; and the free ſons of Britain implicitly obeyed him. In him was realiſed the fable of Orpheus; and his genius, his ſpirit, his eloquence, led millions in his train, ſubdued the rugged ſavage, and diſarmed the fangs of malignity and envy. Nothing is in its nature ſo inconſiſtent as the breath of popular applauſe: and yet that breath was eminently his during the greater part of his life. Want of ſucceſs could not divert it; inconſiſtency of conduct could not change its tenor. The aſtoniſhing extent of his views, and the myſterious comprehenſion of his plans, did not in one reſpect ſet him above little things: nothing that was neceſſary to the execution of his deſigns was beneath him. In another reſpect, however, he was infinitely eſtranged to little things: ſwallowed up in the buſineſs of his country, he did not think of the derangement of his own private affairs; for, though indiſpoſed to all the modes of diſſipated expence, his affairs, even when his circumſtances were much improved, were always deranged. But the features that ſeem moſt eminently to have characteriſed him, were ſpirit and intrepidity: they are conſpicuous in every action and in every turn of his life; nor did this ſpirit and intrepidity leave him even at the laſt.

"The manners of lord Chatham were eaſy and bland, his converſation was ſpirited and gay, and he readily adapted himſelf to the complexion of thoſe with whom he aſſociated. That artificial reſerve, which is the never-failing refuge of ſelf-diffidence and cowardice, was not made for him. He was unconſtrained as artleſs infancy, and generous as the noon day ſun: yet had he ſomething impenetrable that hung about him. By an irreſiſtible energy of ſoul, he was haughty and imperious. He was incapable of aſſociating councils, and he was not formed for the ſweeteſt bands of ſociety. He was a pleaſing companion, but an unpliant friend.

"The ambition of our hero, however generous in its ſtrain, was the ſource of repeated errors in his conduct. To the reſignation of lord Carteret, and again, from the commencement of the year 1770, his proceedings were bold and uniform. In the intermediate period they were marked with a verſatility, incident only in general to the moſt flexible minds. We may occaſionally trace in them the indeciſion of a candidate, and the ſuppleneſs of a courtier. In a word, he aimed at the impoſſible taſk of flattering at once the prejudices of a monarch, and purſuing unremittedly the intereſts of the people.

"A feature, too, ſufficiently prominent in his character, was vanity, or perhaps pride and conſcious ſuperiority. He dealt ſurely ſomewhat too freely with invective. He did not pretend to an ignorance of his talents, or to manage the diſplay of his important ſervices. Himſelf was too often the hero of his tale; and the ſucceſſes of the laſt war (1763) the burden of his ſong.

"Patriotiſm was alſo the ſource of ſome of his imperfections. He loved his country too well; or, if that may ſound abſurd, the benevolence at leaſt that embraces the ſpecies had not ſufficient ſcope in his mind. He once ſtyled himſelf *a lover of honourable war*; and in ſo doing he let us into one trait of his character. The friend of human kind will be an enemy to all war. He indulged too much a puerile antipathy to the houſe of Bourbon: and it was ſurely the want of expanſive affections that led him to ſo unqualified a condemnation of American independency.

"But the eloquence of lord Chatham was one of his moſt ſtriking characteriſtics. He far outſtripped his competitors, and ſtood alone the rival of antiquity.

"His eloquence was of every kind. No man excelled him in cloſe argument and methodical deduction: but this was not the ſtyle into which he naturally fell. His oratory was unlaboured and ſpontaneous: he ruſhed at once upon the ſubject; and uſually illuſtrated it rather by glowing language and original conception, than by cool reaſoning. His perſon was tall and dignified; his face was the face of an eagle; his piercing eye withered the nerves, and looked through the ſouls of his opponents; his countenance was ſtern, and the voice of thunder ſat upon his lips: anon, however, he could deſcend to the eaſy and the playful. His voice ſeemed ſcarcely more adapted to energy and to terror, than it did to the melodious, the inſinuating, and the ſportive. If, however, in the enthuſiaſm of admiration, we can find room for the frigidity of criticiſm, his action ſeemed the moſt open to objection. It was forcible, uniform, and ungraceful. In a word, the moſt celebrated orators of antiquity were in a great meaſure the children of labour and cultivation. Lord Chatham was always natural and himſelf."

To the misfortune of the republic of letters, and of poſterity, his lordſhip never ſought the preſs. Lord Cheſterfield ſays, "that he had a moſt happy turn for poetry: but it is more than probable that Cheſterfield was deceived; for we are told by his biographer, that his verſes to Garrick were very meagre, and lord Chatham himſelf ſaid that he ſeldom indulged and ſeldom avowed it. It ſhould ſeem, then, that he himſelf ſet no great value upon it. Perhaps a proper confidence of one's ſelf is eſſential to all extraordinary merit. Why ſhould we ambitiouſly aſcribe to one mind every ſpecies of human excellence? But though he was no poet, it is more than probable, that he would have excelled as much in writing proſe as he did in ſpeaking it.

PITTACUS, a native of Mitylene in Leſbos, was one of the ſeven wiſe men of Greece: his father's name was Hyrradius. With the aſſiſtance of the ſons of Alcæus, he delivered his country from the oppreſſion of the tyrant Melanchrus; and in the war which the Athenians waged againſt Leſbos, he apppeared at the head of his countrymen, and challenged to ſingle combat Phrynon the enemy's general. As the event of the war ſeemed to depend upon this combat, Pittacus had recourſe to artifice; and when he engaged, he entangled his adverſary in a net which he had concealed under his ſhield, and eaſily diſpatched him. He was amply rewarded for this victory; and his countrymen, ſenſible of his merit, unanimouſly appointed him governor of their city with unlimited authority. In this capacity Pittacus behaved with great moderation and prudence; and after he had governed his fellow citizens with the ſtricteſt juſtice, and after he had eſtabliſhed and enforced the moſt ſalutary laws, he voluntarily reſigned the ſovereign power after having enjoyed it for 10 years, obſerving that the virtues and innocence of private life were incompatible with the power and influence of a ſovereign. His diſintereſtedneſs gained him many admirers; and when the Mityleneans wiſhed to reward his public ſervices by preſenting him with an immenſe tract of territory, he refuſed to accept more land than what ſhould be contained in the diſtance to which he could throw a javelin. He died in the 70th year of his age, about 579 years before Chriſt, after he had ſpent the laſt 10 years of his life in literary eaſe and peaceful retirement.

The following maxims and precepts are aſcribed to Pittacus: The firſt office of prudence is to foreſee threatening misfortunes, and prevent them. Power diſcovers the man. Never talk of your ſchemes before they are executed; leſt, if you fail to accompliſh them, you be expoſed to the double mortification of diſappointment and ridicule. Whatever you do, do it well. Do not that to your neighbour which you would take ill from him. Be watchful for opportunities.

Many of his maxims were inſcribed on the walls of Apollo's temple at Delphi, to ſhow to the world how great an opinion the Mityleneans entertained of his abilities as a philoſopher, a moraliſt, and a man. By one of his laws, every fault committed by a man when intoxicated deſerved double puniſhment.

PITTENWEEM, a ſeaport in Fifeſhire, at the entrance of the frith of Forth, 23 miles N. E. of Edinburgh. W. lon. 2. 49. N. lat. 56. 12.

PITTOSPORUM, in botany; a genus of the monogynia order, belonging to the pentandria claſs of plants. The calyx is pentaphyllous, inferous, and deciduous. The petals are five in number; the ſtyle thread-ſhaped; the capſule ſomewhat angular, trilocular, and containing three or four angulated ſeeds, adhering to the capſule by means of a liquid reſin in the loculaments. Of this there are three ſpecies, *viz.* 1. *Tenuifolium.* 2. *Umbellatum.* 3. *Coriaceum.* The firſt and ſecond are natives of the Cape of Good Hope; the third grows in Madeira, and flowers in May and June.

PITUITARY Gland. See Anatomy.

PITYOCAMPASIS, in entomology, the caterpillar of the pine-tree, received its compound name from that ſubſtance. It was conſidered as a poiſon, and as a remedy, according to its different employment; but our chief information is derived from M. Reaumur, who has attentively obſerved its manner of life. The animal cannot bear much cold, and is therefore never found in the higher latitudes. It is ſtyled proceſſionary, becauſe it never leaves its hole, where many families reſide, till the evening, when it feeds in trains, led on by two or three, and this train leaves a riband of ſilk in its way, for thoſe behind to follow exactly the ſteps of thoſe which preceded, and each leaves its fibre of ſilk. Their neſts are found in autumn; they are born the middle of September, become torpid in December, and recover their ſtrength again in ſpring. They then deſcend from the trees, plunge into the earth, and undergo their laſt change. It is the *bombyx pityocampa* of Fabricius (*Mantiſſa Inſector.* tom. ii. p. 114. No. 66.), and greatly reſembles the proceſſionary caterpillar of the oak. The ancients uſed it as a veſicatory, and the acrimony ſeems to reſide chiefly in a duſt which is concealed in receptacles on its back. This is its offenſive weapon; for it is thrown out at will, and produces very troubleſome effects, though the hair of the animal, and every part of its body, ſeem to have a ſimilar but weaker power. The effect is alſo weaker in winter; but this may depend on the diminiſhed irritability of the human body, as well as on the torpid ſtate of the inſect. Their ſilk is not ſufficiently ſtrong for the loom, and in hot water melts almoſt to a paſte. In the earth it forms neſts of ſtronger ſilk, but it is then found with difficulty: in boxes its ſilk is extremely tender. Adding to all theſe inconveniences, handling the cones produces all the bad effects of the duſt. Matthiolus recommends them as a ſtyptic, and perhaps they may ſerve for burning on the ſkin inſtead of moxa, the downy ſilk of a ſpecies of artemiſia. The ancients, afraid of its hurtful qualities, uſed them with caution, and enacted laws againſt their being ſold promiſcuouſly: the modern planter is chiefly afraid of them becauſe they deſtroy the beauty of his trees, and he endeavours to collect the eggs by cutting off the branches, which are burnt immediately.

PIVAT, or Pivot, a foot or ſhoe of iron or other metal, uſually conical or terminating in a point, whereby a body, intended to turn round, bears on another fixed at reſt, and performs its revolutions. The pivot uſually bears or turns round in a ſole, or piece of iron or braſs hollowed to receive it.

PIUS II. (Æneas-Sylvius Piccolomini), was born on October 18. 1405, at Corſigni in the Sienneſe, the name of which he afterwards changed into that of *Pienza.* His mother Victoria Forteguerra, when ſhe was with child of him, dreamed that ſhe ſhould be delivered of a mitred infant; and as the way of degrading clergymen at that time was by crowning them with a paper mitre, ſhe believed that Æneas would be a diſgrace to his family. But what to her had the appearance of being a diſgrace, was a preſage of the greateſt honours. Æneas was carefully educated, and made conſiderable proficiency in the belles lettres. After having finiſhed his ſtudies at Sienna, he went in 1431 to the council of Bale with cardinal Capranica, ſurnamed *De Fermo*, becauſe he was entruſted with the government of that church. Æneas was his ſecretary, and was then only 26 years of age. He afterwards acted in the ſame capacity to ſome other prelates, and to cardinal Albergati. The council of Bale honoured him with different commiſſions, in order to recompenſe him for the zeal with which he defended that aſſembly againſt pope Eugene IV. He was afterwards ſecretary to Frederic III. who decreed to him the poetic crown, and ſent him ambaſſador to Rome, Milan, Naples, Bohemia, and other places. Nicolas V. advanced him to the biſhopric of Trieſte, which he quitted ſome time after for that of Sienna. At laſt, after having diſtinguiſhed himſelf in various nunciatures, he was inveſted with the Roman purple by Calixtus III. whom he ſucceeded two years after on the 27th of Auguſt 1458. Pius II. now advanced to the holy ſee, made good the proverb, *Honores mutant mores.* From the commencement of his pontificate, he appeared jealous of the papal prerogatives. In 1460 he iſſued a bull, "declaring appeals from the pope to a council to be null, erroneous, deteſtable, and contrary to the ſacred canons." That bull, however, did not prevent the procurator-general of the parliament of Paris from appealing to a council in defence of the Pragmatic ſanction, which the pope had ſtrenuouſly oppoſed. Pius was then at Mantua, whither he had gone in order to engage the Catholic princes to unite in a war againſt the Turks. The greater part of them agreed to furniſh either troops or money; others refuſed both, particularly the French, who from that moment incurred his holineſs's averſion. That averſion abated under Louis XI. whom he perſuaded in 1461 to aboliſh the Pragmatic ſanction, which the parliament of Paris had ſupported with ſo much vigour.

The following year, 1462, was rendered famous by a controverſy which took place between the Cordeliers and Dominicans, whether or not the blood of Jeſus Chriſt was ſeparated from his body while he lay in the grave. It was alſo made a queſtion, whether it was ſeparated from his divinity. The Cordeliers affirmed that it was, but the Dominicans were of an oppoſite opinion. They called each other heretics; which obliged the pope to iſſue a bull, forbidding them, under pain of cenſure, to brand one another with ſuch odious epithets. The bull which his holineſs publiſhed on the 26th of April, retracting what he had written to the council of Bale when he was its ſecretary, did not redound much to his honour. "I am a man, (ſays he,) and as a man I have erred. I am far from denying that a great many things which I have ſaid and written may deſerve condemnation. Like Paul, I have preached through deception, and I have perſecuted the church of God through ignorance. I imitate the bleſſed Auguſtin, who having ſuffered ſome erroneous ſentiments to creep into his works, retracted them. I do the ſame thing; I frankly acknowledge my ignorances, from a fear leſt what I have written in my younger years ſhould be the occaſion of any error that might afterwards be prejudicial to the intereſts of the holy ſee. For, if it be proper for any one to defend and ſupport the eminence and glory of the firſt throne of the church, it is in a peculiar manner my duty, whom God, out of his mercy and goodneſs alone, without any merit on my part, has raiſed to the dignity of *vicar of Jeſus Chriſt*. For all theſe reaſons, we exhort and admoniſh you in the Lord, not to give credit to thoſe writings of ours which tend in any degree to hurt the authority of the apoſtolic ſee, and which eſtabliſh opinions that are not received by the Roman church. If you find, then, any thing contrary to her doctrine, either in our dialogues, in our letters, or in any other of our works, deſpiſe theſe opinions, reject them, and adopt our preſent ſentiments. Believe me rather now that I am an old man, than when I addreſſed you in my earlier days. Eſteem a ſovereign pontiff more than a private perſon; except againſt Æneas Sylvius, but receive Pius II." It might be objected to his holineſs, that it was his dignity alone which had made him alter his opinion. He anticipates that objection, by giving a ſhort account of his life and actions, with the whole hiſtory of the council of Bale, to which he went with cardinal Capranica in 1431; "but (ſays he) I was then a young man, and without any experience, like a bird juſt come from its neſt." In the mean time, the Turks were threatening Chriſtendom. Pius, ever zealous in the defence of religion againſt the infidels, forms the reſolution of fitting out a fleet at the expence of the church, and of paſſing over into Aſia himſelf, in order to animate the Chriſtian princes by his example. He repaired to Ancona with a deſign to embark; but he there fell ſick with the fatigue of the journey, and died on the 16th of Auguſt 1464, aged 59 years. Pius was one of the moſt learned men of his time, and one of the moſt zealous pontiffs; but being of an ambitious and pliant diſpoſition, he ſometimes ſacrificed to that ambition. His principal works are, 1. Memoirs of the council of Bale, from the ſuſpenſion of Eugenius to the election of Felix. 2. The hiſtory of the Bohemians, from their origin to the year 1458. 3. Two books on coſmography. 4. The hiſtory of Frederick III. whoſe vice-chancellor he had been. This performance was publiſhed in 1585 in folio, and is believed to be pretty accurate and very particular. 5. A treatiſe on the education of children. 6. A poem upon the paſſion of Jeſus Chriſt. 7. A collection of 432 letters, printed at Milan, 1473, in folio, in which are found ſome curious anecdotes. 8. The memoirs of his own life, publiſhed by John Gobelin Perſoune his ſecretary, and printed at Rome in 4to, in 1584. There is no doubt of this being the genuine production of that pontiff. 9. *Hiſtoria rerum ubicumque geſtarum*, of which only the firſt part was publiſhed at Venice in 1477, in folio. His works were printed at Helmſtadt in 1700, in folio, at the beginning of which we find his life. That verſe of Virgil's Æneid (lib. i. ver. 382.) which begins thus,

Sum pius Æneas,———

and the end of the following verſe,

———*famâ ſuper æthera notus*,

have been applied to him.

Pius IV. (John Angelo cardinal de Medici), of a different family from that of Florence, was born at Milan in 1499. He was ſon to Bernardin Medechini, and brother of the famous marquis de Marignan, Charles Vth's general. He raiſed himſelf by his own merit, and filled ſeveral important offices under popes Clement VII. and Paul III. Julius III. who had entruſted him with ſeveral legations, honoured him with a cardinal's hat in 1549. After the death of Paul IV. he was advanced to St. Peter's chair on the 25th of December 1559. His predeceſſor had rendered himſelf deteſtable to the Romans, who treated his memory with every mark of indignity, and Pius IV. commenced his pontificate by pardoning them. He did not, however, extend the ſame clemency to the nephews of pope Paul IV.; for he cauſed cardinal Caraffe to be ſtrangled in the caſtle of St. Angelo, and his brother, the prince de Palliano, to be beheaded. His zeal was afterwards directed againſt the Turks and heretics. In order to ſtop, if poſſible, the progreſs of theſe laſt, he renewed the Council of Trent, which had been ſuſpended. He knew well (ſays abbé de Choiſy), that that council might make ſome regulations which would have the effect to leſſen his authority; but on the other hand, he perceived that great inconveniences might reſult from its not being aſſembled; and "*in the main* (ſaid he to his confidents) *it is better to feel evil for once than to be always in dread of it.*" In 1561 he diſpatched nuncios to all the Catholic and Proteſtant princes, to preſent them with the bull for calling that important aſſembly. An end was, however, put to it by the induſtry of his nephew, S. Charles Borromeus, in 1563; and, on the 26th of January the year following, he iſſued a bull for confirming its decrees. In 1565 a conſpiracy was formed againſt his life by Benedict Acolti, and ſome other viſionaries. Thoſe madmen had taken it into their head that Pius IV. was not a lawful pope, and that after his death they would place another in St. Peter's chair, with the title of *Pope Angelicus*, under whom errors might be reformed, and peace reſtored to the church. The conſpiracy was diſcovered, and the fanatic Benedict put to death. This pontiff died a little time after, on the 9th of December 1565, aged 66 years, carrying to the grave with him the hatred of the Romans, whom his ſeverities had exaſperated. He was a man of great addreſs, and very fruitful in his reſources. He adorned Rome with ſeveral public edifices; but theſe ornaments tended greatly to impoveriſh it. If he was the inſtrument of raiſing his relations in the world, it muſt be allowed, at leaſt, that the greater part of them did him honour.

Pius V. (S. Michael Ghiſleri), born at Boſchi or Boſco, in the dioceſe of Tortona, on the 17th of January 1504, was, according to abbé de Choiſy, ſon to a ſenator of Milan. He turned a Dominican friar. Paul IV. informed of his merit and virtue, gave him the biſhopric of Sutri, created him cardinal in 1557, and made him inquiſitor-general of the faith among the Milaneſe and in Lombardy; but the ſeverity with which he exerciſed his office obliged him to quit that country. He was ſent to Venice, where the ardour of his zeal met with ſtill greater obſtacles. Pius IV. added to the cardinal's hat the biſhopric of Mondovi. After the death of that pontiff, he was advanced to St. Peter's chair in 1566. The Romans expreſſed but little joy at his coronation: he was very ſenſible of it, and ſaid, "*I hope they will be as ſorry at my death as they are at my election;*" but he was miſtaken. Raiſed by his merit to the firſt eccleſiaſtical preferment in Chriſtendom, he could not diveſt himſelf of the ſeverity of his character; and the ſituation in which he found himſelf rendered, perhaps, that ſeverity neceſſary. One of his firſt objects was to repreſs the luxury of the clergy, the pride of the cardinals, and the licentious manners of the Romans. He cauſed the decrees of reformation enacted by the Council of Trent to be put in execution; he prohibited bull-baiting in the Circus; he expelled from Rome the women of the town; and allowed the cardinals to be proſecuted for their debts. The errors which overflowed the Chriſtian world gave him great uneaſineſs. After having employed gentle and lenient meaſures in the reclaiming of heretics, he had recourſe to ſeverity, and ſome of them ended their days in the flames of the Inquiſition. He particularly diſplayed his zeal for the grandeur of the Holy See in 1568, by ordaining that the bull *In cœna Domini*, which was publiſhed at Rome every year on *Maunday-Thurſday*, and which Clement XIV. ſuppreſſed, ſhould be publiſhed likewiſe throughout the whole church. That bull, the work of ſeveral ſovereign pontiffs, principally regards the juriſdiction of the eccleſiaſtical and civil power. It anathematizes thoſe who appeal from the decrees of popes to a general council; thoſe who favour the appellants; the univerſities which teach that the pope is ſubject to a general council; the princes who would reſtrain the eccleſiaſtical juriſdiction, or who exact contributions from the clergy. It was rejected by all the ſovereign ſtates, excepting a very few. In 1580, ſome biſhops having endeavoured to introduce it into their dioceſes, the parliament cauſed their temporalities to be ſeized upon, and declared thoſe guilty of high treaſon who ſhould imitate the fanaticiſm of thoſe prelates. Pius V. for ſome time meditated an expedition againſt the Turks. He had the courage to make war on the Ottoman empire, by forming a league with the Venetians and Philip II. king of Spain. This was the firſt time that the ſtandard of the two keys was ſeen diſplayed againſt the creſcent. The naval armies came to an engagement, on the 7th of October 1571, in Lepanto Bay, in which the confederate Chriſtian princes obtained a ſignal victory over the Turks, who left above 30,000 men, and near 200 galleys. This ſucceſs was principally owing to the pope, who exhauſted both his purſe and perſon in fitting out that armament. He died of the gravel ſix months after, on the 30th of April 1572, aged 68. He repeated often, in the midſt of his ſufferings, "*O Lord! increaſe my pains and my patience.*" His name will for ever adorn the liſt of Roman pontiffs. It is true that his bull againſt queen Eliſabeth, and his other bull in favour of the Inquiſition, with his rigorous proſecution of heretics both in France and Ireland, prove that he had more zeal than ſweetneſs in his temper; but in other reſpects he poſſeſſed the virtues of a ſaint and the qualities of a king. He was the model of the famous Sixtus Quintus, to whom he gave an example of amaſſing in a few years ſuch ſavings as were ſufficient to make the Holy See be regarded as a formidable power. Sultan Selim, who had no greater enemy than this pope, cauſed public rejoicings to be made at Conſtantinople for his death during the ſpace of three days. The pontificate of Pius is alſo celebrated for the condemnation of Baius, the extinction of the order of Humilies, and the reformation of that of the Ciſtercians. He was canonized by Clement XI. in 1712. There are extant ſeveral of his letters, printed at Anvers in 1640, in 4to. Felibian, in 1672, publiſhed his *Life*, tranſlated from the Italian of Agatio di Somma; but we cannot vouch for the fidelity of the tranſlation.

PIX. See Mint-*Marks*.

PIZARRO (Francis), a celebrated Spaniſh general, the diſcoverer and conqueror of Peru, in conjunction with Diego Almagro, a Spaniſh navigator. They are both charged with horrid cruelties to the inhabitants; and they fell victims to their own ambition, jealouſy, and avarice. Almagro revolting, was defeated and beheaded by Pizarro, who was aſſaſſinated by Almagro's friends in 1541.

PLACE, Locus, in philoſophy, a mode of ſpace, or that part of immoveable ſpace which any body poſſeſſes. See Metaphysics.

Place, in aſtronomy. The place of the ſun, a ſtar, &c. denotes the ſign and degree of the zodiac which the luminary is in; or the degree of the ecliptic, reckoning from the beginning of aries, which the planet or ſtar's circle of longitude cuts; and therefore coincides with the longitude of the ſun, planet, or ſtar. As the ſine of the ſun's greateſt declination 23° 30′: to the ſine of any preſent declination given or obſerved, for inſtance, 23° 15′ :: ſo is the radius 10: to the ſine of his longitude 81° 52′; which, if the declination were north, would give 20° 52′ of gemini; if ſouth, 20° 52′ of capricorn, for the ſun's place. See Declination, &c.

The place of the moon being that part of her orbit wherein ſhe is found at any time, is of various kinds, by reaſon of the great inequalities of the lunar motions, which render a number of equations and reductions neceſſary before the juſt point be found. The moon's fictitious place is her place once equated; her place nearly true, is her place twice equated; and her true place thrice equated. See Astronomy, *paſſim*.

Place, in war, a general name for all kinds of fortreſſes where a party may defend themſelves. Thus, 1. A ſtrong or fortified place is one flanked, and covered with baſtions. 2. A regular place, one whoſe angles, ſides, baſtions, and other parts, are equal; and this is uſually denominated from the number of its angles, as a pentagon, hexagon, &c. 3. Irregular place is one whoſe ſides and angles are unequal. 4. Place of arms is a ſtrong city or town pitched upon for the chief magazine of an army; or, in a city or garriſon, it is a large open ſpot of ground, uſually near the centre of the place where the grand guard is commonly kept, and the garriſon holds its rendezvous at reviews, and in caſes of alarm to receive orders from the governor. 5. Place of arms of an attack, in a ſiege, is a ſpacious place covered from the enemy by a parapet or epaulement, where the ſoldiers are poſted ready to ſuſtain thoſe at work in the trenches againſt the ſoldiers of the garriſon. 6. Place of arms particular, in a garriſon, a place near every baſtion, where the ſoldiers ſent from the grand place to the quarters aſſigned them relieve thoſe that are either upon the guard or in fight. 7. Place of arms without, is a place allowed to the covert way for the planting of cannon, to oblige thoſe who advance in their approaches to retire. 8. Place of arms in a camp, a large place at the head of the camp for the army to be ranged and drawn up in battalia. There is alſo a place for each particular body, troop, or company, to aſſemble in.

Common-Place. See Common-*Place*.

PLACENTA, in anatomy and midwifery, a ſoft roundiſh maſs, found in the womb of pregnant women; which, from its reſemblance to the liver, was called by the ancients *hepar uterinum*, uterine liver. See Midwifery.

PLACENTIA, called by the natives *Piacenza*, is a town of Italy, and capital of a duchy of the ſame name, with a biſhop's ſee. It is ſeated about 100 paces from the river Po, in a very fertile pleaſant plain, watered by a great number of rivulets, and ſurrounded with hills, abounding in all ſorts of fruits. In its territory there are ſalt-ſprings, from which they make a very white ſalt; and there are alſo mines of iron, woods, and warrens. It contains a great number of merchants, and is reckoned three miles in circumference. Its fortifications are inconſiderable, but the citadel is pretty ſtrong. The ſtreets are ſtraight, and the principal ſtreet, called *Stradone*, is 25 common paces broad and 3000 feet long, in a direct line, with 600 ſtone poſts, for ſeparating the foot from the carriage-way, and on both ſides are 11 ſpacious convents. The other buildings of the city are not very remarkable, though it contains 45 churches, 28 convents, and two alms-houſes. The cathedral is pretty much in the Gothic taſte; but the church of the Auguſtines is reckoned the moſt beautiful, and eſteemed worthy of its architect, the celebrated Vignoli. The ducal palace, though large, makes no great appearance on the outſide; but within are ſome good apartments. In the area before the town-houſe ſtand two admirable braſs ſtatues of Alexander and Renatus IV. both of the houſe of Farneſe, and dukes of Parma and Placentia. The biſhop is ſuffragan to the archbiſhop of Milan. At this city begins the Via Æmilia, which extends as far as Rimini on the Adriatic. The number of the inhabitants is about 30,000, among whom there are 2000 eccleſiaſtics. This city has been taken ſeveral times in the wars of Italy. The king of Sardinia took poſſeſſion of it in 1744, it being ceded to him by the queen of Hungary; but it was taken from him in 1746, after a bloody battle. It has a famous univerſity, and the inhabitants are much eſteemed for their politeneſs. There is a great fair here every year on the 15th of April, which is much frequented. It is about 32 miles north-weſt of Parma, and 83 eaſt of Turin. E. lon. 10. 24. N. lat. 45. 5.

PLAGIARY, in philology, the purloining another man's works, and putting them off as our own. Among the Romans, *plagiarius* was properly a perſon who bought, ſold, or retained a freeman for a ſlave; and was ſo called becauſe by the Flavian law ſuch perſons were condemned *ad plagas*, "to be whipped." Thomaſius has an expreſs treatiſe *De plagio literario*; wherein he lays down the laws and meaſures of the right which authors have to one another's writings.—"Dictionary-writers, at leaſt ſuch as meddle with *arts and ſciences* (as is pertinently obſerved by Mr. Chambers), ſeem exempted from the common laws of *meum* and *tuum*; they do not pretend to ſet up on their own bottom, nor to treat you at their own coſt. Their works are ſuppoſed, in great meaſure, compoſitions of other people; and what they take from others, they do it avowedly, and in the open ſun.—In effect, their quality gives them a title to every thing that may be for their purpoſe, wherever they find it; and if they rob, they do not do it any otherwiſe than as the bee does, for the public ſervice. Their occupation is not pillaging, but collecting contributions; and if you aſk them their authority, they will produce you the practice of their predeceſſors of all ages and nations."

PLAGIUM, in law. See Kidnapping.

PLAGUE, Pestilence, or *Peſtilential Fever*, is a very acute, malignant, and contagious diſeaſe; being a putrid fever of the worſt kind, and ſeldom failing to prove mortal. Though it is generally defined a malignant fever, Diemerbroek thinks they ought to be diſtinguiſhed, ſince the fever is not the eſſence of the diſeaſe, but merely a ſymptom or effect of it. See Medicine. The plague, as is generally agreed, is never bred or propagated in Britain, but always imported from abroad, eſpecially from the Levant, Leſſer Aſia, Egypt, &c. where it is very common. Sydenham has remarked that it rarely infeſts this country oftener than once in 40 years, and happily we have been free of it for a much longer period.

Authors are not as yet agreed concerning the nature of this dreadful diſtemper. Some think that inſects are the cauſe of it, in the ſame way that they are the cauſe of blights, being brought in ſwarms from other climates by the wind, when they are taken into the lungs in reſpiration; the conſequence of which is, that they mix with the blood and juices, and attack and corrode the viſcera. Mr. Boyle, on the other hand, thinks it originates from the effluvia or exhalations breathed into the atmoſphere from noxious minerals, to which may be added ſtagnant waters and putrid bodies of every kind.

Mr. Gibbon thinks that the plague is derived from damp, hot, and ſtagnating air, and the putrefaction of animal ſubſtances, eſpecially locuſts. See *Gibbon's Roman Hiſtory*, 4to edit. vol. iv. p. 327—332, where there is alſo a very particular account of the plague which depopulated the earth in the time of the emperor Juſtinian.

The Mahometans believe that the plague proceeds from certain ſpirits, or goblins, armed with bows and arrows, ſent by God to puniſh men for their ſins; and that when the wounds are given by ſpectres of a black colour, they certainly prove fatal, but not ſo when the arrows are ſhot by thoſe that appear white. They therefore take no precaution to guard themſelves againſt it. The wiſer profeſſors of this religion, however, at preſent act otherwiſe; for we find a receipt recommended by Sidy Mohammed Zerroke, one of the moſt celebrated Marabouts, prefaced with theſe remarkable words: "The lives of us all are in the hands of God, when it is we muſt die. However, it hath pleaſed him to ſave many perſons from the plague, by taking, every morning while the infection rages, one pill or two of the following compoſition; *viz.* of myrrh two parts, ſaffron one part, of aloes two parts, of ſyrup of myrtle-berries, *q. ſ.*" But this remedy is confined to the more enlightened; for the bigotry of the lower ſort is ſo extreme as to make them deſpiſe all precautions which people of other nations uſe. Of this extreme and fooliſh prejudice Dr. Chandler gives an intereſting account, when ſpeaking of the plague at Smyrna. This learned author is of opinion that the diſeaſe ariſes from animalcules, which he ſuppoſes to be inviſible. See *Chandler's Travels in Aſia Minor*, p. 279, &c.

It is a remarkable fact, that *plagues* are ſometimes partial, and that they only attack particular animals, or a particular deſcription of perſons, avoiding others altogether, or attacking them but ſlightly. Thus, Fernelius informs us of a plague, or murrain, in 1514, which invaded only cats. Dionyſius Halicarnaſſeus mentions a plague which attacked none but maids; and that which raged in the time of Gentilis killed ſcarce any women, and very few but luſty men. Boterus mentions another plague, which aſſaulted none but the younger ſort; and we have inſtances of the ſame kind of a later ſtanding, ſuch as the yellow fever of Philadelphia. Cardan ſpeaks of a plague at Baſil, with which the Switzers were infected, and the Italians, Germans, or French, exempted: and John Utenhovius takes notice of a dreadful one at Copenhagen, which, though it raged among the Danes, ſpared the Germans, Dutch, and Engliſh, who went with all freedom, and without the leaſt danger, to the houſes of the infected. During the plague which ravaged Syria in 1760, it was obſerved that people of the ſoundeſt conſtitutions were the moſt liable to it, and that the weak and delicate were either ſpared or eaſily cured. It was moſt fatal to the Moors, and when it attacked them it was generally incurable.

When the plague raged in Holland in 1636, a young girl was ſeized with it, had three carbuncles, and was removed to a garden, where her lover, who was betrothed to her, attended her as a nurſe, and ſlept with her as his wife. He remained uninfected, and ſhe recovered, and was married to him. The ſtory is related by Vinc. Fabricius in the *Miſc. Cur. Ann. II. Obſ.* 188.

Many methods have been adopted in different countries to prevent the importation of this dreadful ſcourge of the human race, and to ſtop the progreſs of infection after it has been imported. In England, mayors, bailiffs, head officers of corporations, and juſtices of peace, have power to tax inhabitants, houſes, and lands, &c. within their precincts, for the relief of perſons infected with the plague; and juſtices of the county may tax perſons within five miles round, on a pariſh's inability; the tax to be levied by diſtreſs and ſale of goods, or in default thereof by impriſonment. Infected perſons going abroad, after being commanded to keep houſe for avoiding farther infection, may be reſiſted by watchmen, &c. and puniſhed as vagrants, if they have no ſores upon them; and if they have infectious ſores on them it is felony. Juſtices of peace, &c. are to appoint ſearchers, examiners, and buriers of the dead, in places infected, and adminiſter oaths to them for the performance of their duties, &c. *Stat.* 1 *Jac.* 1. *cap.* 31. See QUARANTINE.

The commiſſion at Moſcow having, in the year 1770, invented a fumigation-powder, which, from ſeveral leſſer experiments, had proved efficacious in preventing the infection of the plague; in order more fully to aſcertain its virtue in that reſpect, it was determined, towards the end of the year, that ten malefactors under ſentence of death ſhould, without undergoing any other precautions than the fumigations, be confined three weeks in a lazaretto, be laid upon the beds, and dreſſed in the clothes, which had been uſed by perſons ſick, dying, and even dead, of the plague in the hoſpital. The experiment was accordingly tried, and none of the ten malefactors were then infected, or have been ſince ill. The fumigation-powder is prepared as follows:

Powder of the firſt ſtrength.] Take leaves of juniper, juniper-berries pounded, ears of wheat, guaiacum-wood pounded, of each ſix pounds; common ſaltpetre pounded, eight pounds; ſulphur pounded, ſix pounds; Smyrna tar, or myrrh, two pounds. Mix all the above ingredients together, which will produce a pood of the powder of fumigation of the firſt ſtrength. [*N. B.* A pood is 40 pounds Ruſſian, which are equal to 35 pounds and a half or 36 pounds Engliſh avoirdupoiſe.]

Powder of the ſecond ſtrength.] Take ſouthern-wood cut into ſmall pieces, four pounds; juniper-berries pounded, three pounds; common ſaltpetre pounded, four pounds; ſulphur pounded, two pounds and a half; Smyrna tar, or myrrh, one pound and a half. Mix the above together, which will produce half a pood of the powder of fumigation of the ſecond ſtrength.

Odoriferous powder.] Take the root called *kalmus* cut into ſmall pieces, three pounds; leaves of juniper cut into ſmall pieces, four pounds; frankincenſe pounded groſsly, one pound; ſtorax pounded, and roſe-flowers, half a pound; yellow amber pounded, one pound; common ſaltpetre pounded, one pound and a half; ſulphur, a quarter of a pound. Mix all the above together, which will produce nine pounds and three quarters of the odoriferous powder.

Remark on the powder of fumigation.] If guaiacum cannot be had, the cones of pines or firs may be uſed in its ſtead; likewiſe the common tar of pines and firs may be uſed inſtead of the Smyrna tar, or myrrh, and mugwort may ſupply the place of ſouthern-wood.

Thucydides, who was himſelf infected, (lib. ii.) gives us an account of a dreadful plague which happened at Athens about the year before Chriſt 430, while the Peloponneſians under the command of Archidamus waſted all her territory abroad; but of theſe two enemies the plague was by far the moſt dreadful and ſevere.

The moſt dreadful plague that ever raged at Rome was in the reign of Titus, A. D. 80. The emperor left no remedy unattempted to abate the malignity of the diſtemper, acting during its continuance like a father to his people. The ſame fatal diſeaſe raged in all the provinces of the Roman empire in the reign of M. Aurelius, A. D. 167, and was followed by a dreadful famine, by earthquakes, inundations, and other calamities. The Romans believed that Æſculapius ſometimes entered into a ſerpent, and cured the plague.

About the year 430 the plague viſited Britain, juſt after the Picts and Scots had made a formidable invaſion of the ſouthern part of the iſland. The plague raged with uncommon fury, and ſwept away moſt of thoſe whom the ſword and famine had ſpared, ſo that the living were ſcarce ſufficient to bury the dead.

About the year 1348 the plague became almoſt general over Europe. A great many authors give an account of this plague, which is ſaid to have appeared firſt in the kingdom of Kathay in the year 1346, and to have proceeded gradually weſtward to Conſtantinople and Egypt. From Conſtantinople it paſſed into Greece, Italy, France, and Africa, and by degrees along the coaſts of the ocean into Britain and Ireland, and afterwards into Germany, Hungary, Poland, Denmark, and the other northern kingdoms. According to Antoninus, archbiſhop of Florence, the diſtemper carried off 60,000 people in that city, among whom was the hiſtorian John Villani.

In the year 1656 the plague was brought from Sardinia to Naples, being introduced into the city by a tranſport with ſoldiers on board. It raged with exceſſive violence, carrying off in leſs than ſix months 400,000 of the inhabitants. The diſtemper was at firſt called by the phyſicians a malignant fever; but one of them affirming it to be peſtilential, the viceroy, who was apprehenſive leſt ſuch a report would occaſion all communication with Naples to be broke off, was offended with this declaration, and ordered him to be impriſoned. As a favour, however, he allowed him to return, and die in his own houſe. By this proceeding of the viceroy, the diſtemper being neglected, made a moſt rapid and furious progreſs, and filled the whole city with conſternation. The ſtreets were crowded with confuſed proceſſions, which ſerved to ſpread the infection through all the quarters. The terror of the people increaſed their ſuperſtition; and it being reported that a certain nun had propheſied that the peſtilence would ceaſe upon building a hermitage for her ſiſter nuns upon the hill of St. Martin's, the edifice was immediately begun with the moſt ardent zeal: perſons of the higheſt quality ſtrove who ſhould perform the meaneſt offices; ſome loading themſelves with beams, and others carrying baſkets full of lime and nails, while perſons of all ranks ſtripped themſelves of their moſt valuable effects, which they threw into empty hogſheads placed in the ſtreets to receive the charitable contributions. Their violent agitation, however, and the increaſing heats, diffuſed the malady through the whole city, and the ſtreets and the ſtairs of the churches were filled with the dead; the number of whom, for ſome time of the month of July, amounted daily to 15,000.

The viceroy now uſed all poſſible precautions to abate the fury of the diſtemper, and to prevent its ſpreading to the provinces. The infection, however, deſolated the whole kingdom, excepting the provinces of Otranto and the Farther Calabria, and the cities of Gaeta, Sorrento, Paolo, and Belvedere. The general calamity was increaſed in Naples by malecontents, who inſinuated that the diſtemper had been deſignedly introduced by the Spaniards, and that there were people in diſguiſe who went through the city ſowing poiſoned duſt. This idle rumour enraged the populace, who began to inſult the Spaniſh ſoldiers, and threaten a ſedition; ſo that the viceroy, to pacify the mob, cauſed a criminal to be broke upon the wheel, under pretence that he was a diſperſer of the duſt. A violent and plentiful rain falling about the middle of Auguſt, the diſtemper began to abate; and on the 8th of December the phyſicians made a ſolemn declaration that the city was entirely free from infection.

Of the dreadful plague which raged at London in the year 1665, the reader will find an account in every hiſtory of that metropolis. In 1720 the city of Marſeilles was viſited with this deſtructive diſeaſe, brought in a ſhip from the Levant; and in ſeven months, during which time it continued, it carried off not leſs than 60,000 people. This deſolation is not yet obliterated from the minds of the inhabitants; ſome ſurvivors remained alive but a few years ago to tranſmit a traditional account of it to after ages. There are two fine pictures painted by Puget repreſenting ſome of the horrid ſcenes of that time. "They are (ſays lady Craven) only too well executed. I ſaw ſeveral dying figures taking leave of their friends, and looking their laſt anxious, kind, and wiſtful prayers on their ſick infants, that made the tears flow down my cheeks. I was told the phyſicians and noblemen who were aſſiſting the ſick and dying, were all portraits: I can eaſily conceive it; for in ſome faces there is a look of reflection and concern which could only be drawn from the life." *Letters*, p. 34, 35. This fatal event has cauſed the laws of quarantine to be very ſtrictly enforced in the lazaretto here, which is an extenſive inſulated building.

The ravages of this diſeaſe have been dreadful wherever it has made its appearance. On the firſt arrival of the Europeans at the iſland of Gran Canaria, it contained 14,000 fighting men; ſoon after which, two-thirds of the whole inhabitants fell a ſacrifice to the plague, which had doubtleſs been introduced by their new viſitors. The deſtruction it has made in Turkey in Europe, and particularly in Conſtantinople, muſt be known to every reader; and its fatal effects have been particularly heightened there by that firm belief which prevails among the people of predeſtination, &c. as has been already mentioned. It is generally brought into European Turkey from Egypt, where it is very frequent, eſpecially at *Grand* Cairo. To give even a liſt of all the plagues which have deſolated many flouriſhing countries, would extend this article beyond all bounds, and minutely to deſcribe them all would be impoſſible. For the plague at Smyrna, we refer to Chandler's Travels as above. Reſpecting that which raged in Syria in 1760, we refer to the Abbé Mariti's Travels through Cyprus, Syria, and Paleſtine, vol. i. p. 278—296. This plague was one of the moſt malignant and fatal that Syria ever experienced; for it ſcarcely made its appearance in any part of the body when it carried off the patient.

PLAIN, or Plane, in general, an appellation given to whatever is ſmooth and even, or ſimple, obvious, and eaſy to be underſtood; and, conſequently, ſtands oppoſed to rough, enriched, or laboured.

A plain figure, in geometry, is an uniform ſurface; from every point of whoſe perimeter right lines may be drawn to every other point in the ſame.

A plain angle is one contained under two lines, or ſurfaces, in contradiſtinction to a ſolid angle. See Angle.

The doctrine of plain triangles, as thoſe included under three right lines, is termed *plain trigonometry*. See the article Trigonometry.

Plain *Chart*. See the article Chart.

Plain-*Sailing*. See Navigation.

PLAISE, the Engliſh name of a ſpecies of pleuronectes. See Pleuronectes.

PLAN, in general, denotes the repreſentation of ſomething drawn on a plane; ſuch are maps, charts, ichnographies, &c. See Map, Chart, &c. The term *plan*, however, is particularly uſed for a draught of a building, ſuch as it appears, or is intended to appear, on the ground, ſhowing the extent, diviſion, and diſtribution, of its area or ground plot into apartments, rooms, paſſages, &c.

A *geometrical* plan is that wherein the ſolid and vacant parts are repreſented in their natural proportions. The *raiſed* plan of a building is the ſame with what is otherwiſe called an *elevation* or *orthography*. See Orthography. A *perſpective* plan is that exhibited by degradations or diminutions, according to the rules of perſpective. See Perspective.

To render plans intelligible, it is uſual to diſtinguiſh the maſſives with a black waſh; the projectures on the ground are drawn in full lines, and thoſe ſuppoſed over them in dotted lines. The augmentations or alterations to be made are diſtinguiſhed by a colour different from what is already built; and the tints of each plan made lighter as the ſtories are raiſed. In large buildings it is uſual to have three ſeveral plans for the three firſt ſtories.

PLANCUS (Francis), doctor of phyſic, born at Amiens in 1696, and who died on the 19th of September 1765, aged 69 years, is author of ſome works which do honour to his memory. 1. A complete Syſtem of Surgery, in 2 vols. in 12mo; a treatiſe much recommended by ſurgeons to their pupils. 2. A choice Library of Medicine, taken from periodical publications, both French and others: this curious collection, continued and completed by M. Goulin, makes 9 vols. in 4to, or 18 vols. in 12mo. 3. A Tranſlation of Vander Wiel's Obſervations on Medicine and Surgery, 1758, 2 vols. in 12mo. Plancus was the editor of various editions of works on medicine and ſurgery, and enriched them with notes. He ſhut himſelf up in his ſtudy for a long time before he practiſed his profeſſion.

PLANE, in geometry, denotes a plane ſurface, or one that lies evenly between its bounding lines: and as a right line is the ſhorteſt extenſion from one point to another, ſo a plane ſurface is the ſhorteſt extenſion from one line to another.

In aſtronomy, conics, &c. the term *plane* is frequently uſed for an imaginary ſurface, ſuppoſed to cut and paſs through ſolid bodies; and on this foundation is the whole doctrine of conic ſections built. See Astronomy, Conic *Sections*, &c.

In mechanics, planes are either horizontal, that is, parallel to the horizon, or inclined thereto. See Mechanics.

The determining how far any given plane deviates from a horizontal line makes the whole buſineſs of levelling. See the article Levelling.

In *optics*, the planes of reflection and refraction are thoſe drawn through the incident and reflected or refracted rays. See Optics.

In *perſpective* we meet with the perſpective plane, which is ſuppoſed to be pellucid, and perpendicular to the horizon: the horizontal plane, ſuppoſed to paſs through the ſpectator's eye, parallel to the horizon; the geometrical plane, likewiſe parallel to the horizon, wherein the object to be repreſented is ſuppoſed to be placed, &c. See Perspective.

The plane of projection in the ſtereographic projection of the ſphere is that on which the projection is made, correſponding to the perſpective plane. See PROJECTION.

PLANE, in joinery, an edged tool or inſtrument for parting and ſhaving of wood ſmooth.—It conſiſts of a piece of wood very ſmooth at bottom, as a ſtock or ſhaft; in the midſt of which is an aperture, through which a ſteel edge, or chiſel, placed obliquely, paſſes; which, being very ſharp, takes off the inequalities of the wood along which it ſlides.

PLANE-*Tree*, in botany. See PLATANUS.

PLANET, a celeſtial body, revolving round the ſun as a centre, and continually changing its poſition with reſpect to the fixed ſtars; whence the name *planet*, which is a Greek word ſignifying "wanderer."

The planets are uſually diſtinguiſhed into primary and ſecondary. The primary ones, called by way of eminence *planets*, are thoſe which revolve round the ſun as a centre; and the ſecondary planets, more uſually called *ſatellites* or *moons*, are thoſe which revolve round a primary planet as a centre, and conſtantly attend it in its revolution round the ſun.

The primary planets are again diſtinguiſhed into ſuperior and inferior. The ſuperior planets are thoſe farther from the ſun than our earth: as Mars, Jupiter, Saturn, and the Georgium Sidus; and the inferior planets are thoſe nearer the ſun than our earth, as Venus and Mercury. See ASTRONOMY.

That the planets are opaque bodies, like our earth, is thought probable for the following reaſons:—1. Since in Venus, Mercury, and Mars, only that part of the diſk illuminated by the ſun is found to ſhine; and again, Venus, and Mercury, when between the earth and the ſun, appear like dark ſpots or maculæ on the ſun's diſk; it is evident, that Mars, Venus, and Mercury, are opaque bodies illuminated with the borrowed light of the ſun. And the ſame appears of Jupiter, from its being void of light in that part to which the ſhadow of the ſatellites reaches, as well as in that part turned from the ſun; and that his ſatellites are opaque, and reflect the ſun's light, is abundantly ſhown. Again, ſince Saturn, with his ring and ſatellites, only yields a faint light, fainter conſiderably than that of the fixed ſtars, though theſe be vaſtly more remote, and than that of the reſt of the planets; it is paſt doubt that he too and his attendants are opaque bodies. 2. Since the ſun's light is not tranſmitted through Mercury and Venus, when placed againſt him, it is plain they are denſe opaque bodies; which is likewiſe evident of Jupiter, from his hiding the ſatellites in his ſhadow; and therefore, by analogy, the ſame may be concluded of Saturn. 3. From the variable ſpots of Venus, Mars, and Jupiter, it is evident theſe planets have a changeable atmoſphere; which changeable atmoſphere may, by a like argument, be inferred of the ſatellites of Jupiter; and therefore, by ſimilitude, the ſame may be concluded of the other planets. 4. In like manner, from the mountains obſerved in Venus, the ſame may be ſuppoſed in the other planets. 5. Since, then, Saturn, Jupiter, and the ſatellites of both, Mars, Venus, and Mercury, are opaque bodies ſhining with the ſun's borrowed light, are furniſhed with mountains, and encompaſſed with a changeable atmoſphere; they have, of conſequence, waters, ſeas, &c. as well as dry land, and are bodies like the moon, and therefore like the earth. *Q. E. D.* And hence it ſeems alſo highly probable that the other planets have their animal inhabitants as well as our earth.

PLANETARIUM, an aſtronomical machine, ſo called from its repreſenting the motions, orbits, &c. of the planets, agreeably to the Copernican ſyſtem. See ASTRONOMY, and Pl. 43. Vol. I.

PLANETARY, ſomething that relates to the planets. Hence we ſay, planetary worlds, planetary inhabitants, &c. Huyghens and Fontenelle bring ſeveral probable arguments for the reality of planetary animals, plants, men, &c. See PLANET.

PLANETARY *Syſtem*, is the ſyſtem or aſſemblage of the planets, primary and ſecondary, moving in their reſpective orbits round their common centre the ſun. See ASTRONOMY.

PLANETARY *Days*.—Among the ancients, the week was ſhared among the ſeven planets, each planet having its day. This we learn from Dion Caſſius and Plutarch, *Sympoſ.* l. 4. q. 7. Herodotus adds, that it was the Egyptians who firſt diſcovered what god, that is, what planet, preſides over each day; for that among this people the planets were directors. And hence it is, that in moſt European languages the days of the week are ſtill denominated from the planets: Sunday, Monday, &c. See WEEK.

PLANETARY *Years*, the periods of time in which the ſeveral planets make their revolutions round the ſun or earth.—As from the proper revolution of the ſun the ſolar year takes its original, ſo, from the proper revolutions of the reſt of the planets about the earth, ſo many ſorts of years do ariſe, viz. the Saturnian year, which is defined by 29 Egyptian years 174 hours 58 minutes, equivalent in a round number to 30 ſolar years.—The Jovial year, containing 317 days 14 hours 59 minutes.—The Martial year, containing 321 days 23 hours 31 minutes.—For Venus and Mercury, as their years, when judged of with regard to the earth, are almoſt equal to the ſolar year; they are more uſually eſtimated from the ſun, the true centre of their motions: in which caſe the former is equal to 224 days 16 hours 40 minutes; the latter to 87 days 23 hours 14 minutes.

PLANIMETRY, that part of geometry which conſiders lines and plain figures, without conſidering their height or depth. See GEOMETRY.

PLANISPHERE, ſignifies a projection of the ſphere and its various circles on a plane; in which ſenſe, maps, whereon are exhibited the meridians and other circles of the ſphere, are planiſpheres. See MAP.

PLANT is defined to be, an organical body, deſtitute of ſenſe and ſpontaneous motion, adhering to another body in ſuch a manner as to draw from it its nouriſhment, and having a power of propagating itſelf by ſeeds.

The vegetation and economy of plants is one of thoſe ſubjects in which our knowledge is extremely circumſcribed. A total inattention to the ſtructure and economy of plants is the chief reaſon of the ſmall progreſs that has been made in the principles of vegetation, and of the inſtability and fluctuation of our theories concerning it; for which reaſon we ſhall give a ſhort deſcription of the ſtructure of plants, beginning with the ſeed, and tracing its progreſs and evolution to a ſtate of maturity.

1. *Of Seeds.*] The ſeeds of plants are of various figures and ſizes. Moſt of them are divided into two lobes; though ſome, as thoſe of the creſs-kind, have ſix; and others, as the grains of corn, are not divided, but entire.

But as the eſſential properties of all ſeeds are the ſame, when conſidered with regard to the principles of vegetation, our particular deſcriptions ſhall be limited to one ſeed, viz. the great garden-bean. Neither is the choice of this ſeed altogether arbitrary; for, after it begins to vegetate, its parts are more conſpicuous than many others, and conſequently better calculated for inveſtigation.

This ſeed is covered with two coats or membranes. The outer coat is extremely thin, and full of pores; but may be eaſily ſeparated from the inner one (which is much thicker), after the bean has been boiled, or lain a few days in the ſoil. At the thick end of the bean there is a ſmall hole viſible to the naked eye, immediately over the radicle or future root, that it may have a free paſſage into the ſoil (Pl. 4. fig. 1. A). When theſe coats are taken off, the body of the ſeed appears, which is divided into two ſmooth portions or lobes. The ſmoothneſs of the lobes is owing to a thin film or cuticle with which they are covered.

At the baſis of the bean is placed the radicle or future root (fig. 3. A). The trunk of the radicle, juſt as it enters into the body of the ſeed, divides into two capital branches, one of which is inſerted into each lobe, and ſends off ſmaller ones in all directions through the whole ſubſtance of the lobes (Pl. 1. fig. 4. AA). Theſe ramifications become ſo extremely minute towards the edges of the lobes, that they require the fineſt glaſſes to render them viſible. To theſe ramifications Grew and Malpighi have given the name of *ſeminal root*; becauſe, by means of it, the radicle and plume, before they are expanded, derive their principal nouriſhment.

The plume, bud, or germ (Pl. 4. fig. 3.), is encloſed in two ſmall correſponding cavities in each lobe. Its colour and conſiſtence is much the ſame with thoſe of the radicle, of which it is only a continuation, but having a quite contrary direction: for the radicle deſcends into the earth, and divides into a great number of ſmaller branches or filaments; but the plume aſcends into the open air, and unfolds itſelf into all the beautiful variety of ſtem, branches, leaves, flowers, fruit, &c. The plume in corn ſhoots from the ſmaller end of the grain, and among maltſters goes by the name of *acroſpire*.

The next thing to be taken notice of is the ſubſtance or parenchymatous part of the lobes. This is not a mere concreted juice, but is curiouſly organized, and conſiſts of a vaſt number of ſmall bladders reſembling thoſe in the pith of trees (fig. 4.).

Beſides the coats, cuticle, and parenchymatous parts, there is a ſubſtance perfectly diſtinct from theſe, diſtributed in different proportions through the radicle, plume, and lobes. This inner ſubſtance appears very plainly in a tranſverſe ſection of the radicle or plume. Towards the extremity of the radicle it is one entire trunk; but higher up it divides into three branches; the middle one runs directly up to the plume, and the other two paſs into the lobes on each ſide, and ſpread out into a great variety of ſmall branches through the whole body of the lobes (Pl. 1. fig. 4.) This ſubſtance is very properly termed the *ſeminal root*: for, when the ſeed is ſown, the moiſture is firſt abſorbed by the outer coats, which are every where furniſhed with ſap and air-veſſels; from theſe it is conveyed to the cuticle; from the cuticle it proceeds to the pulpy part of the lobes; when it has got thus far, it is taken up by the mouths of the ſmall branches of the ſeminal root, and paſſes from one branch into another, till it is all collected into the main trunk, which communicates both with the plume and radicle, the two principal involved organs of the future plant. After this the ſap or vegetable food runs in two oppoſite directions; part of it aſcends into the plume, and promotes the growth and expanſion of that organ; and part of it deſcends into the radicle, for nouriſhing and evolving the root and its various filaments. Thus the plume and radicle continue their progreſs in oppoſite directions till the plant arrives at maturity.

It is here worth remarking, that every plant is really poſſeſſed of two roots, both of which are contained in the ſeed. The plume and radicle, when the ſeed is firſt depoſited in the earth, derive their nouriſhment from the ſeminal root; but afterwards, when the radicle begins to ſhoot out its filaments, and to abſorb ſome moiſture, not, however, in a ſufficient quantity to ſupply the exigencies of the plume, the two lobes, or main body of the ſeed, riſe along with the plume, aſſume the appearance of two leaves, reſembling the lobes of the ſeed in ſize and ſhape, but having no reſemblance to thoſe of the plume, for which reaſon they have got the name of *diſſimilar leaves*.

Theſe diſſimilar leaves defend the young plume from the injuries of the weather, and at the ſame time, by abſorbing dew, air, &c. aſſiſt the tender radicle in nouriſhing the plume, with which they have ſtill a connection by means of the ſeminal root above deſcribed. But when the radicle or ſecond root has deſcended deep enough into the earth, and has acquired a ſufficient number of filaments or branches for abſorbing as much aliment as is proper for the growth of the plume; then the ſeminal or diſſimilar leaves, their utility being ſuperſeded, begin to decay.

Plate 4. fig. 1. A, the foramen or hole in the bean through which the radicle ſhoots into the ſoil. Fig. 2. A tranſverſe ſection of the bean; the dots being the branches of the ſeminal root. Fig. 3. A, the radicle. B, the plume or bud. Fig. 4. A, a longitudinal ſection of one of the lobes of the bean a little magnified, to ſhow the ſmall bladders of which the pulpy or parenchymatous part is compoſed. Figs. 5, 6. A, a tranſverſe ſection of the radicle. B, a tranſverſe ſection of the plume, ſhowing the organs or veſſels of the ſeminal root. Fig. 7. The appearance of the radicle, plume, and ſeminal root, when a little further advanced in growth.

Pl. 1. fig. 4. A view of the ſeminal root branched out upon the lobes.

Having thus briefly deſcribed the ſeed, and traced its evolution into three principal organic parts, viz. the plume, radicle, and ſeminal leaves, we ſhall next take an anatomical view of the root, trunk, leaves, &c.

2. *Of the root.*] In examining the root of plants, the firſt thing that preſents itſelf is the ſkin, which is of various colours in different plants. Every root, after it has arrived at a certain age, has a double ſkin. The firſt is coëval with the other parts, and exiſts in the ſeed; but afterwards there is a ring ſent off from the bark, and forms a ſecond ſkin; *e. g.* in the root of the dandelion, towards the end of May, the original or outer ſkin appears ſhrivelled, and is eaſily ſeparated frow the new one, which is freſher, and adheres more firmly to the bark. Perennial plants are ſupplied in this manner with a new ſkin every year; the outer one always falls off in the autumn and winter, and a new one is formed from the bark in the ſucceeding ſpring. The ſkin has numerous cells or veſſels, and is a continuation of the parenchymatous part of the radicle. However, it does not conſiſt ſolely of parenchyma; for the microſcope ſhows that there are many tubular ligneous veſſels interſperſed through it.

When the ſkin is removed, the true cortical ſubſtance or bark appears, which is alſo a continuation of the parenchymatous part of the radicle, but greatly augmented. The bark is of very different ſizes. In moſt trees it is exceeding thin in proportion to the wood and pith. On the other hand, in carrots, it is almoſt one-half of the ſemidiameter of the root; and, in dandelion, it is nearly twice as thick as the woody part.

The bark is compoſed of two ſubſtances; the parenchyma or pulp, which is the principal part, and a few woody fibres. The parenchyma is exceedingly porous, and has a great reſemblance to a ſponge; for it ſhrivels conſiderably when dried, and dilates to its former dimenſions when infuſed in water. Theſe pores or veſſels are not pervious, ſo as to communicate with each other; but conſiſt of diſtinct little cells or bladders, ſcarcely viſible without the aſſiſtance of the microſcope. In all roots, theſe cells are conſtantly filled with a thin watery liquor. They are generally of a ſpherical figure; though in ſome roots, as the bugloſs and dandelion, they are oblong. In many roots, as the horſe radiſh, peony, aſparagas, potatoe, &c. the parenchyma is of one uniform ſtructure. But in others it is more diverſified, and puts on the ſhape of rays, running from the centre towards the circumference of the bark. Theſe rays ſometimes run quite through the bark, as in lovage; and ſometimes advance towards the middle of it, as in melilot and moſt of the leguminous and umbelliferous plants. Theſe rays generally ſtand at an equal diſtance from each other in the ſame plant; but the diſtance varies greatly in different plants. Neither are they of equal ſizes: in carrot they are exceedingly ſmall, and ſcarcely diſcernible; in melilot and chervil, they are thicker. They are likewiſe more numerous in ſome plants than in others. Sometimes they are of the ſame thickneſs from one edge of the bark to the other; and ſome grow wider as they approach towards the ſkin. The veſſels with which theſe rays are amply furniſhed, are ſuppoſed to be air-veſſels, becauſe they are always found to be dry, and not ſo tranſparent as the veſſels which evidently contain the ſap.

In all roots there are ligneous veſſels diſperſed in different proportions through the parenchyma of the bark. Theſe ligneous veſſels run longitudinally through the bark in the form of ſmall threads, which are tubular, as is evident from the riſing of the ſap in them when a root is cut tranſverſely. Theſe ligneous ſap-veſſels do not run in direct lines through the bark, but at ſmall diſtances incline towards one another, in ſuch a manner that they appear to the naked eye to be inoſculated; but the microſcope diſcovers them to be only contiguous, and braced together by the parenchyma. Theſe braces or coarctations are very various both in ſize and number in different roots; but in all plants they are moſt numerous towards the inner edge of the bark. Neither are theſe veſſels ſingle tubes; but, like the nerves in animals, are bundles of 20 or 30 ſmall contiguous cylindrical tubes, which uniformly run from the extremity of the root, without ſending off any branches, or ſuffering any change in their ſize or ſhape.

In ſome roots, as parſnep, eſpecially in the ring next the inner extremity of the bark, theſe veſſels contain a kind of lymph, which is ſweeter than the ſap contained in the bladders of the parenchyma. From this circumſtance they have got the name of *lymph-ducts*.

Theſe lymph-ducts ſometimes yield a mucilaginous lymph, as in the comfrey; and ſometimes a white milky glutinous lymph, as in the angelica, ſonchus, burdock, ſcorzonera, dandelion, &c. The lymph-ducts are ſuppoſed to be the veſſels from which the gums and balſams are ſecreted. The lymph of fennel, when expoſed to the air, turns into a clear tranſparent balſam; and that of the ſcorzonera, dandelion, &c. condenſes into a gum.

The ſituation of the veſſels is various. In ſome plants they ſtand in a ring or circle at the inner edge of the bark, as in aſparagus; in others, they appear in lines or rays, as in borage; in the parſnep, and ſeveral other plants, they are moſt conſpicuous towards the outer edge of the bark; and in the dandelion, they are diſpoſed in the form of concentric circles.

The wood of roots is that part which appears after the bark is taken off, and is firmer and leſs porous than the bark or pith. It conſiſts of two diſtinct ſubſtances, viz. the pulpy or parenchymatous, and the ligneous. The wood is connected to the bark by large portions of the bark inſerted into it. Theſe inſertions are moſtly in the form of rays, tending to the centre of the pith, which are eaſily diſcernible by the eye in a tranſverſe ſection of moſt roots. Theſe inſertions, like the bark, conſiſt of many veſſels, moſtly of a round or oval figure.

The ligneous veſſels are generally diſpoſed in collateral rows running longitudinally through the root. Some of theſe contain air, and others ſap. The *air-veſſels* are ſo called, becauſe they contain no liquor. Theſe air-veſſels are diſtinguiſhed by being whiter than the others.

The pith is the centrical part of the root. Some roots have no pith, as the ſtramonium, nicotiana, &c.; others have little or none at the extremities of the roots, but have a conſiderable quantity of it near the top. The pith, like every other part of a plant, is derived from the ſeed; but in ſome it is more immediately derived from the bark: for the inſertions of the bark running in betwixt the rays of the wood, meet in the centre, and conſtitute the pith. It is owing to this circumſtance, that, among roots which have no pith in their lower parts, they are amply provided with it towards the top, as in columbine, lovage, &c.

The bladders of the pith are of very different ſizes, and generally of a circular figure. Their poſition is more uniform than in the bark. Their ſides are not mere films, but a compoſition of ſmall fibres or threads; which gives the pith, when viewed with a microſcope, the appearance of a piece of fine gauze or net-work.

We ſhall conclude the deſcription of roots with obſerving, that their whole ſubſtance is nothing but a congeries of tubes and fibres, adapted by nature for the abſorption of nouriſhment, and of courſe the extenſion and augmentation of their parts.

Pl. 4. fig. 8. is a tranſverſe ſection of the root of wormwood as it appears to the naked eye. Fig. 9. A ſection of fig. 8. magnified. AA, the ſkin, with its veſſels. BBBB, the bark. The round holes CCC, &c. are the lymph-ducts of the bark: All the other holes are little cells and ſap-veſſels. DDD, parenchymatous inſertions from the bark, with the cells, &c. EEEE, the rays of the wood, in which the holes are the air-veſſels. *N. B.* This root has no pith.

3. *Of the Trunk, Stalk, or Stem.*] In deſcribing the trunks of plants, it is neceſſary to premiſe, that whatever is ſaid with regard to them applies equally to the branches.

The trunk, like the root, conſiſts of three parts, viz. the bark, wood, and pith. Theſe parts, though ſubſtantially the ſame in the trunk as in the root, are in many caſes very different in their texture and appearance.

The ſkin of the bark is compoſed of very minute bladders, interſperſed with longitudinal woody fibres, as in the nettle, thiſtle, and moſt herbs. The outſide of the ſkin is viſibly porous in ſome plants, particularly the cane.

The principal body of the bark is compoſed of pulp or parenchyma, and innumerable veſſels much larger than thoſe of the ſkin. The texture of the pulpy part, though the ſame ſubſtance with the parenchyma in roots, yet ſeldom appears in the form of rays running towards the pith; and when theſe rays do appear, they do not extend above half way to the circumference. The veſſels of the bark are very differently ſituated, and deſtined for various purpoſes in different plants. For example, in the bark of the pine, the inmoſt are lymph-ducts, and exceedingly ſmall; the outmoſt are gum or reſiniferous veſſels, deſtined for the ſecretion of turpentine; and are ſo large as to be diſtinctly viſible to the naked eye.

The wood lies between the bark and pith, and conſiſts of two parts, viz. a parenchymatous and ligneous. In all trees, the parenchymatous part of the wood, though much diverſified as to ſize and conſiſtence, is uniformly diſpoſed in diametrical rays, or inſertions running betwixt ſimilar rays of the ligneous part.

The true wood is nothing but a congeries of old dried lymph-ducts. Between the bark and the wood a new ring of theſe ducts is formed every year, which gradually loſes its ſoftneſs as the cold ſeaſon approaches, and towards the middle of winter is condenſed into a ſolid ring of wood. Theſe annual rings, which are diſtinctly viſible in moſt trees when cut through, ſerve as natural marks to diſtinguiſh their age (Pl. 4. fig. 10, 11.) The rings of one year are ſometimes larger, ſometimes leſs, than thoſe of another, probably owing to the favourableneſs or unfavourableneſs of the ſeaſon.

The pith, though of a different texture, is exactly of the ſame ſubſtance with the parenchyma of the bark, and the inſertions of the wood. The quantity of pith is various in different plants. Inſtead of being increaſed every year like the wood, it is annually diminiſhed, its veſſels drying up, and aſſuming the appearance and ſtructure of wood; inſomuch that in old trees there is ſcarce ſuch a thing as pith to be diſcerned.

A ring of ſap-veſſels are uſually placed at the outer edge of the pith, next the wood. In the pine, fig, and walnut, they are very large. The parenchyma of the pith is compoſed of ſmall cells or bladders, of the ſame kind with thoſe of the bark, only of a larger ſize. The general figure of theſe bladders is circular; though in ſome plants, as the thiſtle and borage, they are angular. Though the pith is originally one connected chain of bladders, yet as the plant grows old they ſhrivel, and open in different directions. In the walnut, after a certain age, it appears in the form of a regular tranſverſe hollow diviſion. In ſome plants it is altogether wanting; in others, as the ſonchus, nettle, &c. there is only a tranſverſe partition of it at every joint. Many other varieties might be mentioned; but theſe muſt be left to the obſervation of the reader.

Fig. 10. in Pl. 4. ſhows a tranſverſe ſection of a branch of aſh, as it appears to the eye. Fig. 11. The ſame ſection magnified. AA, the bark. BBB, an arched ring of ſap-veſſels next the ſkin. CCC, the parenchyma of the bark with its cells, and another arched ring of ſap-veſſels. DD, a circular line of lymph-ducts immediately below the above arched ring. EE, the wood. F, the firſt year's growth. G, the ſecond. H, the third year's growth. III, the true wood. KK, the great air veſſels. LL, the leſſer ones. MMM, the parenchymatous inſertions of the bark repreſented by the white rays. NO, the pith, with its bladders or cells.

4. *Of the Leaves.*] The leaves of plants conſiſt of the ſame ſubſtance with that of the trunk. They are full of nerves or woody portions, running in all directions, and branching out into innumerable ſmall threads, interwoven with the parenchyma like fine lace or gauze.

The ſkin of the leaf, like that of an animal, is full of pores, which both ſerve for perſpiration and for the abſorption of dews, air, &c. Theſe pores or orifices differ both in ſhape and magnitude in different plants, which is the cauſe of that variety of texture or grain peculiar to every plant.

The pulpy or parenchymatous part conſiſts of very minute fibres, wound up into ſmall cells or bladders. Theſe cells are of various ſizes in the ſame leaf.

All leaves, of whatever figure, have a marginal fibre, by which all the reſt are bounded. The particular ſhape of this fibre determines the figure of the leaf.

The veſſels of leaves have the appearance of inoſculating; but, when examined by the microſcope, they are found only to be interwoven or laid along each other.

What are called *air-veſſels*, or thoſe which carry no ſap, are viſible even to the naked eye in ſome leaves. When a leaf is ſlowly broke, they appear like ſmall woolly fibres, connected to both ends of the broken piece.

Pl. 5. fig. 14. ſhows the appearance of the air-veſſels to the eye, in a vine-leaf drawn gently aſunder. Fig. 15. A ſmall piece cut off that leaf. Fig. 16. The ſame piece magnified, in which the veſſels have the appearance of a ſcrew. Fig. 17. The appearance of theſe veſſels as they exiſt in the leaf before they are ſtretched out.

5. *Of the Flower.*] It is needleſs here to mention any thing of the texture, or of the veſſels, &c. of flowers, as they are pretty ſimilar to thoſe of the leaf. It would be foreign to our preſent purpoſe to take any notice of the characters and diſtinctions of flowers. Theſe belong to the ſcience of BOTANY, to which the reader is referred.

There is one curious fact, however, which muſt not be omitted, viz. That every flower is perfectly formed in its parts many months before it appears outwardly; that is, the flowers which appear this year are not, properly ſpeaking, the flowers of this year, but of the laſt. For example, mezereon generally flowers in January; but theſe flowers were completely formed in the month of Auguſt preceding. Of this fact any one may ſatisfy himſelf by ſeparating the coats of a tulip-root about the beginning of September; and he will find that the two innermoſt form a kind of cell, in the centre of which ſtands the young flower, which is not to make its appearance till the following April or May. Fig. 18. exhibits a view of the tulip root when diſſected in September, with the young flower towards the bottom.

6. *Of the Fruit.*] In deſcribing the ſtructure of fruits, a few examples ſhall be taken from ſuch as are moſt generally known.

A *pear*, beſides the ſkin, which is a production of the ſkin of the bark, conſiſts of a double parenchyma or pulp, ſap, and air-veſſels, calculary and acetary.

The outer parenchyma is the ſame ſubſtance continued from the bark, only its bladders are larger and more ſucculent.

It is every where interſperſed with ſmall globules or grains, and the bladders reſpect theſe grains as a kind of centres, every grain being the centre of a number of bladders. The ſap and air-veſſels in this pulp are extremely ſmall.

Next the core is the inner pulp or parenchyma, which conſiſts of bladders of the ſame kind with the outer, only larger and more oblong, correſponding to thoſe of the pulp, from which it ſeems to be derived. This inner pulp is much ſourer than the other, and has none of the ſmall grains interſperſed through it; and hence it has got the name of *acetary*.

Between the acetary and outer pulp, the globules or grains begin to grow larger, and gradually unite into a hard ſtony body, eſpecially towards the corculum or ſtool of the fruit; and from this circumſtance it has been called the *calculary*.

Theſe grains are not derived from any of the organical parts of the tree; but ſeem rather to be a kind of concretions precipitated from the ſap, ſimilar to the precipitation from wine, urine, and other liquors.

The core is a roundiſh cavity in the centre of the pear, lined with a hard woody membrane, in which the ſeed is encloſed. At the bottom of the core there is a ſmall duct or canal, which runs up to the top of the pear; this canal allows the air to get into the core, for the purpoſe of drying and ripening the ſeeds.

Fig. 19. in Pl. 5. is a tranſverſe ſection of a pear, as it appears to the naked eye. A, the ſkin, and a ring of ſap-veſſels. B, the outer parenchyma, or pulp, with its veſſels, and ligneous fibres interſperſed. C, the inner parenchyma, or acetary, with its veſſels, which are larger than the outer one. D, the core and ſeeds.—Fig. 20. a piece cut off fig. 19.—Fig. 21. is fig. 20. magnified. A A A, the ſmall grains or globules, with the veſſels radiated from them.—Fig. 22. a longitudinal ſection of the pear, ſhowing a different view of the ſame parts with thoſe of fig. 19. A, the channel, or duct, which runs from the top of the pear to the bottom of the core.

In a *lemon*, the parenchyma appears in three different forms. The parenchyma of the rind is of a coarſe texture, being compoſed of thick fibres, woven into large bladders. Thoſe neareſt the ſurface contain the eſſential oil of the fruit, which burſts into a flame when the ſkin is ſqueezed over a candle. From this outmoſt parenchyma nine or ten inſertions or lamellæ are produced, which run between as many portions of the pulp, and unite into one body in the centre of the fruit, which correſponds to the pith in trunks or roots. At the bottom and top of the lemon this pith evidently joins with the rind, without the intervention of any lamellæ. This circumſtance ſhows, that the pith and bark are actually connected in the trunk and roots of plants, though it is difficult to demonſtrate the connection, on account of the cloſeneſs of their texture, and the minuteneſs of their fibres. Many veſſels are diſperſed through the whole of this parenchyma; but the largeſt ones ſtand on the inner edge of the rind, and the outer edge of the pith, juſt at the two extremities of each lamella.

The ſecond kind of parenchyma is placed between the rind and the pith, is divided into diſtinct bodies by the lamellæ, and each of theſe bodies forms a large bag.

Theſe bags contain a third parenchyma, which is a cluſter of ſmaller bags, diſtinct and unconnected with each other, having a ſmall ſtalk by which they are fixed to the large bag. Within each of theſe ſmall bags are many hundreds of bladders, compoſed of extremely minute fibres. Theſe bladders contain the acid juice of the lemon.

In Pl. 4. fig. 12. a longitudinal ſection of a lemon. A A A, the rind with the veſſels which contain the eſſential oil. B B, the ſubſtance correſponding to the pith, formed by the union of the lamellæ or inſertions. C C, its continuation and connection with the rind, independent of the inſertions. Fig. 13. a tranſverſe ſection of the lemon. B B B, &c. the nine pulpy bags, or ſecond parenchyma, placed between the rind and the pith; and the cluſter of ſmall bags, which contain the acid juice, encloſed in the large ones. C C, the large veſſels that ſurround the pith. D D, two of the large bags laid open, ſhowing the ſeeds, and their connection with the lamellæ or membranes which form the large bags.

Of the Perſpiration of Plants, *and the quantity of moiſture daily imbibed by them.*—Theſe curious particulars have been determined with great accuracy by Dr. Hales. The method he took to accompliſh his purpoſe was as follows:—In the month of July, commonly the warmeſt ſeaſon of the year, he took a large ſun-flower, three feet and a half high, which had been purpoſely planted in a flower-pot when young. He covered the pot with thin milled lead, leaving only a ſmall hole to preſerve a communication with the external air, and another by which he might occaſionally ſupply the plant with water. Into the former he inſerted a glaſs tube nine inches long, and another ſhorter tube into the hole by which he poured in the water; and the latter was kept cloſe ſtopped with a cork, except when there was occaſion to uſe it. The holes in the bottom of the pot were alſo ſtopped up with corks, and all the crevices ſhut with cement.—Things being thus prepared, the pot and plant were weighed for 15 ſeveral days; after which the plant was cut off cloſe to the leaden plate, and the ſtump well covered with cement. By weighing, he found that there perſpired through the unglazed porous pot two ounces every 12 hours; which being allowed for in the daily weighing of the plant and pot, the greateſt perſpiration, in a warm day, was found to be 1 pound 14 ounces; the middle rate of perſpiration, 1 pound 4 ounces; the perſpiration of a dry warm night, without any ſenſible dew, was about 3 ounces; but when there was any ſenſible though ſmall dew, the perſpiration was nothing; and when there was a large dew, or ſome little rain in the night, the plant and pot were increaſed in weight 2 or 3 ounces.

In order to know what quantity was perſpired from a ſquare inch of ſurface, our author cut off all the leaves of the plant, and laid them in five ſeveral parcels, according to their ſeveral ſizes; and then meaſured the ſurface of a leaf of each parcel, by laying over it a large lattice made with threads, in which each of the little ſquares was $\frac{1}{4}$ of an inch; by numbering of which, he had the ſurface of the leaves in ſquare inches; which, multiplied by the number of leaves in the correſponding parcels, gave the area of all the leaves. By this method he found the ſurface of the whole plant above ground to be 5616 ſquare inches, or 39 ſquare feet. He dug up another ſun-flower of nearly the ſame ſize, which had eight main roots, reaching 15 inches deep and ſidewiſe, from the ſtem. It had beſides a very thick buſh of lateral roots from the eight main roots, extending every way in a hemiſphere about nine inches from the ſtem and main roots. In order to eſtimate the length of all the roots, he took one of the main roots with its laterals, and meaſured and weighed them; and then weighed the other ſeven with their laterals; by which means he found the ſum of all their lengths to be 1448 feet. Suppoſing then the periphery of theſe roots at a medium to be 0.131 of an inch, then their ſurface will be 2276 ſquare inches, or 15.8 ſquare feet; that is, equal to 0.4 of the ſurface of the plant above ground. From calculations drawn from theſe obſervations, it appears, that a ſquare inch of the upper ſurface of this plant perſpires $\frac{1}{165}$ part of an inch in a day and a night, and that a ſquare inch of the ſurface underground imbibed $\frac{1}{67}$ of an inch in the ſame time.

The quantity perſpired by different plants, however, is by no means equal. A vine-leaf perſpires only $\frac{1}{191}$ of an inch in 12 hours; a cabbage perſpires $\frac{1}{80}$ of an inch in the ſame time; an apple-tree $\frac{1}{102}$ in 12 hours; and a lemon $\frac{1}{248}$ in 12 hours.

Of the Circulation of the Sap in Plants.—Concerning this there have been great diſputes, ſome maintaining that the vegetable ſap has a circulation analogous to the blood of animals, while others affirm that it only aſcends in the day-time, and deſcends again in the night. In favour of the doctrine of circulation it has been urged, that upon making a tranſverſe inciſion into the trunk of a tree, the juice which runs out proceeds in greater quantity from the upper than the lower part; and the ſwelling in the upper lip is alſo much greater than in the lower. It appears, however, that when two ſimilar inciſions are made, one near the top and the other near the root, the latter expends much more ſap than the former. Hence it is concluded, that the juice aſcends by one ſet of veſſels, and deſcends by another. But, in order to ſhow this clearly, it would be neceſſary firſt to prove that there is in plants, as in animals, ſome kind of centre from which the circulation begins, and to which it returns: but no ſuch centre has been diſcovered by any naturaliſt; neither is there the leaſt proviſion apparently made by nature, whereby the ſap might be prevented from deſcending in the very ſame veſſels through which it aſcends. In the lacteal veſſels of animals, which we may ſuppoſe to be analogous to the roots of vegetables, there are valves which effectually prevent the chyle, when once abſorbed, from returning into the inteſtines; but no ſuch thing is obſerved in the veſſels of vegetables: whence it muſt be very probable, that, when the propelling force ceaſes, the juice deſcends by the very ſame veſſels through which it aſcended.—This matter, however, has been cleared up, almoſt as well as the nature of the ſubject will admit of, by the experiments of Dr. Hales. Theſe experiments are ſo numerous, that for a particular account of them we muſt refer to his Vegetable Statics. But his reaſoning againſt the circulation of the ſap will be ſufficiently intelligible without them. "We ſee (ſays he), in many of the foregoing experiments, what quantities of moiſture trees daily imbibe and perſpire: now the celerity of the ſap muſt be very great, if that quantity of moiſture muſt, moſt of it, aſcend to the top of the tree, then deſcend, and aſcend again, before it is carried off by perſpiration.

"The defect of a circulation in vegetables ſeems in ſome meaſure to be ſupplied by the much greater quantity of liquor which the vegetable takes in than the animal, whereby its

Anatomy of PLANTS.

Fig. 1.
Garden Bean

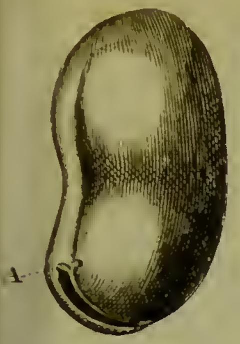


Fig. 2.

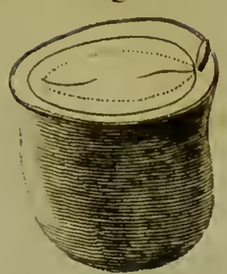


Fig. 3.

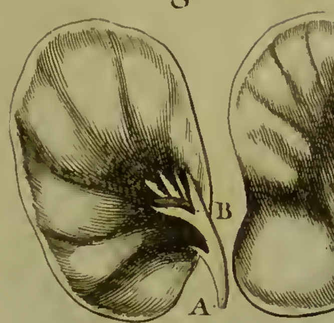


Fig. 4.
Slice of a Bean.

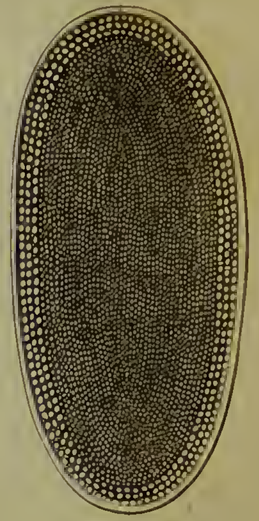


Fig. 9.
ction of Fig. 8 *Magnified*

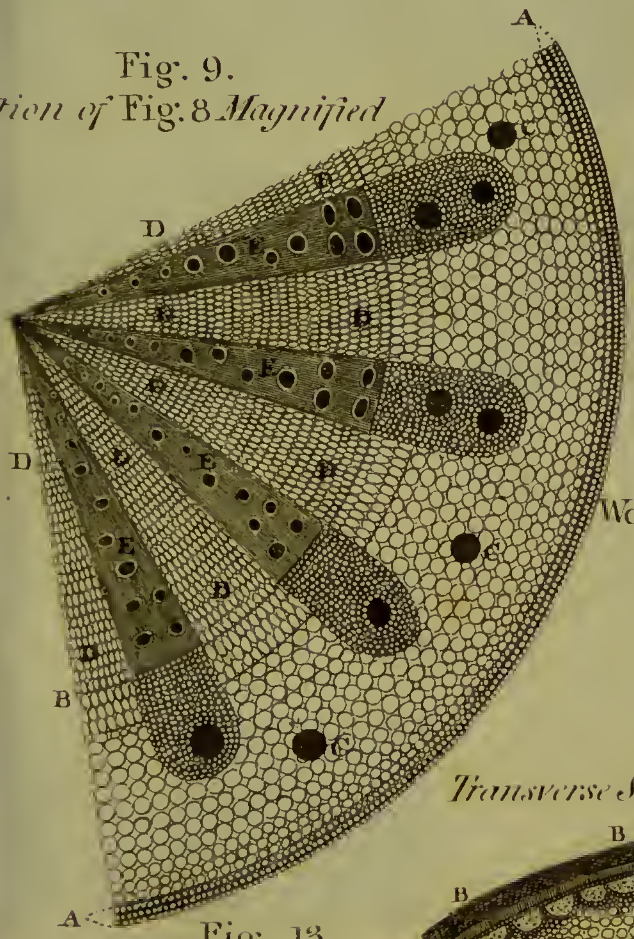


Fig. 5.
Radical

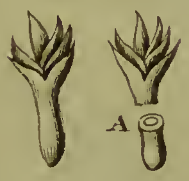


Fig. 6.
Plume

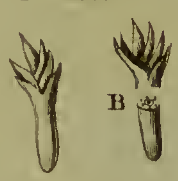


Fig. 7.

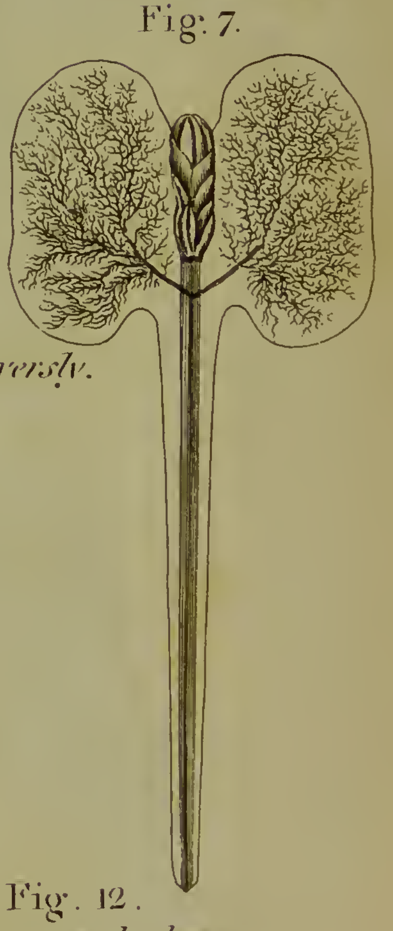


Fig. 8.
Wormwood Root *cut Transversly*

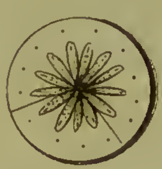


Fig. 10.
Ash Branch *cut Transversly.*

Fig. 11.
Transverse Section of the Ash Branch *Magnified.*

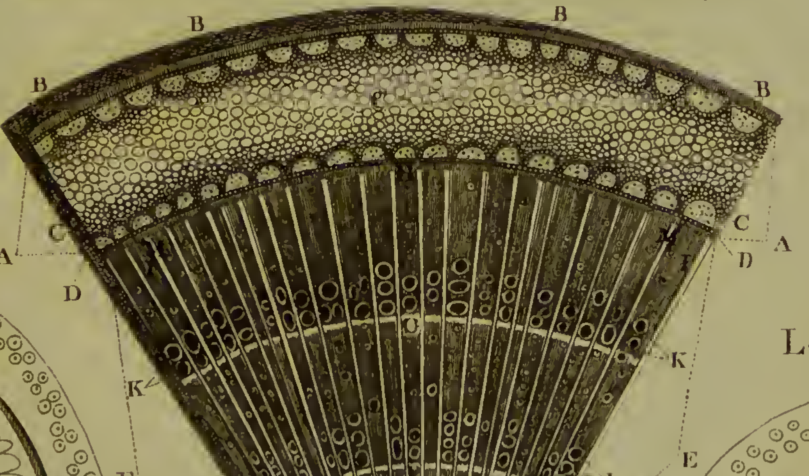


Fig. 13.
Lemon *cut Transversly.*

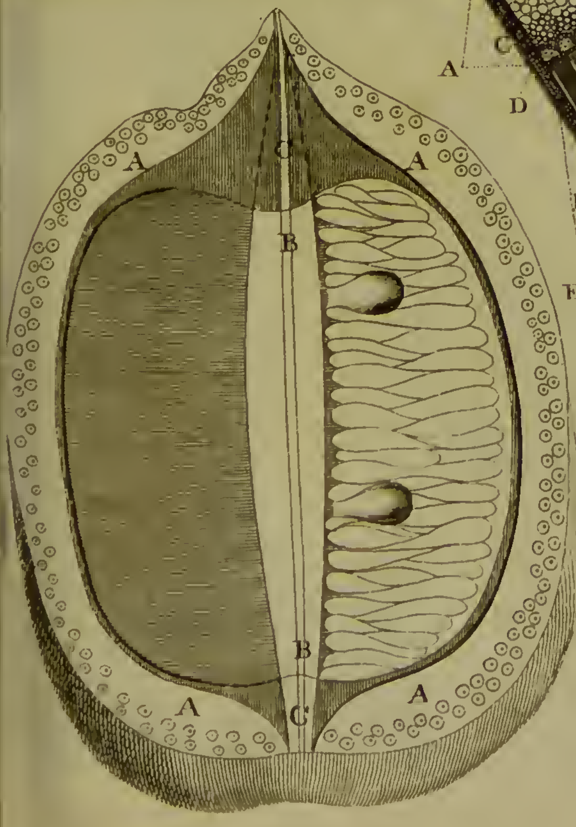
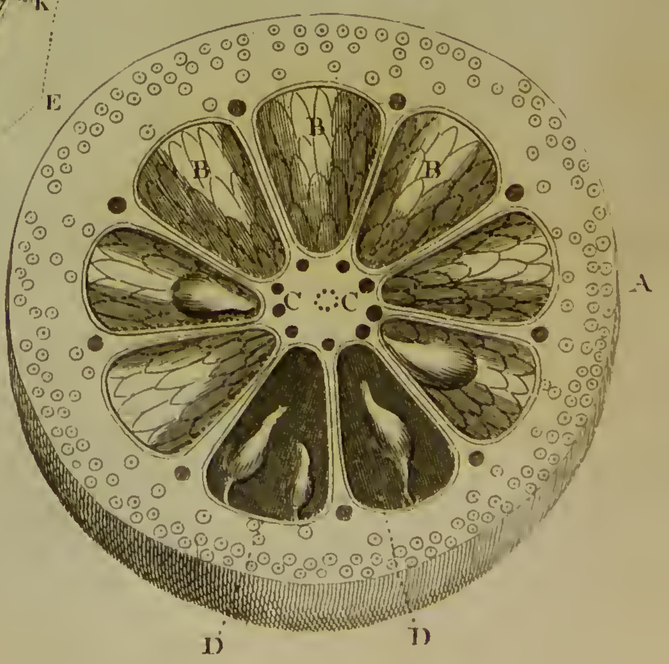


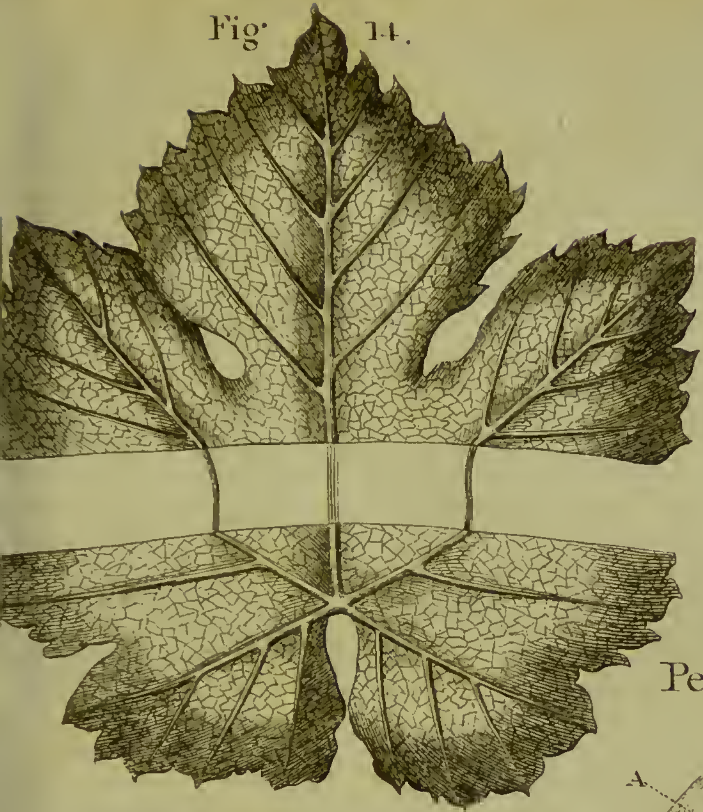
Fig. 12.
Lemon *cut down.*



Anatomy of PLANTS.

Vine Leaf

Fig. 14.



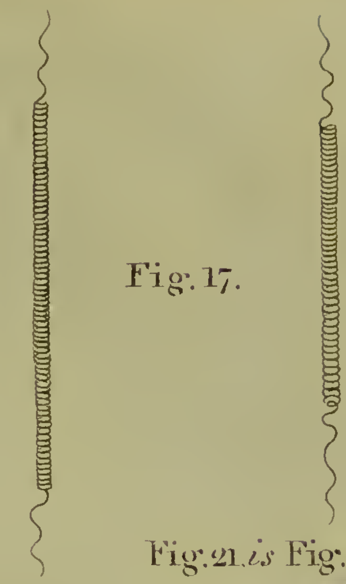


Fig. 17.

Tulip Root.

Fig. 18.

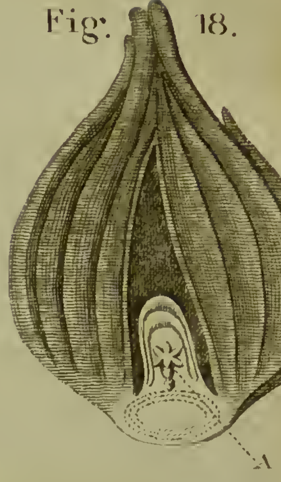


Fig. 22.

Pear *cut Longitudinally.*

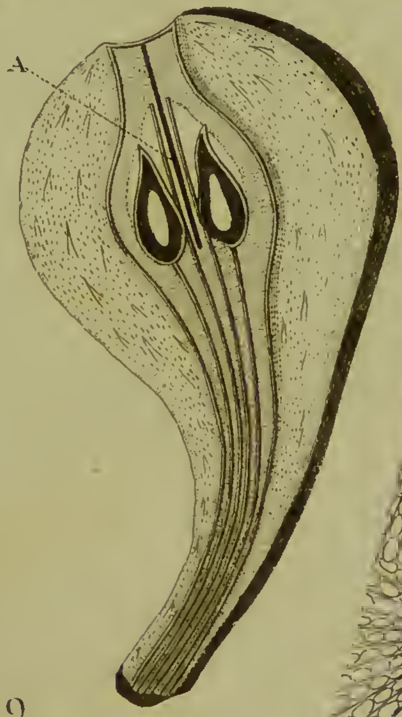


Fig. 20. *cut off* Fig. 19.

Fig. 15.

Fig. 16.

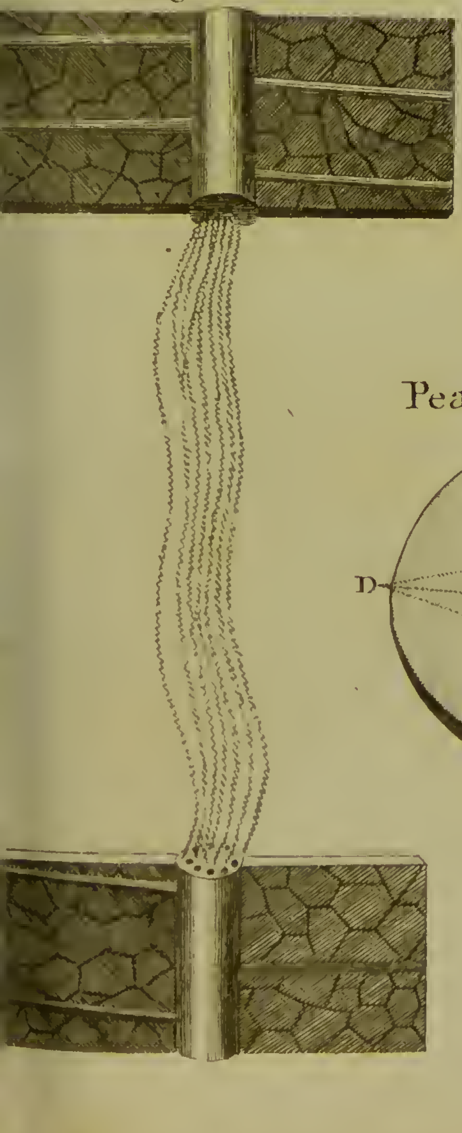


Fig. 19.

Pear *cut Transversely.*

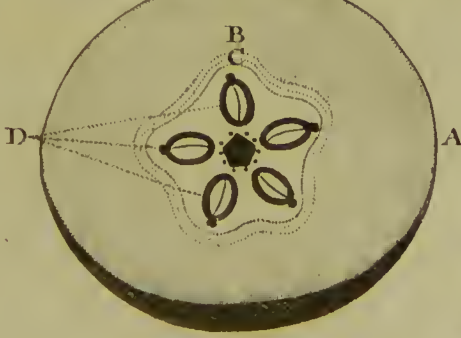
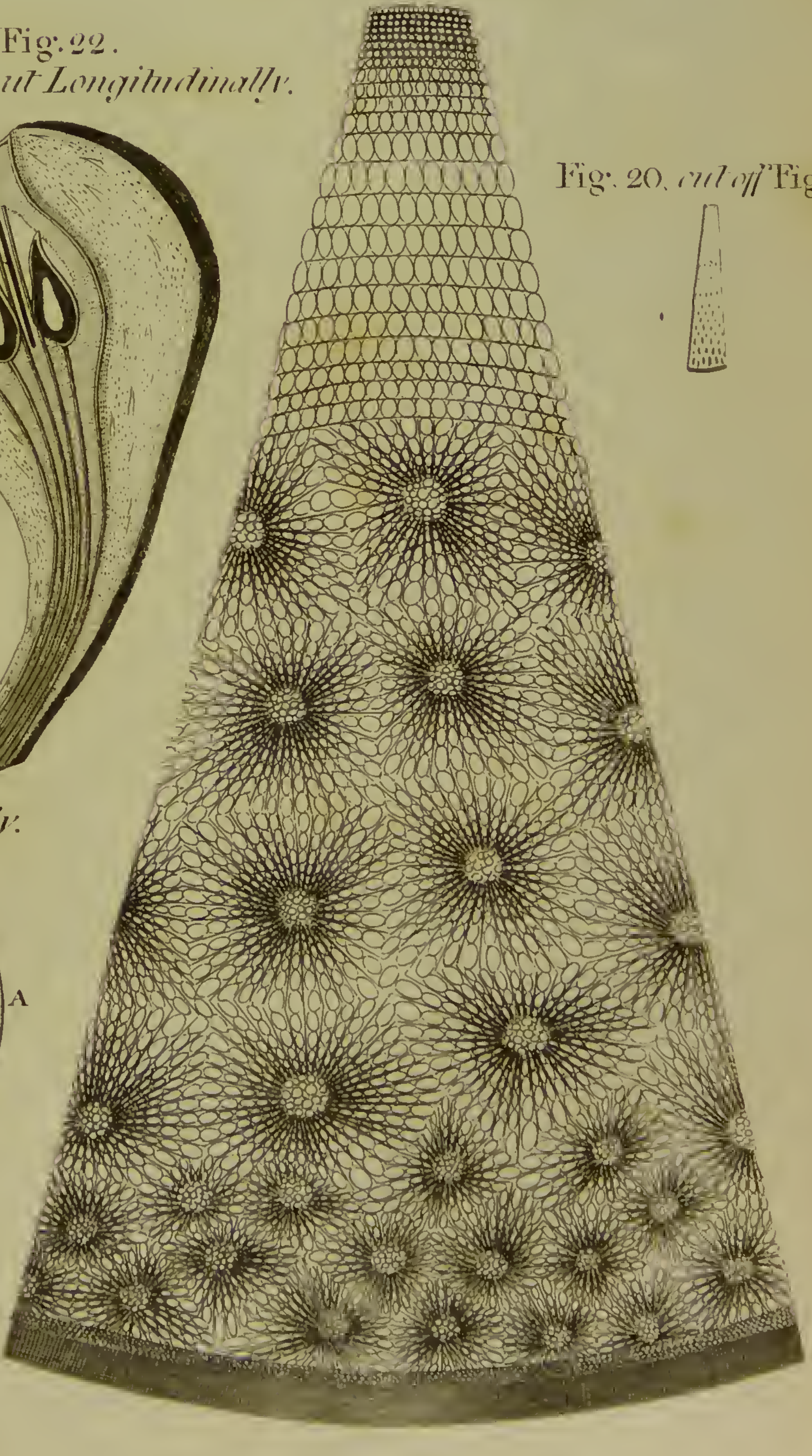


Fig. 21. *is* Fig. 20. *magnified.*



motion is accelerated; for we find the ſun-flower, bulk for bulk, imbibes and perſpires 17 times more freſh liquor than a man, every 24 hours.

" Beſides, Nature's great aim in vegetables being only that the vegetable life be carried on and maintained, there was no occaſion to give its ſap the rapid motion which was neceſſary for the blood of animals.

" In animals it is the heart which ſets the blood in motion, and makes it continually circulate; but in vegetables we can diſcover no other cauſe of the ſap's motion but the ſtrong attraction of the capillary ſap-veſſels, aſſiſted by the briſk undulations and vibrations cauſed by the ſun's warmth, whereby the ſap is carried up to the top of the talleſt trees, and is there perſpired off through the leaves: but when the ſurface of the tree is greatly diminiſhed by the loſs of its leaves, then alſo the perſpiration and motion of the ſap are proportionably diminiſhed, as is plain from many of the foregoing experiments; ſo that the aſcending velocity of the ſap is principally accelerated by the plentiful perſpiration of the leaves, thereby making room for the fine capillary veſſels to exert their vaſtly attracting power, which perſpiration is effected by the briſk rarefying vibrations of warmth; a power that does not ſeem to be any ways well adapted to make the ſap deſcend from the tops of vegetables by different veſſels to the root.

" If the ſap circulated, it muſt needs have been ſeen deſcending from the upper part of large gaſhes cut in branches ſet in water, and with columns of water preſſing on their bottoms in long glaſs tubes. In both which caſes, it is certain that great quantities of water paſſed through the ſtem, ſo that it muſt needs have been ſeen deſcending, if the return of the ſap downwards were by truſion or pulſion, whereby the blood in animals is returned through the veins to the heart; and that pulſion, if there were any, muſt neceſſarily be exerted with prodigious force, to be able to drive the ſap through the finer capillaries. So that, if there be a return of the ſap downwards, it muſt be by attraction, and that a very powerful one, as we may ſee by many of theſe experiments. But it is hard to conceive what and where that power is which can be equivalent to that proviſion nature has made for the aſcent of the ſap in conſequence of the great perſpiration of the leaves.

" The inſtances of the jeſſamine tree, and of the paſſion-tree, have been looked upon as ſtrong proofs of the circulation of the ſap, becauſe their branches, which were far below the inoculated bud, were gilded: but we have many viſible proofs in the vine, and other bleeding trees, of the ſap's receding back and puſhing forwards alternately, at different times of the day and night. And there is great reaſon to think that the ſap of all other trees has ſuch an alternate receding and progreſſive motion, occaſioned by the alternacies of day and night, warm and cool, moiſt and dry.

" For the ſap in all vegetables does probably recede in ſome meaſure from the tops of the branches, as the ſun leaves them; becauſe, its rarefying power then ceaſing, the greatly rarefied ſap, and air mixed with it, will condenſe, and take up leſs room than they did, and the dew and rain will then be ſtrongly imbibed by the leaves: whereby the body and branches of the vegetable, which have been much exhauſted by the great evaporation of the day, may at night imbibe ſap and dew from the leaves; for, by ſeveral experiments, plants were found to increaſe conſiderably in weight, in dewy and moiſt nights. And by other experiments on the vine, it was found that the trunk and branches of vines were always in an imbibing ſtate, cauſed by the great perſpiration of the leaves, except in the bleeding ſeaſon; but when at night that perſpiring power ceaſes, then the contrary imbibing power will prevail, and draw the ſap and dew from the leaves, as well as moiſture from the roots.

" And we have a further proof of this by fixing mercurial gauges to the ſtems of ſeveral trees which do not bleed, whereby it is found that they are always in a ſtrongly imbibing ſtate, by drawing up the mercury ſeveral inches; whence it is eaſy to conceive how ſome of the particles of the gilded bud in the inoculated jeſſamine may be abſorbed by it, and thereby communicate their gilding miaſma to the ſap of other branches; eſpecially when, ſome months after the inoculation, the ſtock of the inoculated jeſſamine is cut off a little above the bud; whereby the ſtock, which was the counteracting part to the ſtem, being taken away, the ſtem attracts more vigorouſly from the bud.

" Another argument for the circulation of the ſap is, that ſome ſorts of the graffs will infect and canker the ſtocks they are grafted on; but by mercurial gauges fixed to freſh-cut ſtems of trees, it is evident that thoſe ſtems were in a ſtrongly imbibing ſtate; and conſequently the cankered ſtocks might very likely draw ſap from the graff, as well as the graff alternately from the ſtock; juſt in the ſame manner as leaves and branches do from each other, in the viciſſitudes of day and night. And this imbibing power of the ſtock is ſo great, where only ſome of the branches of a tree are grafted, that the remaining branches of the ſtock will, by their ſtrong attraction, ſtarve thoſe graffs; for which reaſon it is uſual to cut off the greateſt part of the branches of the ſtock, leaving only a few ſmall ones to draw up the ſap.

" The inſtance of the ilex grafted upon the Engliſh oak ſeems to afford a very conſiderable argument againſt a circulation. For, if there were a free uniform circulation of the ſap through the oak and ilex, why ſhould the leaves of the oak fall in winter, and not thoſe of the ilex?

" Another argument againſt an uniform circulation of the ſap in trees, as in animals, may be drawn from an experiment, where it was found, by the three mercurial gauges fixed to the ſame vine, that while ſome of its branches changed their ſtate of protruding ſap into a ſtate of imbibing, others continued protruding ſap; one nine, and the other thirteen, days longer."

To this reaſoning of Dr. Hales we ſhall ſubjoin an experiment made by Mr. Muſtel of the Academy of Sciences at Rouen, which ſeems deciſive againſt the doctrine of circulation. His account of it is as follows:—" On the 12th of January I placed ſeveral ſhrubs in pots againſt the windows of my hot-houſe, ſome within the houſe and others without it. Through holes made for this purpoſe in the panes of glaſs, I paſſed a branch of each of the ſhrubs, ſo that thoſe on the inſide had a branch without, and thoſe on the outſide one within; after this, I took care that the holes ſhould be exactly cloſed and luted. This inverſe experiment, I thought, if followed cloſely, could not fail affording ſufficient points of compariſon, to trace out the differences, by the obſervation of the effects.

" The 20th of January, a week after this diſpoſition, all the branches that were in the hot-houſe began to diſcloſe their buds. In the beginning of February there appeared leaves; and towards the end of it, ſhoots of a conſiderable length, which preſented the young flowers. A dwarf apple-tree, and ſeveral roſe-trees, being ſubmitted to the ſame experiment, ſhowed the ſame appearance then as they commonly put on in May; in ſhort, all the branches which were within the hot-houſe, and conſequently kept in the warm air, were green at the end of February, and had their ſhoots in great forwardneſs. Very different were thoſe parts of the ſame tree which were without and expoſed to the cold. None of theſe gave the leaſt ſign of vegetation; and the froſt, which was intenſe at that time, broke a roſe-pot placed on the outſide, and killed ſome of the branches of that very tree which, on the inſide, was every day putting forth more and more ſhoots, leaves, and buds; ſo that it was in full vegetation on one ſide, whilſt frozen on the other.

"The continuance of the froſt occaſioned no change in any of the internal branches. They all continued in a very briſk and verdant ſtate, as if they did not belong to the tree, which on the outſide appeared in the ſtate of the greateſt ſuffering. On the 15th of March, notwithſtanding the ſeverity of the ſeaſon, all was in full bloom. The apple-tree had its root, its ſtem, and part of its branches, in the hot-houſe. Theſe branches were covered with leaves and flowers; but the branches of the ſame tree, which were carried on the outſide, and expoſed to the cold air, did not in the leaſt partake of the activity of the reſt, but were abſolutely in the ſame ſtate which all trees are in during winter. A roſe-tree, in the ſame poſition, ſhowed long ſhoots with leaves and buds; it had even ſhot a vigorous branch upon its ſtalk; whilſt a branch which paſſed through to the outſide had not begun to produce any thing, but was in the ſame ſtate with other roſe-trees left in the ground. This branch is 4 lines in diameter, and 18 inches high.

"The roſe-tree on the outſide was in the ſame ſtate; but one of its branches drawn through to the inſide of the hot-houſe was covered with leaves and roſe-buds. It was not without aſtoniſhment that I ſaw this branch ſhoot as briſkly as the roſe-tree which was in the hot-houſe, whoſe roots and ſtalk, expoſed as they were to the warm air, ought, it ſhould ſeem, to have made it get forwarder than a branch belonging to a tree whoſe roots, trunk, and all its other branches, were at the very time froſt-nipped. Notwithſtanding this, the branch did not ſeem affected by the ſtate of its trunk; but the action of the heat upon it produced the ſame effect as if the whole tree had been in the hot-houſe."

Of the Perpendicularity of Plants.—This is a curious phenomenon in natural hiſtory, which was firſt obſerved by M. Dodart, and publiſhed in an eſſay on the affectation of perpendicularity obſerved in the ſtems or ſtalks of all plants, in the roots of many, and even in their branches, as much as poſſible. Though almoſt all plants riſe a little crooked, yet the ſtems ſhoot up perpendicularly, and the roots ſink down perpendicularly: even thoſe, which by the declivity of the ſoil come out inclined, or thoſe which are diverted out of the perpendicular by any violent means, again redreſs and ſtraighten themſelves and recover their perpendicularity, by making a ſecond and contrary bend or elbow without rectifying the firſt. We commonly look upon this affectation without any ſurpriſe; but the naturaliſt who knows what a plant is, and how it is formed, finds it a ſubject of aſtoniſhment.

Each ſeed we know contains in it a little plant, already formed, and needing nothing but to be unfolded; the little plant has its root; and the pulp, which is uſually ſeparated into two lobes, is the foundation of the firſt food it draws by its root when it begins to germinate. If a ſeed in the earth therefore be diſpoſed ſo as that the root of the little plant be turned downwards, and the ſtem upwards, and even perpendicularly upwards, it is eaſy to conceive that the little plant coming to unfold itſelf, its ſtalk and root need only follow the direction they have to grow perpendicularly. But we know that the ſeeds of plants, whether ſown of themſelves or by man, fall in the ground at random; and among the great variety of ſituations with regard to the ſtalk of their plant, the perpendicular one upwards is but one. In all the reſt, therefore, it is neceſſary that the ſtalk rectify itſelf, ſo as to get out of the ground: but what force effects this change, which is unqueſtionably a violent action? Does the ſtalk find a leſs load of earth above it, and therefore go naturally that way where it finds the leaſt obſtacle? Were this ſo, the little root, when it happens to be uppermoſt, muſt alſo follow that direction, and mount up.

To account for two ſuch different actions, M. Dodart ſuppoſes that the fibres of the ſtalks are of ſuch a nature as to be contracted and ſhortened by the heat of the ſun, and lengthened out by the moiſture of the earth; and, on the contrary, that the fibres of the roots are contracted by the moiſture of the earth, and lengthened by the heat of the ſun. When the plantule therefore is inverted, and the root at the top, the fibres which compoſe one of the branches of the root are not alike expoſed to the moiſture of the earth, the lower part being more expoſed than the upper. The lower muſt of courſe contract the moſt; and this contraction is again promoted by the lengthening of the upper, whereon the ſun acts with the greateſt force. This branch of the root muſt therefore recoil towards the earth, and, inſinuating through the pores thereof, muſt get underneath the bulb, &c. By inverting this reaſoning we diſcover how the ſtalk comes to get uppermoſt.

We ſuppoſe then that the earth attracts the root to itſelf, and that the ſun contributes to its deſcent; and, on the other hand, that the ſun attracts the ſtem, and the earth contributes to ſend it towards the ſame. With reſpect to the ſtraightening of the ſtalks in the open air, our author imagines that it ariſes from the impreſſion of external cauſes, particularly the ſun and rain: for the upper part of a ſtalk that is bent is more expoſed to the rain, dew, and even the ſun, &c. than the under; and theſe cauſes, in a certain ſtructure of the fibres, both equally tend to ſtraighten the part moſt expoſed by the ſhortening they ſucceſſively occaſion in it; for moiſture ſhortens by ſwelling, and heat by diſſipating. What that ſtructure is which gives the fibres ſuch different qualities, or whereon it depends, is a myſtery as yet beyond our depth.

M. de la Hire accounts for the perpendicularity of the ſtems or ſtalks of plants in this manner: he ſuppoſes that the root of plants draws a coarſer and heavier juice, and the ſtem and branches a finer and more volatile one. Moſt naturaliſts indeed conceive the root to be the ſtomach of the plant, where the juices of the earth are ſubtilized ſo as to become able to riſe through the ſtem to the extremity of the branches. This difference of juices ſuppoſes larger pores in the roots than the ſtalk, &c. and, in a word, a different contexture. This difference muſt be found even in the little inviſible plant encloſed in the ſeed: in it, therefore, we may conceive a point of ſeparation; ſuch as, that all on one ſide, for example the root, ſhall be unfolded by the groſſer juices, and all on the other ſide by the more ſubtile ones. Suppoſe the plantule, when its parts begin to unfold, to be entirely inverted, the root at the top, and the ſtalk below; the juices entering the root will be coarſeſt: and when they have opened and enlarged the pores ſo as to admit juices of a determinate weight, thoſe juices preſſing the root more and more will drive it downwards; and this will increaſe as the root is more extended or enlarged; for, the point of ſeparation being conceived as the fixed point of a lever, they will act by the longer arm. The volatile juices at the ſame time having penetrated the ſtalk, will give it a direction from below upwards; and, by reaſon of the lever, will give it more and more every day. The little plant is thus turned on its fixed point of ſeparation till it become perfectly erect.

When the plant is thus erected, the ſtalk ſhould ſtill riſe perpendicularly, in order to give it the more firm biding, and enable it to withſtand the effort of wind and weather. M. Parent thus accounts for this effect: If the nutritious juice which arrived at the extremity of a riſing ſtalk evaporate, the weight of the air which encompaſſes it on all ſides will make it aſcend vertically: but if, inſtead of evaporating, it congeal, and remain fixed to that extremity whence it was ready to go off, the weight of the air will give it the ſame direction; ſo that the ſtalk will have acquired a ſmall new part vertically laid over it, juſt as the flame in a candle held in any way obliquely to the horizon ſtill continues vertical by the preſſure of the atmoſphere. The new drops of juice that ſucceed will follow the ſame direction; and as all together form the ſtalk, that muſt of courſe be vertical, unleſs ſome particular circumſtance intervene.

The branches, which are at firſt ſuppoſed to proceed laterally out of the ſtalk in the firſt embryo of the plant, though they ſhould even come out in a horizontal direction, muſt alſo raiſe themſelves upwards by the conſtant direction of the nutritious juice, which at firſt ſcarce meets any reſiſtance in a tender ſupple branch; and afterwards, even though the branch grow more firm, it will act with the more advantage; ſince the branch, being become longer, furniſhes it with a longer arm or lever. The ſlender action of even a little drop becomes very conſiderable by its continuity, and by the aſſiſtance of ſuch circumſtances. Hence may we account for that regular ſituation and direction of the branches, ſince they all make nearly the ſame conſtant angle of 45° with the ſtem, and with one another.

M. Aſtruc accounts for the perpendicularity of the ſtems, and their redreſſing themſelves, thus: 1. He thinks the nutritious juice ariſes from the circumference of the plant, and terminates in the pith: and, 2. That fluids, contained in tubes either parallel or oblique to the horizon, gravitate on the lower part of the tubes, and not at all on the upper. Hence it follows, that, in a plant placed either obliquely or parallel to the horizon, the nutritious juice will act more on the lower part of the canals than on the upper; and by this means they will inſinuate more into the canals communicating therewith, and be collected more copiouſly therein: thus, the parts on the lower ſide will receive more accretion and be more nouriſhed than thoſe on the upper; the extremity of the plant will therefore be obliged to bend upwards.

This principle brings the ſeed into its due ſituation at firſt. In a bean planted upſide down, the plume and radicle may be ſeen with the naked eye ſhooting at firſt directly for about an inch; after which they begin to bend, the one downward, and the other upward. The ſame is the caſe in a heap of barley to be made into malt, or in a quantity of acorns laid to ſprout in a moiſt place, &c. Each grain of barley and each acorn has a different ſituation; and yet every ſprout tends directly upward, and every root downward, and the curvity or bend they make is greater or leſs as their ſituation approaches more or leſs to the direction wherein no curvature at all would be neceſſary. But two ſuch oppoſite motions cannot poſſibly ariſe without ſuppoſing ſome difference between the two parts: the only one we know of is, that the plume is fed by a juice imparted to it by tubes parallel to its ſides, whereas the radicle imbibes its nouriſhment at every pore in its ſurface. When the plume therefore is either parallel or inclined to the horizon, the nutritious juice, feeding the lower parts more than the upper, will determine its extremes to turn upward, for the reaſons before given. On the contrary, when the radicle is in the like ſituation, the nutritious juice penetrating through the upper part more copiouſly than through the under, there will be a greater accretion of the former than of the latter, and the radicle will therefore be bent downwards; and this mutual curvity of the plume and radicle muſt continue till ſuch time as their ſides are nouriſhed alike, which cannot be till they are perpendicular.

Of the Food of Plants.—This hath been ſo fully diſcuſſed under the article Husbandry, that little remains to be ſaid upon the ſubject in this place. The method of making dephlogiſticated or vital air *de novo*, is now ſo much improved, that numberleſs experiments may be made with it both on animals and vegetables. It appears, indeed, that theſe two parts of the creation are a kind of counterbalance to one another; and the noxious parts or excrements of the one prove ſalutary food to the other. Thus, from the animal body continually paſs off certain effluvia, which vitiate or *phlogiſticate* the air. Nothing can be more prejudicial to animal life than an accumulation of theſe effluvia: on the other hand, nothing is more favourable to vegetables than thoſe excrementitious effluvia of animals; and accordingly they greedily abſorb them from the earth, or from the air. With reſpect to the excrementitious parts of living vegetables, the caſe is reverſed. The pureſt air is the common effluvium which paſſes off from vegetables; and this, however favourable to animal life, is by no means ſo to vegetable; whence we have an additional proof of the doctrine concerning the food of plants, delivered under the article Husbandry.

With regard to the effects of other kinds of air on vegetation, a difference of ſome conſequence took place between Dr. Prieſtley and Dr. Percival. The former, in the firſt volume of his Experiments and Obſervations on Air, had aſſerted that fixed air is fatal to vegetable as well as to animal life. This opinion, however, was oppoſed by Dr. Percival, and the contrary one adopted by Dr. Hunter of York in the Georgical Eſſays, vol. v. The experiments related by theſe two gentlemen would indeed have been deciſive, had they been made with ſufficient accuracy. That this was the caſe, however, Dr. Prieſtley denies; and in the 3d volume of his Treatiſe on Air has fully detected the miſtakes in Dr. Percival's experiments; which proceeded in fact from his having uſed, not fixed air, but common air mixed with a ſmall quantity of fixed air. His experiments, when repeated with the pureſt fixed air, and in the moſt careful manner, were always attended with the ſame effect, namely, the killing of the plant.

It had alſo been aſſerted by Drs. Percival and Hunter, that water impregnated with fixed air was more favourable to vegetation than ſimple water. This opinion was likewiſe examined by Dr. Prieſtley: however, his experiments were indeciſive, but ſeem rather unfavourable to the uſe of fixed air than otherwiſe.

Another very remarkable fact with regard to the food of plants has been diſcovered by Dr. Prieſtley; namely, that ſome of them, ſuch as the willow, comfrey, and duck-weed, are nouriſhed by inflammable air. The firſt, he ſays, flouriſhes in this ſpecies of air ſo remarkably, that "it may be ſaid to feed upon it with great avidity. This proceſs terminates in the change of what remains of the inflammable air into phlogiſticated air, and ſometimes into a ſpecies of air as good as common air, or even better; ſo that it muſt be the *inflammable principle* in the air that the plant takes, converting it, no doubt, into its proper nouriſhment."

What the followers of Stahl call phlogiſticated air and inflammable air, are ſo cloſely allied to each other, that it is no wonder they ſhould ſerve promiſcuouſly for the food of plants. The reaſon why both are not agreeable to all kinds of plants, moſt probably is the different quantity of phlogiſtic matter contained in them, and the different action of the latent fire they contain: for all plants do not require an equal quantity of nouriſhment; and ſuch as require but little, will be deſtroyed by having too much. The action of heat alſo is eſſentially neceſſary to vegetation; and it is probable that very much of this principle is abſorbed from the air by vegetables. But if the air by which plants are partly nouriſhed contains too much of that principle, it is very probable that they may be deſtroyed from this cauſe as well as the other; and thus inflammable air, which contains a vaſt quantity of that active principle, may deſtroy ſuch plants as grow in a dry ſoil, though it preſerves thoſe which grow in a wet one. See VEGETATION.

Diſſemination of PLANTS.—So great are the prolific powers of the vegetable kingdom, that a ſingle plant almoſt of any kind, if left to itſelf, would, in a ſhort time, over-run the whole world. Indeed, ſuppoſing the plant to have been only a ſingle annual, with two ſeeds, it would, in 20 years, produce more than a million of its own ſpecies; what numbers then muſt have been produced by a plant whoſe ſeeds are ſo numerous as many of thoſe with which we are acquainted! See NATURAL *Hiſtory*. In that part of our work we have given particular examples of the very prolific nature of plants, which we need not repeat here; and we have made ſome obſervations on the means by which they are carried to diſtant places. This is a very curious matter of fact, and as ſuch we ſhall now give a fuller account of it.

If nature had appointed no means for the ſcattering of theſe numerous ſeeds, but allowed them to fall down in the place where they grew, the young vegetables muſt of neceſſity have choked one another as they grew up, and not a ſingle plant could have arrived at perfection. But ſo many ways are there appointed for the diſſemination of plants, that we ſee they not only do not hinder each others growth, but a ſingle plant will in a ſhort time ſpread through different countries. The moſt evident means for this purpoſe are,

1. The force of the air.—That the efficacy of this may be the greater, nature has raiſed the ſeeds of vegetables upon ſtalks, ſo that the wind has thus an opportunity of acting upon them with the greater advantage. The ſeed-capſules alſo open at the apex, leſt the ripe ſeeds ſhould drop out without being widely diſperſed by the wind. Others are furniſhed with wings, and a pappous down, by which, after they come to maturity, they are carried up into the air, and have been known to fly the diſtance of 50 miles: 138 genera are found to have winged ſeeds.

2. In ſome plants the ſeed-veſſels open with violence when the ſeeds are ripe, and thus throw them to a conſiderable diſtance; and we have an enumeration of 50 genera whoſe ſeeds are thus diſperſed.

3. Other ſeeds are furniſhed with hooks, by which, when ripe, they adhere to the coats of animals, and are carried by them to their lodging-places. Linnæus reckons 50 genera armed in this manner.

4. Many ſeeds are diſperſed by means of birds and other animals; who pick up the berries, and afterwards eject the ſeeds uninjured. Thus, the fox diſſeminates the privet, and man many ſpecies of fruit. The plants found growing upon walls and houſes, on the tops of high rocks, &c. are moſtly brought there by birds; and it is univerſally known, that by manuring a field with new dung, innumerable weeds will ſpring up which did not exiſt there before: 193 ſpecies are reckoned up which may be diſſeminated in this manner.

5. The growth of other ſeeds is promoted by animals in a different way. While ſome are eaten, others are ſcattered and trodden into the ground by them. The ſquirrel gnaws the cones of the pine, and many of the ſeeds fall out. When the loxica eats off their bark, almoſt his only food, many of their ſeeds are committed to the earth, or mixed in the moraſs with moſs, where he had retired. The glandularia, when ſhe hides up her nuts, often forgets them, and they ſtrike root The ſame is obſervable of the walnut; mice collect and bury great quantities of them; and being afterwards killed by different animals, the nuts germinate.

6. We are aſtoniſhed to find moſſes, fungi, byſſus, and mucor, growing every where: but it is for want of reflecting that their ſeeds are ſo minute that they are almoſt inviſible to the naked eye. They float in the air like atoms, and are dropped everywhere, but grow only in thoſe places where there was no vegetation before; and hence we find the ſame moſſes in North America and in Europe.

7. Seeds are alſo diſperſed by the ocean, and by rivers. “In Lapland (ſays Linnæus), we ſee the moſt evident proofs how far rivers contribute to depoſit the ſeeds of plants. I have ſeen alpine plants growing upon their ſhores frequently 36 miles diſtant from the alps; for, their ſeeds falling into the rivers, and being carried along and left by the ſtream, take root there. We may gather likewiſe from many circumſtances how much the ſea furthers this buſineſs.—In Roſlagia, the iſland of Græſœa, Oeland, Gothland, and the ſhores of Scania, there are many foreign and German plants not yet naturalized in Sweden. The centaury is a German plant, whoſe ſeeds being carried by the wind into the ſea, the waves landed this foreigner upon the coaſts of Sweden. I was aſtoniſhed to ſee the veronica maritima, a German plant, growing at Tornea, which hitherto had been found only in Græſœa; the ſea was the vehicle by which this plant was tranſported thither from Germany; or poſſibly it was brought from Germany to Græſœa, and from thence to Tornea. Many have imagined, but erroneouſly, that ſeed corrupts in water, and loſes its principle of vegetation. Water at the bottom of the ſea is ſeldom warm enough to deſtroy ſeeds; we have ſeen water cover the ſurface of a field for a whole winter, while the ſeed which it contained remained unhurt, unleſs at the beginning of ſpring the waters were let down ſo low by drains, that the warmth of the ſun-beams reached to the bottom. Then the ſeeds germinate, but preſently become putreſcent; ſo that for the reſt of the year the earth remains naked and barren. Rain and ſhowers carry ſeeds into the cracks of the earth, ſtreams, and rivers; which laſt, conveying them to a diſtance from their native places, plant them in a foreign ſoil.”

8. Laſtly, ſome ſeeds aſſiſt their projection to a diſtance in a very ſurpriſing manner. The crupina, a ſpecies of centaury, has its ſeeds covered over with erect briſtles, by whoſe aſſiſtance it creeps and moves about in ſuch a manner, that it is by no means to be kept in the hand. If you confine one of them between the ſtocking and the foot, it creeps out either at the ſleeve or neck-band, travelling over the whole body. If the bearded oat, after harveſt, be left with other grain in the barn, it extricates itſelf from the glume; nor does it ſtop in its progreſs till it gets to the walls of the building. Hence, ſays Linnæus, the Dalecarlian, after he has cut and carried it into the barn, in a few days finds all the glumes empty, and the oats ſeparate from them; for every oat has a ſpiral ariſta or beard annexed to it, which is contracted in wet, and extended in dry weather,. When the ſpiral is contracted, it drags the oat along with it: the ariſta being bearded with minute hairs pointing downward, the grain neceſſarily follows it; but when it expands again, the oat does not go back to its former place, the roughneſs of the beard the contrary way preventing its return. If you take the ſeeds of equiſetum, or fern, theſe being laid upon paper, and viewed in a microſcope, will be ſeen to leap over any obſtacle as if they had feet; by which they are ſeparated and diſperſed one from another; ſo that a perſon ignorant of this property would pronounce theſe ſeeds to be ſo many mites or ſmall inſects.

We cannot finiſh this article without remarking, that many ingenious men* believe that plants have a power of perception.

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* The ingenious Dr. Bell held this opinion, as appears from the cloſe of his *Theſis de Phyſiologia Plantarum*, which was publiſhed at Edinburgh, June 1777, and a tranſlation of which by Dr. Currie we find in the ſecond volume of the Mancheſter Tranſactions, where our readers will alſo find memoirs of its author. Dr. Currie informs us, that Dr Hope, the late excellent

Of this opinion we ſhall now give an account from the ſecond volume of the Mancheſter Tranſactions, where we find ſome *ſpeculations on the perceptive power of vegetables by Dr. Percival*, who attempts to ſhow, by the ſeveral analogies of organization, life, inſtinct, ſpontaneity, and ſelf-motion, that plants, like animals, are endued both with the powers of perception and enjoyment. The attempt is ingenious, and is ingeniouſly ſupported, but in our opinion fails to convince. That there is an analogy between animals and vegetables is certain; but we cannot from thence conclude that they either perceive or enjoy. Botaniſts have, it is true, derived from *anatomy* and *phyſiology*, almoſt all the terms employed in the deſcription of plants. But we cannot from thence conclude, that their organization, though it bears an analogy to that of animals, is the ſign of *a living principle*, if to this *principle* we annex the idea of *perception*. Yet ſo fully is our author convinced of the truth of it, that he does not think it extravagant to ſuppoſe, that, in ſome future period, perceptivity may be diſcovered to extend even beyond the limits now aſſigned to vegetable life. Corallines, madrepores, millepores, and ſpunges, were formerly conſidered as foſſil bodies: but the experiments of count Marſigli evinced, that they are endued with life, and led him to claſs them with the maritime plants. And the obſervations of Ellis, Juſſieu, and Peyſonel, have ſince raiſed them to the rank of animals. The detection of error in long-eſtabliſhed opinions concerning one branch of natural knowledge, juſtifies the ſuſpicion of its exiſtence in others which are nearly allied to it. And it will appear from the proſecution of our inquiry into the inſtincts, ſpontaneity, and ſelf-moving power of vegetables, that the ſuſpicion is not without foundation.

He then goes on to draw a compariſon between the inſtincts of animals and thoſe of vegetables: the calf, as ſoon as it comes into the world, applies to the teats of the cow; and the duckling, though hatched under a hen, runs to the water.

"Inſtincts analogous to theſe (ſays our author) operate with equal energy on the vegetable tribe. A ſeed contains a germ, or plant in miniature, and a radicle, or little root, intended by nature to ſupply it with nouriſhment. If the ſeed be ſown in an inverted poſition, ſtill each part purſues its proper direction. The plumula turns upward, and the radicle ſtrikes downward into the ground. A hop-plant, turning round a pole, follows the courſe of the ſun, from ſouth to weſt, and ſoon dies when forced into an oppoſite line of motion: but remove the obſtacle, and the plant will quickly return to its ordinary poſition. The branches of a honeyſuckle ſhoot out longitudinally, till they become unable to bear their own weight; and then ſtrengthen themſelves, by changing their form into a ſpiral: when they meet with other living branches, of the ſame kind, they coaleſce, for mutual ſupport, and one ſpiral turns to the right and the other to the left; thus ſeeking, by an inſtinctive impulſe, ſome body on which to climb, and increaſing the probability of finding one by the diverſity of their courſe: for, if the auxiliary branch be dead, the other uniformly winds itſelf round from the right to the left.

"Theſe examples of the inſtinctive economy of vegetables have been purpoſely taken from ſubjects familiar to our daily obſervation. But the plants of warmer climates, were we ſufficiently acquainted with them, would probably furniſh better illuſtrations of this acknowledged power of animality: and I ſhall briefly recite the hiſtory of a very curious exotic, which has been delivered to us from good authority, and confirmed by the obſervations of ſeveral European botaniſts."

The Doctor then goes on to give a deſcription of the *dionæa muſcipula* *, and concludes, that if in what he has adduced he has furniſhed any preſumptive proof of the inſtinctive power of vegetables, it will neceſſarily follow that they are endued with ſome degree of ſpontaneity. More fully to evince this, however, the Doctor points out a few of thoſe phenomena in the vegetable kingdom which ſeem to indicate ſpontaneity. "Several years ago (ſays he), whilſt engaged in a courſe of experiments to aſcertain the influence of fixed air on vegetation, the following fact repeatedly occurred to me: A ſprig of mint, ſuſpended by the root, with the head downwards, in the middle glaſs veſſel of Dr. Nooth's machine, continued to thrive vigorouſly, without any other pabulum than what was ſupplied by the ſtream of mephitic gas to which it was expoſed. In 24 hours the ſtem formed into a curve, the head became erect, and gradually aſcended towards the mouth of the veſſel; thus producing, by ſucceſſive efforts, a new and unuſual configuration of its parts. Such exertions in the ſprig of mint, to rectify its inverted poſition, and to remove from a foreign to its natural element, ſeems to evince a volition to avoid what was evil, and to recover what had been experienced to be good. If a plant, in a garden-pot, be placed in a room which has no light except from a hole in the wall, it will ſhoot towards the hole, paſs through it into the open air, and then vegetate upwards in its proper direction. Lord Kames relates, that, 'amongſt the ruins of New Abbey, formerly a monaſtery in Galloway, there grows on the top of a wall a plane-tree, 20 feet high. Straightened for nouriſhment in that barren ſituation, it ſeveral years ago directed roots down the ſide of the wall till they reached the ground ten feet below: and now the nouriſhment it afforded

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profeſſor of botany in Edinburgh, in his courſe of lectures, uſed to ſpeak of Dr. Bell with the higheſt eſteem; but did not approve of the idea which he entertained reſpecting the feeling or perception of plants.

* Dr. Watſon, the preſent biſhop of Landaff, who has eſpouſed the ſame ſide of the queſtion with Dr. Percival (ſee the 5th vol. of his *Chemical Eſſays*), reaſons thus on the motions of vegetables: "Whatever can produce any effect (ſays he) upon an animal organ, as the impact of external bodies, heat and cold, the vapour of burning ſulphur, of volatile alkali, want of air, &c. are found to act alſo upon the plants called *ſenſitive*. But not to inſiſt upon any more inſtances, the muſcular motions of the dionæa muſcipula, lately brought into Europe from America, ſeem far ſuperior in quickneſs to thoſe of a variety of animals. Now, to refer the muſcular motions of ſhell-fiſh and zoophytes to an internal principle of volition, to make them indicative of the perceptivity of the being, and to attribute the more notable ones of vegetables to certain mechanical dilatations and contractions of parts occaſioned by external impulſe, is to err againſt that rule of philoſophizing which aſſigns the ſame cauſes for effects of the ſame kind. The motions in both caſes are equally accommodated to the preſervation of the being to which they belong, are equally diſtinct and uniform, and ſhould be equally derived from mechaniſm, or equally admitted as criterions of perception.

"I am ſenſible that theſe and other ſimilar motions of vegetables may by ſome be conſidered as analogous to the automatic or involuntary motions of animals; but as it is not yet determined amongſt the phyſiologiſts, whether the motion of the heart, the periſtaltic motion of the bowels, the contractions obſervable upon external impulſe in the muſcles of animals deprived of their heads and hearts, be attributable to an irritability unaccompanied with perceptivity, or to an uneaſy ſenſation, there ſeems to be no reaſon for entering into ſo obſcure a diſquiſition; eſpecially ſince irritability, if admitted as the cauſe of the motions of vegetables, muſt *a fortiori* be admitted as the cauſe of the leſs exquiſite and diſcernible motions of beings univerſally referred to the animal kingdom."

to theſe roots, during the time of deſcending, is amply repaid; having every year ſince that time made vigorous ſhoots. From the top of the wall to the ſurface of the earth, theſe roots have not thrown out a ſimple fibre, but are now united into a pretty thick hard root.

" The regular movements by which the ſun-flower preſents its ſplendid diſk to the ſun have been known to naturaliſts, and celebrated by poets, both of ancient and modern times. Ovid founds upon it a beautiful ſtory; and Thomſon deſcribes it as an attachment of love to the celeſtial luminary.

> ' But one, the lofty follower of the ſun,
> ' Sad when he ſets, ſhuts up her yellow leaves,
> ' Drooping all night; and when he warm returns,
> ' Points her enamour'd boſom to his ray.'
>
> SUMMER, line 216.

Dr. Percival next touches on motion; he mentions corallines, ſea-pens, oyſters, &c. as endued with the power of motion in a very ſmall degree, and then he ſpeaks in the following manner: " Mr. Miller (ſays he), in his late account of the iſland of Sumatra, mentions a ſpecies of coral, which the inhabitants have miſtaken for a plant, and have denominated it *lalan-cout*, or ſea-graſs. It is found in ſhallow bays, where it appears like a ſtraight ſtick, but when touched withdraws itſelf into the ſand. Now, if ſelf-moving faculties like theſe indicate animality, can ſuch a diſtinction be denied to vegetables poſſeſſed of them in an equal or ſuperior degree? The water-lily, be the pond deep or ſhallow in which it grows, puſhes up its flower-ſtems till they reach the open air, that the farina fecundans may perform without injury its proper office. About ſeven in the morning the ſtalk erects itſelf, and the flowers riſe above the ſurface of the water: in this ſtate they continue till four in the afternoon, when the ſtalk becomes relaxed, and the flowers ſink and cloſe. The motions of the ſenſitive plant have been long noticed with admiration, as exhibiting the moſt obvious ſigns of perceptivity. And if we admit ſuch motions as criteria of a like power in other beings, to attribute them in this inſtance to mere mechaniſm, actuated ſolely by external impulſe, is to deviate from the ſoundeſt rule of philoſophizing, which directs us not to multiply cauſes when the effects appear to be the ſame. Neither will the laws of electricity better ſolve the phenomena of this animated vegetable: for its leaves are equally affected by the contact of electric and non-electric bodies; ſhow no change in their ſenſibility whether the atmoſphere be dry or moiſt; and inſtantly cloſe when the vapour of volatile alkali or the fumes of burning ſulphur are applied to them. The powers of chemical ſtimuli to produce contractions in the fibres of this plant may perhaps lead ſome philoſophers to refer them to the *vis inſita*, or irritability, which they aſſign to certain parts of organized matter, totally diſtinct from, and independent of, any ſentient energy. But the hypotheſis is evidently a ſolecism, and refutes itſelf. For the preſence of irritability can only be proved by the experience of irritations, and the idea of irritation involves in it that of feeling.

" But there is a ſpecies of the order of decandria, which conſtantly and uniformly exerts a ſelf-moving power, uninfluenced either by chemical ſtimuli, or by any external impulſe whatſoever. This curious ſhrub, which was unknown to Linnæus, is a native of the Eaſt Indies, but has been cultivated in ſeveral botanical gardens here. I had an opportunity of examining it in the collection of the late Dr. Brown. See HEDYSARUM. I cannot better comment on this wonderful degree of vegetable animation than in the words of Cicero: *Inanimum eſt omne quod pulſu agitatur externo; quod autem eſt animal, id motu cietur interiore et ſuo.*

" I have thus attempted, with the brevity preſcribed by the laws of this ſociety, to extend our views of animated nature; to gratify the mind with the contemplation of multiplied acceſſions to the general aggregate of felicity; and to exalt our conceptions of the wiſdom, power and beneficence of God. In an undertaking never yet accompliſhed, diſappointment can be no diſgrace: in one directed to ſuch noble objects, the motives are a juſtification, independently of ſucceſs. Truth, indeed, obliges me to acknowledge, that I review my ſpeculations with much diffidence; and that I dare not preſume to expect they will produce any permanent conviction in others, becauſe I experience an inſtability of opinion in myſelf. For, to uſe the language of Tully, *Neſcio quomodo, dum lego, aſſentior; cum poſui librum, aſſenſio omnis illa elabitur.* But this ſcepticiſm is perhaps to be aſcribed to the influence of habitual preconceptions, rather than to a deficiency of reaſonable proof. For, beſides the various arguments which have been advanced in favour of vegetable perceptivity, it may be further urged, that the hypotheſis recommends itſelf by its conſonance to thoſe higher analogies of nature, which lead us to conclude, that the greateſt poſſible ſum of happineſs exiſts in the univerſe. The bottom of the ocean is overſpread with plants of the moſt luxuriant magnitude. Immenſe regions of the earth are covered with perennial foreſts. Nor are the Alps, or the Andes, deſtitute of herbage, though buried in deeps of ſnow. And can it be imagined that ſuch profuſion of life ſubſiſts without the leaſt ſenſation or enjoyment? Let us rather, with humble reverence, ſuppoſe, that vegetables participate, in ſome low degree, of the common allotment of vitality; and that our great Creator hath apportioned good to all living things, ' in number, weight, and meaſure.' See SENSITIVE *Plant*, MIMOSA, DIONÆA *Muſcipula*, *Vegetable* MOTION, &c.

To theſe ingenious and ſpirited obſervations we ſhall ſubjoin nothing of our own, but leave our readers to determine for themſelves *. Speculations of this kind, when carried on by ſober men, will never be productive of bad conſequences; but by the ſubtle ſceptic, or the more unwary inquirer, they may be made the engine of very dangerous errors. By this we do not mean to inſinuate that the ſpirit of inquiry ſhould be ſuppreſſed, becauſe that ſpirit, in the hands of weak or of wicked men, may be abuſed. By thoſe, however, who know the bad conſequences that may be drawn, and indeed that have been drawn, from the opinions we have now given an account of, our caution will not be deemed impertinent. See PHYSIOLOGY *paſſim*.

PLANTS *growing on Animals*. See INSECTS *giving root to Plants*.

Sexes of PLANTS. See SEXES and BOTANY.

Colours of PLANTS. See COLOUR *of Plants*.

Colours extracted from PLANTS. See COLOUR-*making*.

Method of Drying and Preſerving PLANTS *for Botaniſts*.— Many methods have been deviſed for the preſervation of plants: we ſhall relate only thoſe that have been found moſt ſucceſsful.

Firſt prepare a preſs, which a workman will make by the following directions: Take two planks of a wood not liable to warp. The planks muſt be two inches thick, 18 inches long, and 12 inches broad. Get four male and four female ſcrews, ſuch as are commonly uſed for ſecuring ſaſh-windows. Let the four female ſcrews be let into the four corners of one of the planks, and correſponding holes made through the four corners of the other plank for the male ſcrews to paſs through, ſo as to allow the two planks to be ſcrewed tightly together. It will not be amiſs to face the bearing of the male ſcrews upon the wood with iron plates; and if the iron plates went acroſs from corner to corner of the wood, it would be a good ſecurity againſt the warping.

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* In the 2d volume of *Tranſactions of the Linnæan Society*, we find Dr. Percival's reaſoning very ably combated, as far as he draws his conſequences from the external motions of plants; where it is argued, that theſe motions, though in ſome reſpects ſimilar to thoſe of animals, can and ought to be explained without concluding that they are endowed either with perception or volition. Mr. Townſon concludes his paper in theſe words: " When all is conſidered (ſays he), I think we ſhall place this opinion amongſt the many ingenious flights of the imagination, and ſoberly follow that blind impulſe which leads us naturally to give ſenſation and perceptivity to animal life, and to deny it to vegetables; and ſo ſtill ſay with Ariſtotle, and our great maſter Linnæus, *Vegetabilia creſcunt & vivunt; animalia creſcunt, vivunt, & ſentiunt.*"

Secondly, get half a dozen quires of large ſoft ſpongy paper (ſuch as the ſtationers call *bloſſom blotting paper* is the beſt), and a few ſheets of ſtrong paſteboard.

The plants you wiſh to preſerve ſhould be gathered in a dry day, after the ſun hath exhaled the dew; taking particular care to collect them in that ſtate wherein their generic and ſpecific characters are moſt conſpicuous. Carry them home in a tin-box nine inches long, four inches and a half wide, and one inch and a half deep. Get the box made of the thinneſt tinned iron that can be procured; and let the lid open upon hinges. If any thing happens to prevent the immediate uſe of the ſpecimens you have collected, they will be kept freſh two or three days in this box much better than by putting them in water. When you are going to preſerve them, ſuffer them to lie upon a table until they become limber; and then they ſhould be laid upon a paſteboard, as much as poſſible in their natural form, but at the ſame time with a particular view to their generic and ſpecific characters. For this purpoſe it will be adviſable to ſeparate one of the flowers, and to diſplay the generic character. If the ſpecific character depends upon the flower or upon the root, a particular diſplay of that will be likewiſe neceſſary. When the plant is thus diſpoſed upon the paſteboard, cover it with eight or ten layers of ſpongy paper, and put it into the preſs. Exert only a ſmall degree of preſſure for the firſt two or three days; then examine it, unfold any unnatural plaits, rectify any miſtakes, and, after putting freſh paper over it, ſcrew the preſs harder. In about three days more ſeparate the plant from the paſteboard, if it is ſufficiently firm to allow of a change of place; put it upon a freſh paſteboard, and, covering it with freſh bloſſom-paper, let it remain in the preſs a few days longer. The preſs ſhould ſtand in the ſun-ſhine, or within the influence of a fire.

When it is perfectly dry, the uſual method is to faſten it down, with paſte or gum-water, on the right-hand inner page of a ſheet of large ſtrong writing-paper. It requires ſome dexterity to glue the plant neatly down, ſo that none of the gum or paſte may appear to defile the paper. Preſs it gently again for a day or two, with a half ſheet of bloſſom-paper betwixt the folds of the writing-paper. When it is quite dry, write upon the left-hand inner page of the paper the name of the plant; the ſpecific character; the place where and the time when it was found; and any other remarks you may think proper. Upon the back of the ſame page, near the fold of the paper, write the name of the plant, and then place it in your cabinet. A ſmall quantity of finely powdered arſenic, or corroſive ſublimate, is uſually mixed with the paſte or gum-water, to prevent the devaſtations of inſects; but the ſeeds of ſtaves-acre finely powdered will anſwer the ſame purpoſe, without being liable to corrode or to change the colour of the more delicate plants. Some people put the dried plants into the ſheets of writing-paper, without faſtening them down at all; and others only faſten them by means of ſmall ſlips of paper, paſted acroſs the ſtem or branches. Where the ſpecies of any genus are numerous, and the ſpecimens are ſmall, ſeveral of them may be put into one ſheet of paper.

Another more expeditious method is to take the plants out of the preſs after the firſt or ſecond day; let them remain upon the paſteboard; cover them with five or ſix leaves of bloſſom paper, and iron them with a hot ſmoothing-iron until they are perfectly dry. If the iron is too hot, it will change the colours; but ſome people, taught by long practice, will ſucceed very happily. This is quite the beſt method to treat the orchis and other ſlimy mucilaginous plants.

Another method is, to take the plants when freſh gathered, and, inſtead of putting them into the preſs, immediately to faſten them down to the paper with ſtrong gum water: then dip a camel-hair pencil into ſpirit-varniſh, and varniſh the whole ſurface of the plant two or three times over. This method ſucceeds very well with plants that are readily laid flat, and it preſerves their colours better than any other. The ſpirit-varniſh is made thus. To a quart of highly rectified ſpirit of wine put five ounces of gum ſandarach; two ounces of maſtich in drops; one ounce of pale gum elemi, and one ounce of oil of ſpike-lavender. Let it ſtand in a warm place, and ſhake it frequently to expedite the ſolution of the gums.

Where no better convenience can be had, the ſpecimens may be diſpoſed ſyſtematically in a large folio book; but a vegetable cabinet is upon all accounts more eligible. In plate 3. there is a ſection of a cabinet, in the true proportions it ought to be made, for containing a complete collection of Britiſh plants. By the aſſiſtance of this drawing, and the adjoining ſcale, a workman will readily make one. The drawers muſt have backs and ſides, but no other front than a ſmall ledge. Each drawer will be 14 inches wide, and 10 inches from the back to the front, after allowing half an inch for the thickneſs of the two ſides, and a quarter of an inch for the thickneſs of the back. The ſides of the drawers, in the part next the front, muſt be ſloped off in a ſerpentine line, ſomething like what the workmen call an *ogee*. The bottoms of the drawers muſt be made to ſlide in grooves cut in the uprights, ſo that no ſpace may be loſt betwixt drawer and drawer. After allowing a quarter of an inch for the thickneſs of the bottom of each drawer, the clear perpendicular ſpace in each muſt be as in the following table:

I. Two tenths of an inch.
II. One inch and two-tenths.
III. Four inches and ſix tenths.
IV. Two inches and three tenths.
V. Seven inches and eight tenths.
VI. Two inches and two tenths.
VII. Two tenths of an inch.
VIII. One inch and four tenths.
IX. Two tenths of an inch.
X. Two inches and eight tenths.
XI. One inch and two tenths.
XII. Three inches and five tenths.
XIII. Two inches and four tenths.
XIV. Three inches and eight tenths.
XV. Three inches and four tenths.
XVI. One inch and three tenths.
XVII. Two inches and eight tenths.
XVIII. Six tenths of an inch.
XIX. Ten inches.
XX. One inch and nine tenths.
XXI. Four inches and four tenths.
XXII. Two inches and ſix tenths.
XXIII. One inch and two tenths.
XXIV. Seventeen inches.

This cabinet ſhuts up with two doors in front; and the whole may ſtand upon a baſe, containing a few drawers for the reception of duplicates and papers.

Foſſil PLANTS. Many ſpecies of tender and herbaceous plants are found at this day, in great abundance, buried at conſiderable depths in the earth, and converted, as it were, into the nature of the matter they lie among; foſſil wood is often found very little altered, and often impregnated with ſubſtances of almoſt all the different foſſil kinds, and lodged in all the ſeveral ſtrata ſometimes firmly imbedded in hard matter, ſometimes looſe but this is by no means the caſe with the tenderer and more delicate ſubjects of the vegetable world. Theſe are uſually immerſed either in a blackiſh ſlaty ſubſtance, found lying over the ſtrata of coal, elſe in looſe nodules of ferruginous matter of a pebble-like form, and they are always altered into the nature of the ſubſtance they lie among: what we meet with of theſe are principally of the fern kind; and what is very ſingular, though a very certain truth, is, that theſe are principally the ferns of American growth, not thoſe of our own climate. The moſt frequent foſſil plants are the polypody, ſpleenwort, oſmund, trichomanes, and the ſeveral larger and ſmaller ferns; but beſides theſe there are alſo found pieces of the equiſetum or horſe-tail, and joints of the ſtellated plants, as the clivers, madder, and the like; and theſe have been too often miſtaken for flowers: ſometimes there are alſo found complete graſſes, or parts of them, as alſo reeds, and other watery plants; ſometimes the ears of corn, and not unfrequently the twigs or bark, and impreſſions of the bark, and fruit of the pine or fir kind, which have been, from their ſcaly appearance, miſtaken for the ſkins of fiſhes; and ſometimes, but that very rarely, we meet with moſſes and ſea-plants.

Many of the ferns not unfrequently found, are of very ſingular kinds, and ſome ſpecies yet unknown to us; and the leaves of ſome appear ſet at regular diſtances, with round protuberances and cavities. The ſtones which contain theſe plants ſplit readily, and are often found to contain, on one ſide, the impreſſion of the plant, and on the other the prominent plant itſelf: and, beſide all that have been mentioned, there have been frequently ſuppoſed to have been found with us ears of common wheat, and of the maize or Indian corn; the firſt being in reality no other than the common endmoſt branches of the firs, and the other the thicker boughs of various ſpecies of that and of the pine kind, with their leaves fallen off: ſuch branches in ſuch a ſtate cannot but afford many irregular tubercles and papillæ, and, in ſome ſpecies, ſuch as are more regularly diſpoſed.

Theſe are the kinds moſt obvious in England; and theſe are either immerſed in the ſlaty ſtone which conſtitutes whole ſtrata, or in flatted nodules, uſually of about three inches broad, which readily ſplit into two pieces on being ſtruck.

They are moſt common in Kent, on coal-pits near Newcaſtle, and the foreſt of Dean in Glouceſterſhire; but are more or leſs found about almoſt all our coal-pits, and many of our iron-mines. Though theſe ſeem the only ſpecies of plants found with us, yet in Germany there are many others, and thoſe found in different ſubſtances. A whitiſh ſtone, a little harder than chalk, frequently contains them: they are found alſo often in a grey ſlaty ſtone of a firmer texture, not unfrequently in a blackiſh one, and at times in many others. Nor are the bodies themſelves leſs various here than the matter in which they are contained: the leaves of trees are found in great abundance, among which thoſe of the willow, poplar, whitethorn, and pear trees, are the moſt common; ſmall branches of box, leaves of the olive-tree, and ſtalks of garden thyme, are alſo found there; and ſometimes ears of the various ſpecies of corn, and the larger as well as the ſmaller moſſes in great abundance.

Theſe ſeem the tender vegetables, or herbaceous plants, certainly found thus immerſed in hard ſtone, and buried at great depths in the earth: others of many kinds there are alſo named by authors; but as in bodies ſo imperfect errors are eaſily fallen into, theſe ſeem all that can be aſcertained beyond mere conjecture.

Plants, *method of preſerving them in their original ſhape and colour.* Waſh a ſufficient quantity of fine ſand, ſo as perfectly to ſeparate it from all other ſubſtances; dry it; paſs it through a ſieve to clear it from any groſs particles which would not riſe in the waſhing: take an earthen veſſel of a proper ſize and form, for every plant and flower which you intend to preſerve; gather your plants and flowers when they are in a ſtate of perfection, and in dry weather, and always with a convenient portion of the ſtalk: heat a little of the dry ſand prepared as above, and lay it in the bottom of the veſſel, ſo as equally to cover it; lay the plant or flower upon it, ſo as that no part of it may touch the ſides of the veſſel: ſift or ſhake in more of the ſame ſand by little and little upon it, ſo that the leaves may be extended by degrees, and without injury, till the plant or flower is covered about two inches thick: put the veſſel into a ſtove or hot-houſe, heated by little and little to the 50th degree; let it ſtand there a day or two, or perhaps more, according to the thickneſs and ſucculence of the flower or plant; then gently ſhake the ſand out upon a ſheet of paper, and take out the plant, which you will find in all its beauty, the ſhape as elegant and the colour as vivid as when it grew.

Some flowers require certain little operations to preſerve the adherence of their petals, particularly the tulip; with reſpect to which it is neceſſary, before it is buried in the ſand, to cut the triangular fruit which riſes in the middle of the flower: for the petals will then remain more firmly attached to the ſtalk.

A hortus ſiccus prepared in this manner would be one of the moſt beautiful and uſeful curioſities that can be.

Moving Plant. See Hedysarum.

Sea Plants. See Sea *Plants.*

Senſitive Plant. See Mimosa and Sensitive *Plant.*

Plant-*Lice*, *Vine-fretters*, or *Pucerons*. See Aphis.

PLANTA, a plant. See Plant.

Planta *Fœminea*, a female plant, is one which bears female flowers only. It is oppoſed to a *male* plant, which bears only male flowers; and to an *androgynous* one, which bears flowers of both ſexes. Female plants are produced from the ſame ſeed with the male, and arrange themſelves under the claſs of diœcia in the ſexual method.

PLANTAGENET, the ſurname of the kings of England from Henry II. to Richard III. incluſive. Antiquarians are much at a loſs to account for the origin of this name; and the beſt derivation they can find for it is, that Fulk, the firſt earl of Anjou of that name, being ſtung with remorſe for ſome wicked action, went in pilgrimage to Jeruſalem as a work of atonement; where being ſoundly ſcourged with broom twigs, which grew plentifully on the ſpot, he ever after took the ſurname of *Plantagenet* or *broomſtalk*, which was retained by his noble poſterity.

PLANTAGO, plantain; a genus of the monogynia order, belonging to the tetrandria claſs of plants. To this genus Linnæus has joined the coronopus and pſyllium of Tournefort. The firſt of theſe is called *hartſhorn*, the latter *fleawort*. Of theſe there are ſeveral diſtinct ſpecies, and ſome varieties; but as they are rarely cultivated in gardens, we ſhall not enumerate them here, and ſhall only mention ſuch of them as grow naturally in Britain. Of the plantain there are the following ſorts: The common broad-leaved plantain, called *weybread*; the great hoary plantain, or lambs-tongue; the narrow-leaved plantain, or ribwort: and the following varieties have alſo been found in England, which are accidental; the beſom-plantain and roſe-plantain. The plantains grow naturally in paſtures in moſt parts of England, and are frequently very troubleſome weeds. The common plantain and ribwort plantain are both uſed in medicine, and are ſo well known as to need no deſcription. They are ſaid to be ſlightly aſtringent; and the green leaves are commonly applied to freſh wounds by the common people.

Of the coronopus, or bucks-horn plantain, there are two varieties growing in England, viz. the common bucks-horn, which grows plentifully on heaths everywhere; and the narrow-leaved Welch ſort, which is found upon many of the Welch mountains. The firſt of theſe was formerly cultivated as a ſalad herb in gardens, but has been long baniſhed from thence for its rank diſagreeable flavour; it is ſometimes uſed in medicine. There has been one ſpecies of pſyllium or fleawort found growing naturally in England, which is uſed in medicine. It was found in the earth thrown out of the bottom of the canals which were dug for the Chelſea water-works, where it grew in great plenty. The ſeeds of it muſt have been buried there ſome ages; for no perſon remembers any of the plants growing in that neighbourhood before. The ſeeds of this ſpecies are ſometimes uſed, as they are imported from the ſouth of France.

PLANTAIN. See Plantago.

Plantain-*Tree*. See Musa.

PLANTATION, in the Weſt Indies, denotes a ſpot of ground which a planter, or perſon arrived in a new colony, pitches on to cultivate for his own uſe, or is aſſigned for that purpoſe. However, the term *plantation* is often uſed in a ſenſe ſynonymous with colony. See Colony.

PLANTERSHIP, in a general ſenſe, the buſineſs of a planter.

Plantership, in the Weſt Indies, denotes the management of a ſugar plantation, including not only the cultivation of the cane, but the various proceſſes for the extraction of the ſugar, together with the making of ſugar-ſpirits. See Rum, Saccharum, and Sugar. To effect a deſign ſo comprehenſive, it is neceſſary for a planter to underſtand every branch of the art preciſely, and to uſe the utmoſt attention and caution both in the laying down and executing of his plans. It is therefore the duty of a good planter to inſpect every part of his plantation with his own eyes; to place his proviſions, ſtores, and utenſils, in regular order, and in ſafe repoſitories, that, by preſerving them in perfection, all kinds of waſte may be prevented. But as negroes, cattle, mules, and horſes, are as it were the nerves of a ſugar-plantation, it is expedient to treat that ſubject with ſome accuracy.

Of Negroes, Cattle, &c.] In the firſt place, then, as it is the intereſt of every planter to preſerve his negroes in health and ſtrength; ſo every act of cruelty is not leſs repugnant to the maſter's real profit, than it is contrary to the laws of humanity: and if a manager conſiders his own eaſe and his employer's intereſt, he will treat all negroes under his care with due benevolence; for good diſcipline is by no means inconſiſtent with humanity: on the contrary, it is evident from experience, that he who feeds his negroes well, proportions their labour to their age, ſex, and ſtrength, and treats them with kindneſs and good nature, will reap a much larger product, and with infinitely more eaſe and ſelf-ſatisfaction, than the moſt cruel taſkmaſter, who ſtarves his negroes, or chaſtiſes them with undue ſeverity. Every planter then (ſays Mr. Martin) who wiſhes to grow rich with eaſe, muſt be a good economiſt; muſt feed his negroes with the moſt wholeſome food, ſufficient to preſerve them in health and vigour. Common experience points out the methods by which a planter may preſerve his people in health and ſtrength. Some of his moſt fruitful land ſhould be allotted to each negro in proportion to his family, and a ſufficient portion of time allowed for the cultivation of it; but becauſe ſuch allotment cannot in long droughts produce enough for his comfortable ſupport, it is the incumbent duty of a good planter to have always his ſtores well filled with Guinea corn, yams, or eddoes, beſides potatoes growing in regular ſucceſſion: for plenty begets cheerfulneſs of heart, as well as ſtrength of body; by which more work is effected in a day by the ſame hands than in a week when enervated by want and ſeverity. Scanty meals may ſuſtain life; but it is evident, that more is requiſite to enable a negro or any other perſon to go through the neceſſary labours. He, therefore, who will reap plentifully, muſt plant great abundance of proviſions as well as ſugar-canes; and it is nature's economy ſo to fructify the ſoil by the growth of yams, plantains, and potatoes, as to yield better harveſts of ſugar, by that very means, than can be produced by many other arts of cultivation. Plantains are the principal ſupport of all the negroes in Jamaica; and are alſo much cultivated, at great expence of manure, in Barbadoes; but ought not to be ſolely depended upon in climates ſubject to hurricanes. A celebrated planter and economiſt of the laſt-mentioned iſland, who raiſed an immenſe fortune from very ſmall beginnings only by planting, affirmed, that he fed conſtantly at leaſt 300 negroes out of 12 acres of plantains. How that excellent produce came to be ſo long neglected in ſome of the iſlands it is hard to gueſs; but at preſent the neglect ſeems to be founded upon a vulgar error, that plantains cannot thrive in any other than low moiſt ſoils. In ſuch places, no doubt they flouriſh moſt luxuriantly; but yet they thrive and bear fruit abundantly on mountains and in marſhes, and in the drieſt black mould, upon marle or rocks, and even in ſharp gravelly ſoils, as may be evinced by numberleſs inſtances.

However plenty of wholeſome food may be conducive to health, there are alſo other means, equally neceſſary to ſtrength and the longevity of negroes, well worth the planter's attention: and thoſe are, to chooſe airy dry ſituations for their houſes; and to obſerve frequently that they be kept clean, in good repair, and perfectly water-tight; for naſtineſs, and the inclemencies of weather, generate the moſt malignant diſeaſes. If theſe houſes are ſituated alſo in regular order, and at due diſtances, the ſpaces may at once prevent general devaſtations by fire, and furniſh plenty of fruits and pot-herbs, to pleaſe an unvitiated palate, and to purify the blood. Thus then ought every planter to treat his negroes with tenderneſs and generoſity, that they may be induced to love and obey him out of mere gratitude, and become real good beings by the imitation of his behaviour; and therefore a good planter, for his own eaſe and happineſs, will be careful of ſetting a good example.

Having thus hinted the duties of a planter to his negroes, let the next care be of cattle, mules, and horſes. The planters of Barbadoes (who are perhaps the moſt ſkilful of all others, and exact to a nicety in calculations of profit and loſs) are, with reſpect to their cattle, the moſt remiſs of any in all the iſlands; as if the carriage of canes to the mill, and of plantation-produce to the market, was not as eſſential as any other branch of plantership. At Barbadoes, in particular, the care of theſe animals is of more importance; becauſe the ſoil, worn out by long culture, cannot yield any produce without plenty of dung. Some planters are nevertheleſs ſo ingeniouſly thrifty, as to carry their canes upon negroes heads; acting in that reſpect diametrically oppoſite to their own apparent intereſt, which cannot be ſerved more effectually than by ſaving the labour of human hands, in all caſes where the labour of brutes can be ſubſtituted; and for that end no means of preſerving thoſe creatures in health and ſtrength ought to be neglected.

The firſt care therefore is to provide plenty and variety of food. In crop-time, profuſion of cane-tops may be had for the labour of carriage; but they will be more wholeſome and nutritious if tedded like hay by the ſun's heat, and ſweated by laying them in heaps a few days before they are eaten. In this ſeaſon of abundance, great ricks of cane tops (the butt ends turned inwards) ſhould be made in the moſt convenient corner of each field, to ſupply the want of paſturage and other food: and theſe are very wholeſome if chopped into ſmall parts, and mixed ſometimes with common ſalt or ſprinkled with melaſſes mixed with water: but yet the cattle require change of food to preſerve them in ſtrength; ſuch as Guinea corn, and a variety of graſs, which every ſoil produces with a little care in moiſt weather; and indeed this variety is found neceſſary in all climes.

But ſince that variety is not to be had during thoſe ſevere droughts to which hot climates are liable, and much leſs in thoſe ſmall iſlands which cannot furniſh large tracts of meadow lands for hay, the only reſource is the fodder of cane-tops or tedded Guinea-corn leaves ; which are very nutritious, and may be preſerved in perfection for more than a whole year, provided the tops or Guinea-corn are well tedded for three or four hot days as they lie ſpread in the field ; and then, being tied into bundles or ſheaves, they muſt lie in the hot ſun for three or four days more, when they may be fit to be put up into ricks. The beſt method of making them is in an oblong figure, about 30 feet in length, and 16 or 18 feet wide ; ſeven feet high at the ſides, and from thence ſloping like the roof of a houſe, the ridge of which muſt be thatched very carefully ; for the ſides may be ſecured from wet by placing the bundles with the butts upwards towards the ridge, in courſes, and lapping the upper over the lower courſe.

The beſt method of forming thoſe ricks is to place the firſt courſe of bundles all over the baſe one way ; the ſecond courſe reverſely ; and ſo alternately till the rick be finiſhed.

When cattle are to be fed with this fodder, it muſt be obſerved to take down the bundles from the top, at the weſt end of the rick, to the bottom ; for all theſe ricks muſt ſtand eaſt and weſt lengthwiſe, as well to ſecure them from being overturned by high winds, as for the convenience of preſerving them from wet, which cannot be done when ricks are made round. By this huſbandry, a herd of cattle may be kept in ſtrength, either in ſevere droughts, or in wet ſeaſons when graſs is purgative ; and thus the neceſſity or expence of large paſtures may be totally ſaved. The hay-knife uſed in England for cutting hay anſwers for cutting ricks of tops.

The method of tedding Guinea-corn to make a kind of hay will require a little explanation here. When Guinea-corn is planted in May, and to be cut down in July, in order to bear ſeed that year, that cutting, tedded properly, will make an excellent hay, which cattle prefer to meadow-hay. In like manner, after Guinea-corn has done bearing ſeed, the after crop will furniſh a great abundance of that kind of fodder, which will keep well in ricks for two or three years.

The next care of a planter is to provide ſhade for his cattle ; either by trees where they are fed in the heat of the day, if his ſoil requires not dung ; or by building a flat ſhade over the pen where cattle are confined for making it. That ſuch ſhades are eſſentially neceſſary to the well-being of all animals in hot weather, is apparent to every common obſerver, who cannot fail of ſeeing each creature forſaking the moſt luxuriant paſtures in the heat of the day for the ſake of ſhade ; thus convincing the owners, by inſtinctive argument, that ſhade is almoſt as neceſſary to the well-being of the brute creatures as food. Yet, notwithſtanding that demonſtration from the unerring courſe of nature, throughout all our iſlands (except in a very few inſtances) theſe poor creatures are expoſed to the ſcorching ſun-beams without mercy. Such inhuman neglect is not always ſo much the effect of inattention, as of a miſtaken notion that ſhades are impedimental to the making of much dung ; but a flat ſhade, covered with cane-traſh, may be ſo made as to let rain paſs through it without admiſſion of ſun-beams. This will do for cattle ; but mules, which are ſpirited creatures, and work themſelves by draught into a foaming heat, ſhould be put into a warm ſtable until quite cool : for turning them looſe to paſture when ſo hot is probably the cauſe of their deſtruction by the glanders.

If the care of providing ſhade for brute creatures is ſo much the duty and intereſt of their owners, how much more is it agreeable to the laws of humanity to provide ſhade for human creatures travelling upon the high-roads in this hot climate ! Nothing ſurely of ſo much beauty coſts ſo little expence as planting cocoa-nut or ſpreading timber-trees in avenues along the highways, if each proprietor of the lands adjoining hath any taſte of elegance, or feeling for other men : but both thoſe kinds of trees will yield alſo great profit to the proprietor, by furniſhing him with timber, when perhaps not otherwiſe to be had ; or with a delicious milk fitted by nature to cool the effervеſcence of the blood in this hot region ; and alſo to improve the ſpirits made from ſugar to the delicacy and ſoftneſs of arrack. Cocoa-nut and cabbage-trees are both very beautiful and ſhady, bearing round heads of great expanſion, upon natural trunks or pillars of elegant proportion, and of ſuch a height as to furniſh a large ſhade, with a free circulation of air equally refreſhing to man and beaſt.

The common objection of injury to canes by the roots of ſuch trees growing on their borders, may be eaſily removed by digging a ſmall trench between the canes and trees, which may intercept their roots, and oblige them to ſeek ſuſtenance in the common road. Let it alſo be conſidered, beſides the benefits above ſuggeſted, that the planter will thus beautify his eſtate to the reſemblance of a moſt ſumptuous garden. And probably that very beauty might not only render the iſlands more healthful to the inhabitants, by preſerving them from fevers kindled by the burning ſun-beams, but alſo much more fruitful by making the weather more ſeaſonable : for as, by cutting down all its woods, a hot country becomes more ſubject to exceſſive droughts ; ſo, by replanting it in the manner above deſcribed, this inconvenience would probably be prevented.

Let then the planter be kind not only to his fellow creatures but merciful to his beaſts ; giving them plenty and variety of wholeſome food, clear water, cool ſhade, and a clean bed, bleeding them after a long courſe of hard labour, currying their hides from filth and ticks [*] ; affording them ſalt and other phyſic when neceſſary ; protecting them from the flaying rope-laſhes of a cruel driver (who needs no other inſtrument than a goad) ; proportioning their labour to their ſtrength ; and by every art rendering their work as eaſy as poſſible. The general management of planters is not, perhaps, more defective in any other reſpect than in this: for, by pairing the cattle unequally, and by the driver's ill conduct in writhing to the right and left, the poor creatures are fatigued by much needleſs labour. A horſe ought therefore to be harneſſed before them as a leader. This docile creature, by being led in a ſtraight line, will ſoon learn to be an unerring guide, and the cattle will follow in the ſame direction with united ſtrength, and conſequently with more effect and leſs fatigue to each individual.

The Portugueſe of Madeira, by their poverty and ſcantineſs of paſture, breed the ſmalleſt kind of cattle ; and yet one yoke of them will draw a much greater weight than a pair of our largeſt oxen, ſolely by an equal exertion of their joint ſtrength. That equality or evenneſs of draught is preſerved by boring gimblet holes through their horns, within two inches of the points, and running a thong of leather through thoſe holes, ſo as to tie the horns of each pair at ſix inches diſtance from each other. By this ligature the pair of cattle are abſolutely hindered from turning different ways, and draw in an even direction with united force. Thus it appears evidently from reaſon, as well as from experience, that the labour of our beaſts may, by a little contrivance, be rendered more eaſy and effectual.

Of the Culture of various Soils.] In the Britiſh ſugar-colonies there is as great a variety of ſoils as in any country of Europe ; ſome naturally very rich or fruitful, yielding a luxuriant product with little labour or culture. This fruitful ſoil is of three kinds ; a looſe hazel mould mixed with ſand, like that of St. Chriſtopher's, and is the beſt in the known world for producing ſugar in great quantity, and of the beſt quality. The brick mould of Jamaica is ſomewhat of the ſame nature, and next in value; and then the various mixtures of mould and gravel, to be found in veins or plats over all the other iſlands. When any of theſe ſoils are exhauſted of their fertility by long and injudicious culture, they may be reſtored by any kind of dung well rotted; for theſe * warm ſoils cannot bear hot unrotten dung, without being laid fallow for a conſiderable time after it. Another improvement is by ſea-ſand or ſea-weed; or by digging in the cane-traſh into ſteep lands, and by letting it lie to rot for ſome months. A third method is, by ploughing and laying it fallow; and the fourth method (the beſt of all) is by folding the fallows by ſheep. But this can be practiſed only where there are extenſive paſtures; nor can the plough be employed where the ſoil abounds with large ſtones. In that caſe, however, the former method of digging in traſh will be nearly as effectual, though more expenſive, by hand-labour or hoe-ploughing.

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[*] One pound of native ſulphur, a quart of lamp-oil, and the like quantity of hog's-lard, intimately mixed and made into an ointment, is a cure for the mange, lice, &c.

The next beſt ſoil for producing good ſugar is a mould upon clay, which if ſhallow requires much culture and good labour, or its produce will be ſmall in quantity, though of a ſtrong grain and bright colour, ſo as to yield moſt profit to the refiner of any ſugar, except that produced from a hazel or gravelly ſoil, as before mentioned. All the black-mould ſoils upon marle are generally fruitful, and will take any kind of dung; but yield not ſo ſtrong or large-grained ſugar. Marle, however, of a white, yellow, or blue colour, or rich mould from waſhes, or aſhes of every kind, are excellent for every ſtrong ſoil, as the chief ingredient in the compoſt of dung: either of them will do alone for ſtiff lands; but the yellow and chocolate marle are the moſt ſoapy, and the richeſt kind of manure (except fine mould) for all ſtiff lands. If theſe are well opened, pulverized by culture, and mixed with hot dung, or any kind of looſe earth or marle, they will produce as plentifully as lighter ſoils: and all kinds of clay-ſoils, except that of a white colour, have theſe two advantages above the fineſt gravel ſoils, that they do not ſcorch ſoon by dry weather, and never grow weary of the ſame manure, as moſt other ſoils do.

The extraordinary hand-labour beſtowed in making dung, may be ſaved by the art of caving, now in general uſe in England. Ten mules or horſes, and two light tumbrels with broad wheels, and ten able negroes, may, by the common uſe of ſpades, ſhovels, and light mattocks, or grubbing hoes, make more dung than 60 able negroes can do in the preſent methods.

If marle lies upon riſing ground, or in hillocks, as it often does, the pit is to be opened at the foot of the declivity; which being dug inwards, till the bank is three feet high, then it is to be *caved* thus. Dig a hollow ſpace of 12 or 18 inches deep under the foot of the bank; then dig into each ſide of it another perpendicular cut of the ſame depth, and 18 inches wide from the top of the bank to the bottom: that being finiſhed, make a ſmall trench a foot or two from the brink of the bank; pour into it water till full; and when that is done, fill it again, till the water ſoaking downward makes the marle ſeparate and fall down all at once. This may be repeated till the pit riſes to 50 feet high; and then many hundreds of cart-loads of marle may be thrown down by four negroes in two hours; from whence it may be carted into cattle-pens or laid out upon lands, as occaſion requires. Five or ſix negroes with ſpades or ſhovels will keep two or three tumbrels employed, according to the diſtance of cartage: and thus as much dung may be made by ten negro men as will dung richly at leaſt 70 or 80 acres of land every year, and laid out alſo with the aſſiſtance of cattle-carts: An improvement highly worth every planter's conſideration, when negroes and feeding them are ſo expenſive; and this is no ſpeculation, but has been confirmed by practice. In level lands, the ſame operation may be as effectual, provided the mouth of the pit be opened by gradual deſcent to any depth: but when marle is to be found on the ſides of hills, the operation is leſs laborious for the horſes. But if the ſurface of the marle-pits (as it often happens) be covered with clay or ſtiff ſoil, ſo that the water cannot quickly ſoak from the trench above; in that caſe, pieces of hard wood, made like piles, four feet long, and four inches ſquare, pointed at one end, and ſecured at the other ſquare head by an iron clamp, may be driven by heavy mauls into the trench, as ſo many wedges, which will make the caved part tumble down: but a ſkilful eye muſt watch the laſt operation, or the labourers may be buried or hurt.

But then clay-ſoils that are level, and ſubject to be drowned, or to retain water in ſtagnated pools, can never be made fruitful by any kind of manure, without being firſt well drained: for water lying upon any ſoil will moſt certainly transform it to a ſtiff unfruitful clay; as appears evidently by the bogs of Ireland, the fens of Lincoln and Cambridgeſhire, and even by the ponds of Barbadoes ſituated in the deepeſt and lighteſt black mould; for that fine ſoil, being waſhed into thoſe ponds, becomes the ſtiffeſt black clay, not fit even for an ingredient in dung, until it has been laid dry, and expoſed to the ſun for a whole year: but when theſe bogs and fens are well drained, they become the moſt fruitful ſoils. Natural clay the celebrated Boerhaave thinks the fatteſt of all ſoils; but then it muſt be opened by culture, marle, or ſandy manures. It is hard to conjecture how the opinion prevailed in the Britiſh plantations, that ſandy gut-mould was moſt unfit for clay-ſoils, as being the means of binding them to the compactneſs of brick; whereas it is proved, from long experience, to be one of the beſt means of opening clay-ſoils, and rendering them abundantly fruitful. Brick is made of *clay alone*; no ſand being uſed in it, farther than to ſprinkle the board on which it is moulded into ſhape. From repeated experience it appears, that a mixture of ſand in gut-mould is the beſt of all manure for ſtiff and barren clay-lands; provided they be well drained, by throwing the whole ſoil into round ridges of 12 feet wide, with furrows of three feet wide between each ridge. And this is done with little more hand-labour than that of hoe-ploughing well in the common way. For, if a piece of land be marked in lines at ſeven feet and a half diſtance from each other, and the labourers are ſet in to hoe-plough at the ſecond line, hauling back each clod 12 inches; half the ridge, and near half the furrow, is made at the ſame time: and thus a piece of land may be round-ridged, and the furrows all made at once, by the common operation of hoe-ploughing, provided the digger drives his hoe up to the eye at every ſtroke. Hoe-ploughing in clay-ſoils that have lain long under water, is indeed hard labour; but it will every year grow the lighter by being well drained by round-ridging: and in the meanwhile the labour may be rendered much more eaſy by the plough conducted by the lines above deſcribed. As therefore ſandy mould is the beſt manure for ſtiff clay; ſo, by parity of reaſon, confirmed by long experience, ſtiff clay is the beſt manure for ſandy or chaffy ſoils.

The method of round-ridging before deſcribed, is, by ſeveral years experience, found the moſt eſſential improvement of flat clayey ſoils: and yet there are ſome who will prefer ſpeculation to ocular demonſtration, fancying that all kinds of ridges will carry off the mould in heavy rains. The fact is otherwiſe in clay-ſoils: and plain reaſon, without experience, vouches, that where great confluxes of water are divided into many ſmall rills, the force is broken ; and therefore leſs mould carried off the land. Another objection made to round-ridging is, that by digging much clay to form the ſides of the ridge, the ſoil is impoveriſhed: but this objection ſtands good only againſt thoſe ridges which are raiſed too high, and made too broad ; but if land is ridged in the manner before directed, that is, 12 feet broad and not above ſix or eight inches higher in the middle than at the ſides, the objection vaniſhes. Ridges were never propoſed for light ſoils or ſteep lands; and even in flat ſoils upon loam they ſhould be made with great caution, becauſe *loam melts away by water.* But there are poachy lands of a white clay, even upon ſmall deſcents, too retentive of water ; theſe may certainly be improved much by ridges of 12 feet wide, as above deſcribed, without fear of waſhes.

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* Theſe ſoils, which are naturally looſe and upon marle, Mr. Martin calls *hot ſoils*; and theſe, he ſays, have been much injured in ſome of the iſlands by dung haſtily made with marle: but if the ſediment of lees were thrown into theſe pens, after being turned over, it would much improve the dung.

But ſuppoſing, as the objection urges, that a little clay ſhould be turned up at the ſides of ſuch ridges, can it not be manured ſomewhat more than the other parts with marle or ſandy mould, ſo as to become equally good with any other part of the ſoil ? And is not this well worth the labour, ſince round-ridging not only improves the ſoil by draining it to a ſurpriſing degree, but adds one-fifth part to the depth of the ſtaple ? And will not a ridge made a little rounding throw off the water much better than a flat ridge ?

The general maxim of not burning cane-traſh (which may be called the *ſtubble of cane-lands)* upon any kind of ſoil, is ſurely a great miſtake; as may be evinced by obſerving the contrary practice of the beſt huſbandmen in England, where burn-baiting or baſtard burn-baiting, is found by experience an admirable method of fertilizing cold, ſtiff, or clayey lands. It muſt indeed be a conſtant practice, not only for the ſake of contributing to warm and divide the ſoil, but as the only effectual means of deſtroying pernicious inſects, and weeds of various kinds, ſuch as French weed, wild peaſe, and wild vines.

Soon after the diſuſe of burning traſh upon our lands in the iſlands, the blaſt made its firſt appearance with incredible devaſtation : to revive that practice, therefore, ſeems to be the moſt obvious means of expelling it. It may be preſumed that the diſuſe of burning traſh was founded upon the miſtaken notion of burn-baiting, which is turning up a thick ſod of very dry, light, and ſhallow ſoils, and burning the whole ſuperficies or ſtaple to aſhes. This practice the writers upon huſbandry condemn univerſally, and very juſtly: for though by this practice the land will produce two or three crops more plentifully than ever, yet the ſoil is blown away by the wind, and the ſubſtratum, being generally a hungry gravel or chalk, can never be reſtored to fertility by the common arts of huſbandry. But ſurely this has no reſemblance to our ſuperficial burning of the little traſh we can ſpare from dung: and though this method of burn-baiting light and ſhallow ſoils be juſtly condemned, yet the beſt writers recommend that very practice in cold, moiſt, and heavy ſoils, as is obſerved above; and long experience juſtifies it.

Deep mould upon clay or loam being ſubject to the grub-worm *, will not take any kind of dung till perfectly rotten, except that of the ſheep-fold ; which is the beſt manure for all kinds of light ſoils, and is of all others the leaſt expenſive, as not requiring hand-labour. But the uſe of the fold is impracticable in any iſland not abounding with large ſavannas or ſheep paſtures, as in Jamaica.

Thoſe ſoils therefore which are ſubject to the grub, and muſt be fertilized by common dung, which is a proper neſt for the mother-beetle to depoſit its eggs, muſt be well impregnated with the brine of diſſolved ſalt after the dung is firſt cut up ; two large hogſheads of ſalt will make brine enough for a dung-pen of 50 feet ſquare.

This cure for the grub is a late diſcovery ; and which has been attended with ſucceſs, ſo far as the experiment is made. But though it proves effectual to deſtroy that pernicious inſect in plant canes, it probably will not be ſufficient to ſave-rattoons without a new application of ſalt in powder ; becauſe the firſt brine muſt be waſhed away by the time when rattoons ſpring up.

The planter who would ſave his rattoons from the grub ought therefore to cut off the heads of his ſtools with ſharp hoes three inches below the ſurface of the ſoil, and then threw a handful of ſalt round each ſtool, and cover it up to a level with fine mould taken from the edges.

In ſoils where there is no grub, and the planter wiſhes to have very good rattoons, let him, as ſoon as his canes are cut, draw all the traſh from the ſtools into the alternate ſpaces, if planted in that manner ; or into the furrows, if his land be round-ridged ; and then cut off the head of his ſtools with ſharp hoes, as above directed. Experience has ſhown the conſiderable advantage of this practice, and reaſon demonſtrates the great benefit of the rattoon-ſprouts riſing from three inches below the ſurface, inſtead of ſuperficial ſhoots which come to nothing, and only ſtarve the ſtrong ſprouts. Beſides, the ſtubs which are left upon the ſtools after the canes are cut, canker, and rot the ſtools ; which is one reaſon why good rattoons are uncommon in ſoils long cultivated. Yet it is the opinion of ſome, that, by hoe-ploughing and even dunging rattoons, the produce might be as good plant-canes, which would ſave the labour of holing and planting ſo often as planters commonly do.

Fallowing is of incredible advantage to every ſoil, not only by being divided into the minuteſt parts, but alſo by imbibing thoſe vegetative powers with which the air is impregnated by the bountiful hand of Providence, whenever rain falls. What thoſe powers are has been explained under the articles HUSBANDRY and PLANT ; and experience evinces, that the tender vegetables of the earth are invigorated more by the ſmalleſt ſhower of rain, than by all the water which human art can beſtow. Let it therefore be a conſtant maxim of the planter, never to plant his ground until the ſoil is well mellowed by fallowing, even though he beſtows upon it a due proportion of dung : we ſay a due proportion ; for too much will force up rank canes, which never yield good ſugar ; and though ſome advantage may be reaped from the rattoons, yet it will be found by experience not to compenſate the loſs by the plants. In ſtony or ſteep ſoils, where the plough cannot be uſed, or where a ſufficient ſtrength of cattle cannot be ſupported for that purpoſe, hand-labour or hoe-ploughing muſt be ſubſtituted : but, even in that caſe, much labour may be ſaved by ſpreading the dung according to the Engliſh huſbandry, and digging it into the ſoil. To evince this truth, let any planter compute his negroes labour of diſtributing dung by baſkets, and by ſpreading it with dung-forks ; and then judge for himſelf by one ſingle experiment which is the moſt profitable.

But if ſome planters are ſo devoted to the old cuſtom of diſtributing dung by baſkets inſtead of wheel-barrows in level ground, or hand-barrows in uneven land, by which three times the labour may be accompliſhed in the ſame time and by the ſame hands ; let them at leaſt ſave much of their hand-labour, by the following method of laying out dung before the diſtribution by baſkets.

In holing a piece of land, let a ſpace be left after 80 holes from the firſt interval, and then the like ſpace after 80 holes throughout the whole part, which ſpaces muſt run exactly parallel to the intervals on the right and left of the holes. Into theſe ſpaces the dung may be carted, even before it be rotten[*], at the moſt leiſure times, and covered with mould or cane-traſh, to prevent exhalation; and in ſuch quantity as will ſuffice only to dung a row of 40 holes, from the point oppoſite to each ſide of it. In the intervals at each ſide of the cane-piece, which are parallel to thoſe ſpaces, there muſt be dung enough carted to manure a row of 40 holes, and covered in like manner.

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* This pernicious inſect is moſt apt to engender in dung made from mill-traſh, which therefore never ought to be put into dung compoſt or ſtill-ponds : but after being burnt, the aſhes will be as good as any other kind. Round-ridging, with manure of unwet aſhes, ſea-ſand, or lime, or dry marle, kills the grub.

By thus placing the dung or gut-mould, it is evident at the firſt ſight, that the fartheſt diſtance cannot be above 40 holes in diſtributing the dung; and in caſe it be not ſufficiently rotten for preſent uſe, it may be diſtributed even in dry weather, and covered by the bank; which will both prevent its ſpirit from exhalation, and occaſion it to rot ſooner; which is no ſmall advantage. Moreover, by being thus laid out at the moſt leiſure times, and covered with the banks, the dung will be more intimately mixed with the ſoil, and therefore continue to nouriſh the plant for a longer time than if laid as uſual at the bottom of the holes. A further advantage of thus diſtributing the dung, and covering it, reſults from the more expeditious planting the land after a ſhort or ſudden ſhower: for the labour of covering the dung, and uncovering it when the land is planted, however it may appear in ſpeculation, is in practice a trifle; and, beſides all the other advantages ariſing by the diſtribution of dung from the ſpaces above deſcribed, this is not the leaſt, that not a bank is trodden under foot. But it is evident, that by diſtributing the dung with baſkets in the preſent method, the ſoil is much trampled under foot; and by that means, the very end of hoe-ploughing, or looſening the ſoil, is much defeated. In like manner, by the preſent method of hoe-ploughing, the ſame ill effect is produced; for, as the negroes hoe-plough or dig the ſoil directly forward, ſo they muſt neceſſarily tread the ground as faſt as they dig it: whereas, by putting the labourers to dig ſidewiſe, no one puts a foot upon the ſoil after it is dug; and, by lining the land before it is hoe-ploughed, each negro may have an equal ſhare to dig. The only difficulty of hoe-ploughing ſidewiſe is in firſt ſetting the negroes to that work; but it may be done without loſs of time when working in a contiguous field. Whether hoe-ploughing before or after the land be holed for canes is moſt eligible, experience muſt determine; but certainly both operations will be moſt effectual: and therefore it will be adviſable[†], firſt to plough the ſoil where the land will admit the plough; and where it will not, to hoe plough it with or without dung, as requiſite; then let it lie fallow till perfectly mellowed; then hole and plant it; and, inſtead of weeding in the uſual manner, let the weeds in all the ſpaces be dug into the ſoil: but as this is not to be done ſo well with the hoe, it is ſubmitted to future experience, whether the dexterous uſe of ſpades, as in England, will not anſwer the purpoſe much better, and with equal diſpatch. But whatever method is preferred, moſt certain it is, that by looſening the ſoil in all the ſpaces between the young canes after being come up, their fibres will more eaſily expand on every ſide, and acquire more nutrition to invigorate their growth. But where the planter grudges this labour, by thinking it needleſs in a rich looſe ſoil, he may diſpatch more weeding-work by the Dutch hoe than by any other; which being faſtened upon the end of a ſtick, is puſhed forward under the roots of the ſmall weeds, in ſuch a manner as to cut them up a little below the ſurface of the ſoil, and will do more execution at one ſhove than can be done at three ſtrokes of the common hoe. But there is yet another practice of the horſe-hoe plough, whereby all weeds growing in rows between beans and peaſe, are extirpated with incredible eaſe and expedition. It is a very ſimple machine, drawn by one or two horſes, conſiſting of a pair of low wheels turning upon a common axis; from whence two ſquare irons are let down at equal diſtances, and triangular hoes made at the ends, the points of the triangles being placed forward, and ſo fixed as to cut all weeds an inch below the ſurface, in the ſame manner as the Dutch garden-hoe above mentioned. By this machine a man and a boy, with two horſes or mules, will clear perfectly all the ſpaces of a field of ten acres in two days, and it may be of admirable uſe in all looſe and dry ſoils in the ſugar-iſlands: for, while two horſes or mules draw in the ſpace before each other, the wheels paſs on the outſide of each row of canes, without doing the leaſt injury, while the plough-holder attends to his buſineſs. In ſtiff ſoils which require draining, neither the horſe-hoe plough nor the Dutch hoe can be proper; or any other inſtrument ſo effectual as the ſpade uſed in the manner above hinted, where the ſtaple is deep.

But where the ſtaple of land is ſhallow, care muſt be taken not to dig much below it, according to the univerſal opinion of all the beſt writers, ſupported by the experience of 100 years. Yet ſome good planters are fallen into the contrary practice, and dig up ſtiff clay far below the ſtaple. This, Mr. Martin ſays, was done in his own lands, during his abſence, by injudiciouſly ploughing below the ſtaple; and ſo injured the ſoil, that all the arts of culture for many years hardly retrieved its former fertility. Indeed, where the ſtaple is ſhallow, upon a fat clay, the turning up a little of it at a time, from the bottom of the cane-holes, and mixing it with rich hot dung, made of marle, or ſandy mould, which may take off its coheſive quality, will in due time, and by long fallow, convert it into good ſoil: but if ſtiff clay be turned up, without any ſuch mixture, in large quantities, it will infallibly diſappoint the operator's hopes: for, though ſolid clay will moulder, by expoſure, to a ſeeming fine earth, yet it will return to its primitive ſtate very ſoon after being wet and covered from the external air, if not divided as above ſuggeſted.

After all, the common horſe-hoeing plough drawn by two mules in a line before each other, or the hand hoe in common uſe, will anſwer the purpoſe very well, where the lands are planted in Mr. Tull's method; that is, where the ſpaces are equal to the land planted, in the following manner.

Suppoſe ſix feet planted in two rows of canes, and ſix feet of land left as a ſpace unplanted; and ſo a whole piece of land, planted in alternate double rows[‡], with equal ſpaces, may be hoe-ploughed with eaſe, as before hinted, and that at any time during the growth of canes, when it is moſt convenient to the planter; which is a conſiderable advantage: and yet it is the leaſt of all attending this method of culture; for, by leaving theſe ſpaces, the canes will have both more air and ſun. By hoe-ploughing them, the roots of each double row will have large room for expanſion, and conſequently, by gaining more nutriment, will grow more luxuriantly. By theſe ſpaces the canes may be cleaned from the blaſt with more eaſe and convenience; and will ſerve as proper beds to plant great corn, without the leaſt injury to the canes; as well as to contain the traſh taken off the land, where, by rotting, and being hoe-ploughed into the ſoil, it will wonderfully enrich it, and will fit it to be planted immediately after the canes in the neighbouring double rows are cut down. Beſides all theſe admirable advantages of planting the land in alternate double rows with equal ſpaces, the canes, when at full age, may be eaſily ſtripped of their traſh, and by that means the juice rendered ſo mature as to yield double the produce, and much better ſugars than unſtripped canes. This method of culture may be recommended for all kinds of ſoil: for as by this practice the rank luxuriant canes will be more matured, ſo the poor ſoils will be rendered more fruitful; and as the roots of the canes which expand into theſe ſpaces will be kept moiſt by being covered with rotten traſh, ſo they muſt bear dry weather much longer in the burning ſoils. In thoſe low lands which require draining by furrows, the alternate double rows and ſpaces muſt be made croſs the ridges; by which means thoſe ſpaces, being hoe-ploughed from the centre to the ſides, will be always preſerved in a proper ſtate of roundneſs. By this method of planting, the canes may be ſo well ripened as to yield double the quantity of ſugar of canes planted in the cloſe manner; which ſaves half the labour of cartage, half the time of grinding and boiling, and half the fuel, beſides yielding finer ſugar.

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[*] In order to make dung rot the ſooner, much labour is beſtowed in digging and turning it over by hoes: but two-thirds of that labour may be ſaved by the uſe of hay-knives; ſix of which, uſed dexterouſly, will cut up a pen in leſs time than 60 negroes can do by hoes: but hay-knives cannot be uſed where gritty mould is uſed in pens.

[†] Deep and looſe ſoils may be ploughed with a ſmall ſtrength of cattle or mules: but ſtiff lands in hot climates require more ſtrength of cattle than can be maintained in the ſmall paſtures of the planters; for, if thoſe ſtrong ſoils are either too wet or too dry (as is generally the caſe), ploughing is impracticable.

[‡] In ſtiff lands, the ſingle alternate rows of four feet diſtance, as preventive of much labour in weeding, are found beſt; and alſo yield more ſugar by the acre; and are leſs apt to be affected by drought.

Yet, how well ſoever the method of planting in ſingle or double alternate rows has ſucceeded in the looſe and ſtiff ſoils, experience has ſhown that it is a wrong practice in ſtiff lands that are thrown into round or flat ridges: for, theſe being moſt apt to crack, the ſun-beams penetrate ſoon to the cane-roots, ſtop their growth, and have an ill influence upon the ſugar. It is therefore adviſable to plant ſuch lands full, but in large holes of 4 feet, by 5 feet towards the banks: after the plant-canes are cut, to dig out one, and leave two rows ſtanding, hoe-ploughing the ſpaces after turning all the traſh into furrows till almoſt rotten: for, if the traſh is drawn upon the hoe-ploughed ſpaces, they will hardly ever moulder, at leaſt not till the traſh is quite rotten. This is an infallible proof from experience of how little advantage traſh is to the ſoil, unleſs it be in great droughts, to keep out the intenſe ſun-beams: for, in all other reſpects, it prevents that joint operation of the ſun and air in mouldering and fructifying the ſoil, as has been proved by repeated experiments.

But in flat ſtiff ſoils that are properly drained by round-ridging, no culture prevents cracking ſo effectually as hoe-ploughing into them a quantity of looſe marle, of which that of a chocolate or of a yellow colour is beſt; and it will be ſtill much better, by lying upon the land, in ſmall heaps, or in cane holes, for ſome time, to imbibe the vegetative powers of the air before it is intimately mixed with the ſoil.

As to the manner of planting canes, the general practice of allowing four feet by five to a hole, and two freſh [*] plants, is found by common experience to be right and good in alternate rows. But the following precautions are neceſſary to be obſerved. Firſt, let all the cane-rows run eaſt and weſt, that the trade-wind may paſs freely through them: becauſe air and ſunſhine are as conducive to the growth and maturation of ſugar-canes as of any other vegetable. Secondly, let not any acceſſion of mould be drawn into hills round the young canes, except where water ſtagnates [†]; becauſe the fibres which run horizontally, and near the ſurface, are much broken and ſpoiled by that practice. Thirdly, let the ſugar-canes be cut at their full maturity; which, in a dry looſe ſoil, is generally at the end of 14 or 15 months after being planted; but in cold clay-ſoils, not till 16 or 17 months. Fourthly, as the cane-rows run eaſt and weſt in as proper a direction as poſſible for cartage to the ſugar-work, ſo canes muſt be cut the contrary way if the planter expects any great produce from his rattoons: for, by beginning to cut canes at the part of his field moſt remote from the works, the carts cannot often paſs over the ſame track, and conſequently the cane ſtools cannot be injured, more eſpecially if he take due care to cut the canes very cloſe to their roots; for, by leaving a long ſtub (which muſt periſh) the cane-ſtools are much injured. It may be objected to the practice of the cutting canes tranſverſely to the rows, that the negroes' labour will not be ſo equally divided: but let every man conſider both ſides of the queſtion, and be determined by his own experience; and then he will be convinced, that it matters very little which way he cuts ſtraight ſtanding canes; but in caſes where the ſugar-canes lean, or are lodged by preceding high winds, it is a point of great importance to place the labourers ſo as to cut the canes firſt at the roots, and then, drawing them, cut off the tops: for thus by two ſtrokes each cane will be cut; and twice the quantity cut in the ſame time, and by the ſame hands, more than by cutting in any other direction. In round-ridged land, it is proper to cut canes in the ſame direction of the ridges, throwing the tops and traſh into the furrows to render the cartage eaſy, and to preſerve the ridges in their proper form.

It is almoſt needleſs to ſuggeſt the expediency of planning the cane-pieces of a plantation in exact ſquares, ſo that the intervals may interſect at right angles; ſince ſuch regularity is not only more beautiful, more ſafe in caſe of accidental fires, and a better diſpoſition of the whole for dividing and planting one-third or fourth part of a plantation every year, but alſo much eaſier guarded by a few watchmen: for one of theſe walking in a line from eaſt to weſt, and the other from north to ſouth, look through every avenue, where the moſt ſubtle thief cannot eſcape the watchful eye. And if the intervals ſurrounding the boundary of a regular plantation be made 24 feet wide, the proprietor will receive ample recompenſe for ſo much land, by the ſecurity of his canes from fires kindled in the neighbourhood, and by planting all that land in plantain-trees, which may at once yield food and ſhade to the watchmen, who by that means can have no excuſe for abſence from their proper ſtations. But as fuel grows very ſcarce in moſt of our iſlands, it is alſo expedient to plant a logwood or flower-fence in all the boundaries of every plantation, which, being cut every year, will furniſh good ſtore of faggots. Logwood makes the ſtrongeſt and quickeſt of all fences, and agrees with every ſoil: the cuttings make excellent oven-fuel.

So much for the general operations of planterſhip, according to the approved directioms of Mr. Martin. For the particular cultivation of the ſugar-canes, the extraction of the ſugar, and the diſtillation of rum, ſee the articles SACCHARUM, SUGAR, and RUM.

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[*] It is an odd fancy that ſtale plants grow beſt, when both reaſon and experience vouch that the moſt ſucculent plants are beſt: one good plant in the centre of a large hole is ſufficient when the land is full holed.

[†] The ſtagnation of water in pools (uſual in ſtiff level lands) is the moſt injurious circumſtance attending it; for that, by long duration, will convert the fineſt mould into ſtiff clay. The proprietor of ſuch a ſoil muſt therefore grudge no labour to drain it well; and yet by ſuch eaſy gradation as to prevent the mould from being waſhed away by great floods, in caſe the under ſtratum be a loam.

PLANTIN (Christopher), a celebrated printer, was born near Tours in 1533, and bred to an art which he carried to the higheſt degree of perfection. He went and ſettled at Antwerp; and there erected a printing-office, which was conſidered not only as the chief ornament of the town, but as one of the moſt extraordinary edifices in Europe. A great number of ancient authors were printed here; and theſe editions were valued not only for the beauty of the characters, but alſo for the correctneſs of the text, with regard to which Plantin was ſo very nice, that he procured the moſt learned men to be correctors of his preſs. He got immenſe riches by his profeſſion; which, however, he did not hoard up, but ſpent like a gentleman. He died in 1598, aged 65 years; and left a moſt ſumptuous and valuable library to his grandſon Balthaſar.

PLANTING, in agriculture and gardening, is ſetting a tree or plant, taken from its proper place, in a new hole or pit; throwing freſh earth over its root, and filling up the hole to the level of the ſurface of the ground.

The firſt thing in planting is to prepare the ground before the trees or plants are taken out of the earth, that they may remain out of the ground as ſhort a time as poſſible; and the next is, to take up the trees or plants, in order to their being tranſplanted. In taking up the trees, carefully dig away the earth round the roots, ſo as to come at their ſeveral parts to cut them off: for, if they are torn out of the ground without care, the roots will be broken and bruiſed, to the great injury of the trees. When you have taken them up, the next thing is to prepare them for planting by pruning the roots and heads. And firſt, as to the roots; all the ſmall fibres are to be cut off, as near to the place from whence they are produced as may be, except they are to be replanted immediately after they are taken up. Then prune off all the bruiſed or broken roots, all ſuch as are irregular and croſs each other, and all downright roots, eſpecially in fruit-trees: ſhorten the larger roots in proportion to the age, the ſtrength, and nature of the tree; obſerving that the walnut, mulberry, and ſome other tender-rooted kinds ſhould not be pruned ſo cloſe as the more hardy ſorts of fruit and foreſt trees: in young fruit-trees, ſuch as pears, apples, plums, peaches, &c. that are one year old from the time of their budding or grafting, the roots may be left only about eight or nine inches long; but in older trees, they muſt be left of a much greater length: but this is only to be underſtood of the larger roots; for the ſmall ones muſt be chiefly cut quite out, or pruned very ſhort. The next thing is the pruning of their heads, which muſt be differently performed in different trees; and the deſign of the trees muſt alſo be conſidered. Thus, if they are deſigned for walls or eſpaliers, it is beſt to plant them with the greateſt part of their heads, which ſhould remain on till they begin to ſhoot in the ſpring, when they muſt be cut down to five or ſix eyes, at the ſame time taking care not to diſturb the roots. But if the trees are deſigned for ſtandards, you ſhould prune off all the ſmall branches cloſe to the place where they are produced, as alſo the irregular ones which croſs each other; and, after having diſplaced theſe branches, you ſhould alſo cut off all ſuch parts of branches as have by any accident been broken or wounded; but by no means cut off the main leading ſhoots, which are neceſſary to attract the ſap from the root, and thereby promote the growth of the tree. Having thus prepared the trees for planting, you muſt now proceed to place them in the earth: but firſt, if the trees have been long out of the ground, ſo that the fibres of the roots are dried, place them eight or ten hours in water, before they are planted, with their heads erect, and the roots only immerſed therein; which will ſwell the dried veſſels of the roots, and prepare them to imbibe nouriſhment from the earth. In planting them, great regard ſhould be had to the nature of the ſoil: for, if that be cold and moiſt, the trees ſhould be planted very ſhallow; and if it be a hard rock or gravel, it will be better to raiſe a hill of earth where each tree is to be planted, than to dig into the rock or gravel, and fill it up with earth, as is too often practiſed, by which means the trees are planted as it were in a tub, and have but little room to extend their roots. The next thing to be obſerved is, to place the trees in the hole in ſuch a manner that the roots may be about the ſame depth in the ground as before they were taken up; then break the earth fine with a ſpade, and ſcatter it into the hole, ſo that it may fall in between every root, that there may be no hollowneſs in the earth: then having filled up the hole, gently tread down the earth with your feet, but do not make it too hard; which is a great fault, eſpecially if the ground be ſtrong or wet. Having thus planted the trees, they ſhould be faſtened to ſtakes driven into the ground to prevent their being diſplaced by the wind, and ſome mulch laid upon the ſurface of the ground about their roots: as to ſuch as are planted againſt walls, their roots ſhould be placed about five or ſix inches from the wall, to which their heads ſhould be nailed to prevent their being blown up by the wind. The ſeaſons for planting are various, according to the different ſorts of trees, or the ſoil in which they are planted. For the trees whoſe leaves fall off in winter, the beſt time is the beginning of October, provided the ſoil be dry; but if it be a very wet ſoil, it is better to defer it till the latter end of February, or the beginning of March: and for many kinds of evergreens, the beginning of April is by far the beſt ſeaſon; though they may be ſafely removed at midſummer, provided they are not to be carried very far; but we ſhould always make choice of a cloudy wet ſeaſon.

In the ſecond volume of the papers, &c. of the Bath Society there is a letter on planting waſte grounds. The gentleman who writes it informs us, that in the county of Norfolk, where he reſides, there were about 60 or 70 years ago vaſt tracts of uncultivated ground, which were then thought totally barren. “The weſtern parts of it (ſays he) abounded with ſands of ſo light a texture, that they were carried about by every wind; and in many places the ſands were ſo looſe that no graſs could grow upon them. Art and induſtry, however, have now ſo altered the face of this once Arabian deſert, that it wears a very different appearance. Moſt of theſe tracts are either planted, or rendered very good corn-land and ſheep-walks.

“About 30 years ſince, the ſides of many of our little ſand-hills were ſown with the ſeeds of French furze; and when a wet ſeaſon followed, they ſucceeded very well, and grew ſo faſt, that once in three or four years they were cut for fuel, and ſold at a good price at Thetford, Brandon, Harling, Swaffham, and places adjacent. This excited ſome public-ſpirited gentlemen, among whom was the late Mr. Buxton of Shadwell-Lodge, near Thetford, to attempt the planting of Scotch and ſpruce firs, and other hardy foreſt-trees. At firſt they found ſome difficulty from the extreme looſeneſs of the ſand. But as there is in all this part of the country fine white and yellow marle, at about three feet depth below the ſand, they very judiciouſly thought that incorporating it with the ſand in the holes where their young trees were planted, would inſure ſucceſs; nor were they diſappointed. The method ſucceeded beyond expectation; the plantations throve exceedingly, and the roots ſoon reached below the ſand, after which they were out of danger. This excited them to further attempts.

“On the ſpots where they intended to raiſe new plantations from ſeeds and acorns, they laid on a thick coat of marle and clay, which, after being rough ſpread, and lying a winter in that ſtate, was made fine, and ploughed in juſt before planting. By theſe means the ſoil became fixed, and in a little time covered with graſs and herbage; ſo that there are now vaſt plantations of firs, oak, and foreſt-trees, in the moſt healthy and vigorous ſtate, where within my memory ten acres of land would not maintain a ſingle ſheep three months.

" But the benefit of plantations, whether of ſhrubs, copſe, or trees, is not confined to the immediate advantage, or even the future value of the wood. By annually ſhedding a great number of leaves, which the winds diſperſe, and the rains waſh into the ſoil, it is conſiderably improved; and whenever ſuch copſes have been ſtubbed up, the ground (however unfruitful before planting) has thereby been ſo enriched as to bear excellent crops for many years, without the additional help of manure." How much land-owners are intereſted in planting waſte or barren ſpots I need not mention; and nothing but a degree of indolence or ignorance unpardonable in this enlightened age could induce them to neglect it.

" Nature has furniſhed us with plants, trees, and ſhrubs, adapted to almoſt every ſoil and ſituation; and as the laws of vegetation are now much better underſtood than formerly, it is a reproach to thoſe whoſe practice does not keep pace with their knowledge in making the beſt uſe of her bounty. Let no man repine, and ſay *the land is barren*; for thoſe ſpots which appear to be ſo, owe that appearance to human negligence. Induſtry and art might ſoon render an eighth part of this kingdom nearly as valuable as the reſt, which now remains in a ſtate unprofitable to the owners, and diſgraceful to the community."

Reverſe Planting, a method of planting in which the natural poſition of the plant or ſhoot is inverted; the branches being ſet into the earth, and the root reared into the air. Dr. Agricola mentions this monſtrous method of planting, which he found to ſucceed very well in moſt or all ſorts of fruit-trees, timber-trees, &c. Bradley affirms, that he has ſeen a lime-tree in Holland growing with its firſt roots in the air, which had ſhot out branches in great plenty, at the ſame time that its firſt branches produced roots and fed the tree. Mr. Fairchild of Hoxton has practiſed the ſame with us, and gives the following directions for performing it: Make choice of a young tree of one ſhoot, of alder, elm, willow, or any other tree that eaſily takes root by laying; bend the ſhoot gently down into the earth, and ſo let it remain until it has taken root. Then dig about the firſt root, and raiſe it gently out of the ground, till the ſtem be nearly upright, and ſtake it up. Then prune the roots, now erected in the air, from the bruiſes and wounds they received in being dug up; and anoint the pruned parts with a compoſition of two ounces of turpentine, four ounces of tallow, and four ounces of bees wax, melted together, and applied pretty warm. Afterwards prune off all the buds or ſhoots that are upon the ſtem, and dreſs the wounds with the ſame compoſition, to prevent any collateral ſhootings, that might ſpoil the beauty of the ſtem.

PLANUDES (Maximus), a Greek monk of Conſtantinople, towards the end of the 14th century, who publiſhed a collection of epigrams entitled *Anthologia*; a Greek tranſlation of Ovid's Metamorphoſes; a Life of Æſop, which is rather a romance than a hiſtory; and ſome other works. We know nothing more of him, than that he ſuffered ſome perſecution on account of his attachment to the Latin church.

PLASHING *of* Hedges, is an operation thought by ſome perſons to promote the growth and continuance of old hedges; but whether the fact be ſo or not will admit of ſome diſpute. See Hedges. It is performed in this manner: The old ſtubs muſt be cut off, &c. within two or three inches of the ground; and the beſt and longeſt of the middle-ſized ſhoots muſt be left to lay down. Some of the ſtrongeſt of theſe muſt alſo be left to anſwer the purpoſe of ſtakes. Theſe are to be cut off to the height at which the hedge is intended to be left; and they are to ſtand at ten feet diſtance one from another: when there are not proper ſhoots for theſe at the due diſtances, their places muſt be ſupplied with common ſtakes of dead wood. The hedge is to be firſt thinned, by cutting away all but thoſe ſhoots which are intended to be uſed either as ſtakes, or the other work of the plaſhing: the ditch is to be cleaned out with the ſpade; and it muſt be now dug as at firſt, with ſloping ſides each way; and when there is any cavity on the bank on which the hedge grows, or the earth has been waſhed away from the roots of the ſhrubs, it is to be made good by facing it, as they expreſs it, with the mould dug from the upper part of the ditch: all the reſt of the earth dug out of the ditch is to be laid upon the top of the bank: and the owner ſhould look carefully into it that this be done; for the workmen, to ſpare themſelves trouble, are apt to throw as much as they can upon the face of the bank; which being by this means overloaded, is ſoon waſhed off into the ditch again, and a very great part of the work undone; whereas what is laid on the top of the bank always remains there, and makes a good fence of an indifferent hedge.

In the plaſhing the quick, two extremes are to be avoided; theſe are, the laying it too low, and the laying it too thick. The latter makes the ſap run all into the ſhoots, and leaves the plaſhes without ſufficient nouriſhment; which, with the thickneſs of the hedge, finally kills them. The other extreme of laying them too high, is equally to be avoided; for this carries up all the nouriſhment into the plaſhes, and ſo makes the ſhoots ſmall and weak at the bottom, and conſequently the hedge thin. This is a common error in the north of England. The beſt hedges made anywhere in England are thoſe in Hertfordſhire; for they are plaſhed in a middle way between the two extremes, and the cattle are by that prevented both from cropping the young ſhoots, and from going through; and a new and vigorous hedge ſoon forms itſelf.

When the ſhoot is bent down that is intended to be plaſhed, it muſt be cut half-way through with the bill: the cut muſt be given ſloping, ſomewhat downwards, and then it is to be wound about the ſtakes; and after this its ſuperfluous branches are to be cut off as they ſtand out at the ſides of the hedge. If for the firſt year or two, the field where a new hedge is made can be ploughed, it will thrive the better for it; but if the ſtubs are very old, it is beſt to cut them quite down, and to ſecure them with good dead hedges on both ſides, till the ſhoots are grown up from them ſtrong enough to plaſh; and wherever void ſpaces are ſeen, new ſets are to be planted to fill them up. A new hedge raiſed from ſets in the common way, generally requires plaſhing in about eight or nine years after.

PLASSEY, is a grove near the city of Muxadab, in India, famous for a battle fought between the Engliſh under lord Clive and the native Hindoos under the nabob Surajah Dowlah. The Britiſh army conſiſted of about 3200 men, of whom the Europeans did not exceed 900; while that of the nabob conſiſted of 50,000 foot, and 18,000 horſe. Notwithſtanding this great diſproportion, however, lord Clive effectually routed the nabob and his forces, with the loſs of 3 Europeans and 26 ſepoys killed, and 5 Europeans and 40 ſepoys wounded. The nabob's loſs was eſtimated at about two hundred men, beſides oxen and elephants. See Clive.

PLASTER, or Emplaster, in pharmacy, an external application of a harder conſiſtence than an ointment; to be ſpread, according to the different circumſtances of the wound, place, or patient, either upon linen or leather. See Pharmacy.

Plaster, or *Plaiſter*, in building, a compoſition of lime, ſometimes mixed with ſand, &c. uſed to parget or cover the nudities of a building. See the articles PARGETING and STUCCO.

PLASTER *of Paris*, a preparation of ſeveral ſpecies of gypſum dug near Mount Maitre, a village in the neighbourhood of Paris; whence the name. See ALABASTER, GYPSUM, and CHEMISTRY. The beſt ſort is hard, white, ſhining, and marbly; known by the name of *plaſter-ſtone* or *parget of Mount Maitre*. It will neither give fire with ſteel, nor ferment with aquafortis; but very freely and readily calcines in the fire into a fine plaſter, the uſe of which in building and caſting ſtatues is well known.

The method of repreſenting a face truly in plaſter of Paris is this: The perſon whoſe figure is deſigned is laid on his back, with any convenient thing to keep off the hair. Into each noſtril is conveyed a conical piece of ſtiff paper, open at both ends, to allow of reſpiration. Theſe tubes being anointed with oil, are ſupported by the hand of an aſſiſtant; then the face is lightly oiled over, and the eyes being kept ſhut, alabaſter freſh calcined, and tempered to a thinniſh conſiſtence with water, is by ſpoonfuls nimbly thrown all over the face, till it lies near the thickneſs of an inch. This matter grows ſenſibly hot, and in about a quarter of an hour hardens into a kind of ſtony concretion; which being gently taken off, repreſents, on its concave ſurface, the minuteſt part of the original face. In this a head of good clay may be moulded, and therein the eyes are to be opened, and other neceſſary amendments made. This ſecond face being anointed with oil, a ſecond mould of calcined alabaſter is made, conſiſting of two parts joined lengthwiſe along the ridge of the noſe; and herein may be caſt, with the ſame matter, a face extremely like the original.

If finely powdered alabaſter, or plaſter of Paris, be put into a baſon over a fire, it will, when hot, aſſume the appearance of a fluid by rolling in waves, yielding to the touch, ſteaming, &c. all which properties it again loſes on the departure of the heat; and being thrown upon paper, will not at all wet it, but immediately diſcover itſelf to be as motionleſs as before it was ſet over the fire; whereby it appears, that a heap of ſuch little bodies, as are neither ſpherical nor otherwiſe regularly ſhaped, nor ſmall enough to be below the diſcernment of the eye, may, without fuſion, be made fluid, barely by a ſufficiently ſtrong and various agitation of the particles which compoſe it; and moreover loſe its fluidity immediately upon the ceſſation thereof.

Two or three ſpoonfuls of burnt alabaſter, mixed up thin with water, in a ſhort time coagulate, at the bottom of a veſſel full of water, into a hard lump, notwithſtanding the water that ſurrounded it. Artificers obſerve, that the coagulating property of burnt alabaſter will be very much impaired or loſt, if the powder be kept too long, eſpecially if in the open air, before it is made uſe of; and when it hath been once tempered with water, and ſuffered to grow hard, they cannot, by any burning or powdering of it again, make it ſerviceable for their purpoſe as before.

This matter, when wrought into veſſels, &c. is ſtill of ſo looſe and ſpongy a texture, that the air has eaſy paſſage through it. Mr. Boyle gives an account, among his experiments with the air-pump, of his preparing a tube of this plaſter, cloſed at one end and open at the other; and on applying the open end to the cement, as is uſually done with the receivers, it was found utterly impoſſible to exhauſt all the air out of it; for freſh air from without preſſed in as faſt as the other, or internal air, was exhauſted, though the ſides of the tube were of a conſiderable thickneſs. A tube of iron was then put on the engine; ſo that, being filled with water, the tube of plaſter of Paris was covered with it; and on uſing the pump it was immediately ſeen, that the water paſſed through into it as eaſily as the air had done, when that was the ambient fluid. After this, trying it with Venice turpentine inſtead of water, the thing ſucceeded very well; and the tube might be perfectly exhauſted, and would remain in that ſtate ſeveral hours. After this, on pouring ſome hot oil upon the turpentine, the caſe was much altered; for, the turpentine melting with this, that became a thinner fluid, and in this ſtate capable of paſſing like water into the pores of the plaſter. On taking away the tube after this, it was remarkable that the turpentine, which had pervaded and filled its pores, rendered it tranſparent, in the manner that water gives tranſparency to that ſingular ſtone called *oculus mundi*. In this manner, the weight of air, under proper management, will be capable of making ſeveral ſorts of glues penetrate plaſter of Paris; and not only this, but baked earth, wood, and all other bodies porous enough to admit water on this occaſion.

Plaſter of Paris is uſed as a manure in Pennſylvania, as we find mentioned in a letter from a gentleman in that country, inſerted in the 5th volume of the Bath Society papers, and which we ſhall inſert here for the ſatisfaction and information of our agricultural readers. "The beſt kind is imported from hills in the vicinity of Paris: it is brought down the Seine, and exported from Havre de Grace. There are large beds of it in the bay of Fundy, ſome of which I have ſeen nearly as good as that from France; nevertheleſs ſeveral cargoes brought from thence to Philadelphia have been uſed without effect. It is probable this was taken from the top of the ground, and by the influence of the ſun and atmoſphere diſpoſſeſſed of the qualities neceſſary for the purpoſes of vegetation. The lumps compoſed of flat ſhining ſpecula are preferred to thoſe which are formed of round particles like ſand: the ſimple method of finding out the quality is to pulverize ſome, and put it dry into an iron pot over the fire, when that which is good will ſoon boil, and great quantities of the fixed air eſcape by ebullition. It is pulveriſed by firſt putting it in a ſtamping-mill. The finer its pulverization the better, as it will thereby be more generally diffuſed.

"It is beſt to ſow it in a wet day. The moſt approved quantity for graſs is ſix buſhels per acre. No art is required in ſowing it more than making the diſtribution as equal as poſſible on the ſward of graſs. It operates altogether as a top manure, and therefore ſhould not be put on in the ſpring until the principal froſts are over and vegetation hath begun. The general time for ſowing with us is in April, May, June, July, Auguſt, and even as late as September. Its effects will generally appear in 10 or 15 days; after which the growth of the graſs will be ſo great as to produce a large burden at the end of ſix weeks after ſowing.

"It muſt be ſown on dry land, not ſubject to be overflown. I have ſown it on ſand, loam, and clay, and it is difficult to ſay on which it has beſt anſwered, although the effect is ſooner viſible on ſand. It has been uſed as a manure in this ſtate for upwards of twelve years. Its duration may, from the beſt information I can collect, be eſtimated from ſeven to twelve years; for, like other manure, its continuance very much depends on the nature of the ſoil on which it is placed.

"One of my neighbours ſowed ſome of his graſs ground ſix years ago, another four years ago; a great part of my own farm was ſown in May 1788. We regularly mow two crops, and paſture in autumn; no appearance of failure, the preſent crop being full as good as any preceding. I have this ſeaſon mowed fifty acres of red clover, timothy graſs, white clover, &c. which was plaſtered laſt May, July, and September: many who ſaw the graſs eſtimated the produce at two tons per acre, but I calculate the two crops at three tons. Several ſtripes were left in the different fields without plaſter; theſe were in a meaſure unproductive, being ſcarce worth mowing. In April 1788, I covered a piece of graſs land two inches thick with barn manure; in the ſame worn-out field I ſowed plaſter, to contraſt it with the dung. I mowed the dunged and plaſtered land twice laſt year and once this; in every crop the plaſter has produced the moſt. You will remember, in all experiments with clover, to mix about one-third timothy graſs ſeed; it is of great advantage in ſerving as a ſupport for the clover; it very much facilitates the curing of clover, and when cured is a ſuperior fodder. The plaſter operates equally as well on the other graſſes as on clover. Its effect is ſaid to be good on wheat, if ſown in the ſpring; but I cannot ſay this from experience. On Indian corn I know its operation to be great; we uſe it at the rate of a table-ſpoonful for a hill, put in immediately after dreſſing.

"From ſome accurate experiments laſt year made and reported to our Agricultural Society, it appears that nine buſhels of additional corn per acre were produced by this method of uſing plaſter."

PLASTERING. See Pargeting.

PLASTIC, denotes a thing endowed with a formative power, or a faculty of forming or faſhioning a maſs of matter after the likeneſs of a living being.

Plastic-*Nature*, a certain power by which, as an inſtrument, many philoſophers, both ancient and modern, have ſuppoſed the great motions in the corporeal world, and the various proceſſes of generation and corruption, to be perpetually carried on.

Among the philoſophers of Greece, ſuch a power was almoſt univerſally admitted. It ſeems, indeed, to have been rejected only by the followers of Democritus and Epicurus, who talk as if they had thought gravity eſſential to matter, and the *fortuitous* motion of atoms, which they held to have been from eternity, the ſource not only of all the *regular* motions in the univerſe, but alſo of the *organization* of all corporeal ſyſtems, and even of *ſenſation* and *intellection*, in brutes and in men. It is needleſs to ſay, that thoſe men, whatever they might profeſs, were in reality atheiſts; and Democritus, it is univerſally known, avowed his atheiſm.

The greater part of the philoſophers who held the exiſtence of a plaſtic nature, conſidered it not as an *agent* in the ſtrict ſenſe of the word, but merely as an inſtrument in the hand of the Deity; though even among them there were ſome who held no ſuperior power, and were of courſe as groſs atheiſts as Democritus himſelf. Such was *Strato* of Lampſacus. This man was originally of the peripatetic ſchool, over which he preſided many years, with no ſmall degree of reputation for learning and eloquence. He was the firſt and chief aſſertor of what has been termed *Hylozoic atheiſm*; a ſyſtem which admits of no power ſuperior to a certain *natural* or *plaſtic life*, *eſſential*, *ingenerable*, and *incorruptible*, inherent in matter, but without ſenſe and conſciouſneſs. That ſuch was his doctrine we learn from Cicero, who makes *Velleius* the Epicurean ſay, "Nec audiendus *Strato* qui *Phyſicus* appellatur, qui omnem vim divinam in Natura ſitam eſſe cenſet, quæ cauſas gignendi, augendi, minuendive habeat, ſed careat omni ſenſu." That Strato, in admitting this plaſtic principle, differed widely from Democritus, is apparent from the following account of him by the ſame author: "*Strato Lampſacenus* negat opera deorum ſe uti ad fabricandum mundum, quæcunque ſint docet omnia eſſe effecta *naturæ*, nec ut ille, qui aſperis, et levibus, et hamatis uncinatiſque corporibus concreta hæc eſſe dicat, interjecto inani; ſomnia cenſet hæc eſſe *Democriti*, non docentis ſed optantis."

That the rough and ſmooth, and hooked and crooked, atoms of Democritus were indeed dreams and dotages, is a poſition which no man will controvert; but ſurely Strato was himſelf as great a dreamer when he made ſenſation and intelligence reſult from a certain plaſtic or ſpermatic life in matter, which is itſelf devoid of ſenſe and conſciouſneſs. It is, indeed, inconceivable, to uſe the emphatic language of Cudworth, "how any one in his ſenſes ſhould admit ſuch a monſtrous paradox as this, that every atom of duſt has in itſelf as much wiſdom as the greateſt politician and moſt profound philoſopher, and yet is neither conſcious nor intelligent!" It is to be obſerved of Strato likewiſe, that though he attributed a certain kind of life to matter, he by no means allowed of one common life as ruling over the whole material univerſe. He ſuppoſed the ſeveral parts of matter to have ſo many ſeveral plaſtic lives of their own, and ſeems to have attributed ſomething to chance in the production and preſervation of the mundane ſyſtem.

In denying the exiſtence of a God, perpetually directing his plaſtic principle, and in ſuppoſing as many of theſe principles as there are atoms of matter, Strato deviated far from the doctrine of Ariſtotle. The great founder of the peripatetic ſchool, as well as his apoſtate diſciple, taught that mundane things are not effected by fortuitous mechaniſm, but by ſuch a *nature* as acts regularly and artificially for *ends*; yet he never conſiders this *nature* as the higheſt principle, or ſupreme *Numen*, but as ſubordinate to a perfect mind or intellect; and he expreſsly affirms, that "*mind*, together with *nature*, formed or faſhioned this univerſe." He evidently conſiders mind as the principal and intelligent agent, and nature as the ſubſervient and executive inſtrument. Indeed, we are ſtrongly inclined to adopt the opinion of the learned Moſheim, who thinks that by nature Ariſtotle meant nothing more than that *θερμοτης φυσικη*, or *animal heat*, to which he attributes immortality, and of which he expreſsly ſays that all things are full. Be this as it may, he always joins God and nature together, and affirms that they do nothing in vain. The ſame doctrine was taught before him by Plato, who affirms that "nature, together with reaſon, and according to it, orders all things." It muſt not, however, be concealed, that Plato ſeems to have attributed intelligence to the principle by which he ſuppoſed the world to be animated; for Chalcidius, commenting on the Timæus, thus expreſſes himſelf: "Hæc eſt illa *rationabilis* anima mundi, quæ gemina juxta meliorem naturam veneratione tutelam præbet inferioribus, divinis diſpoſitionibus obſequens, providentiam nativis impertiens, æternorum ſimilitudine propter cognationem beata."—Apuleius, too, tells us, "Illam cœleſtem animam, fontem animarum omnium, optimam virtutem eſſe genetricem, ſubſerviri etiam Fabricatori Deo, et præſto eſſe ad omnia inventa ejus." *Plato pronunciat.*

This doctrine of Plato has been adopted by many moderns of great eminence both for genius and for learning. The celebrated Berkeley biſhop of Cloyne, after giving the view of Plato's *anima mundi*, which the reader will find in our article Motion, thus recommends the ſtudy of his philoſophy: "If that philoſopher himſelf was not read only, but ſtudied alſo with care, and made his own interpreter, I believe the prejudice that now lies againſt him would ſoon wear off, or be even converted into high eſteem, for thoſe exalted notions, and fine hints, that ſparkle and ſhine throughout his writings; which ſeem to contain not only the moſt valuable learning of Athens and Greece, but alſo a treaſure of the moſt remote traditions and early ſcience of the eaſt." Cudworth, and the learned author of *Ancient Metaphyſics*, are likewiſe ſtrenuous advocates for the Ariſtotelian doctrine of a plaſtic nature diffuſed through the material world; and a notion very ſimilar has lately occurred to a writer who does not appear to have borrowed it either from the *Lyceum* or the *Academy*.

This writer is Mr. Young, of whoſe *active ſubſtance*, and its agency in moving bodies, ſome account has been given elſewhere, (ſee Motion.) As a mere unconſcious agent, *immaterial*, and, as he expreſſes himſelf, *immental*, it bears a ſtriking reſemblance to the *plaſtic nature* or *vegetable life* of Cudworth: but the author holds it to be not only the principle of motion, but alſo the *baſis* or *ſubſtratum* of matter itſelf; in the production of which, by certain motions, it may be ſaid to be more ſtrictly *plaſtic* than the *hylarchical* principle, or *vis genetrix*, of any other philoſopher with whoſe writings we have any acquaintance. Though this opinion be ſingular, yet, as its author is evidently a man who thinks for himſelf, unawed by the authority of celebrated names, and as one great part of the utility of ſuch works as ours conſiſts in their ſerving as indexes to ſcience and literature, we ſhall lay before our readers a ſhort abſtract of the reaſonings by which Mr. Young endeavours to ſupport his hypotheſis, and we ſhall take the liberty of remarking upon thoſe reaſonings as we proceed.

The author, af er a ſhort introduction, enters upon his work, in a chapter entitled, *Analyſis of Matter in general*. In that chapter there is little novelty. He treats, as others have done, of primary and ſecondary qualities, and adheres too cloſely to the language of Locke, when he ſays, that "the nature of bodies ſignifies the aggregate of all thoſe *ideas* with which they furniſh us, and by which they are made known." To ſay the beſt of it, this ſentence is inaccurately expreſſed. An aggregate of *ideas* may be occaſioned by the impulſe of bodies on the organs of ſenſe, but the effect of impulſe cannot be that which impels. We ſhould not have made this remark, which may perhaps be deemed captious, were we not perſuaded that the vague and inaccurate uſe of terms is the ſource of thoſe miſtakes into which we cannot help thinking that the very ingenious author has ſometimes fallen. Having juſtly obſerved, that we know nothing directly of bodies but their qualities, he proceeds to inveſtigate the nature of ſolidity.

"Solidity (he ſays) is the quality of body which principally requires our notice. It is that which fills extenſion, and which reſiſts other ſolids, occupying the place which it occupies; thus making extenſion and figure real, and different from mere ſpace and vacuity. If the ſecondary qualities of bodies, or their powers, variouſly to affect our ſenſes, depend on their primary qualities, it is chiefly on this of ſolidity; which is therefore the moſt important of the primary qualities, and that in which the eſſence of body is by ſome conceived to conſiſt. This idea of ſolidity has been judged to be incapable of any analyſis; but it appears evident to me (continues our author), that the idea of ſolidity may be reſolved into another idea, which is that of the power of reſiſting within the extenſion of body. Hence it becomes unneceſſary, and even inadmiſſible, to ſuppoſe that ſolidity in the body is at all a pattern or archetype of our ſenſation."

That ſolidity in the body, and we know nothing of ſolidity any where elſe, is no pattern of any ſenſation of ours, is indeed moſt true (ſee METAPHYSICS): but to reconcile this with what our author aſſerts immediately afterwards, that "ſolidity is no more in bodies than colours and flavours are, and that it is equally with them a *ſenſation* and an *idea*," would be a taſk to which our ingenuity is by no means equal. He affirms, indeed, that ſolidity, as it is ſaid to be in bodies, is utterly incomprehenſible; that we can perfectly comprehend it as a ſenſation in ourſelves, but that in bodies nothing more is required than a power of active reſiſtance to make upon our ſenſes thoſe impreſſions from which we infer the reality of primary and ſecondary qualities. This power of reſiſtance, whether it ought to be called active or paſſive, we apprehend to be that which all other philoſophers have meant by the word *ſolidity*; and though Locke, who uſes the words *idea* and *notion* indiſcriminately, often talks of the *idea* of ſolidity, we believe our author to be the firſt of human beings who has thought of treating *ſolidity* as a ſenſation in the mind.

Though it is wrong to innovate in language, when writing on ſubjects which require much attention, we muſt, however, acknowledge it to be unworthy of inquirers after truth to diſpute about the proper or improper uſe of terms, ſo long as the meaning of him who employs them can be eaſily diſcovered. We ſhall, therefore, follow our author in his endeavours to aſcertain what this power of reſiſtance is which is commonly known by the name of ſolidity. All power he juſtly holds to be active; and having, by an argument * of which we do not perceive the force, attempted to prove that it is by an inward *power*, and not by its *inertia*, that one body prevents another from occupying the ſame place with itſelf, he naturally enough infers matter to be eſſentially active. "But the activity of matter is to be conſidered in a certain limited ſenſe, and its inertneſs is to be regarded in another limited ſenſe; ſo that theſe are compatible within their reſpective limits. The activity of body may be conſidered as belonging to the parts of a compound; its inertia as the inertia formed of thoſe parts. The actions of the parts are everywhere oppoſed to each other, and equal; and hence reſults the inactivity of the whole."

SOLIDITY alone of the primary qualities being poſitive, and peculiar to bodies, and our author having reſolved this into ACTION OR POWER, it follows, by his analyſis, that the ESSENCE OF BODY is reduced to power likewiſe. But, as he properly obſerves, power is an idea of reflection, not acquired by the ſenſes, but ſuggeſted by thought. Hence our knowledge of real exiſtence in body muſt be ſuch as is ſuggeſted to us by our thoughts exerciſed about our ſenſations. "We are capable of acting and producing changes in appearances; and this faculty, which we experience to exiſt in ourſelves, we call power. We are conſcious of the exertion of our own power; and therefore, when we ſee ACTION or CHANGE happen without any exertion of ours, we refer this to other powers without us, and neceſſarily conclude the POWER to exiſt where the change begins or the action is exerted. This power, then, referred to bodies, muſt exiſt in them, or it can exiſt no where."

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* We can only conceive of ſolidity as being a reſiſtance of the *parts* of any body, to a power which endeavours to *ſeparate* them, or to bring them *nearer* together. Now, that which reſiſts any power, and prevents its effect, is alſo a power By reſiſtance, I mean here an active reſiſtance, ſuch as an animal can employ againſt an animal. If a horſe pulls againſt a load, he draws it along; but if he draws againſt another horſe, he is put to a ſtand, and his endeavour is defeated. When any endeavour to change the ſituation of the parts of any ſolid is in like manner prevented from taking effect, and the parts retain their ſituation, the ſituation has plainly been preſerved by an active reſiſtance or power, equivalent to that which was fruitleſsly exerted on them.

Such is our author's reaſoning to prove that matter is eſſentially active, and that from this activity reſults our notion of its ſolidity: but does he not here confound ſolidity with hardneſs, and impenetrability with coheſion? He certainly does; for *water* is as *ſolid*, in the proper ſenſe of the word, as *adamant*, and the particles of *air* as the particles of *iron*. The parts of water are, indeed, ſeparated with eaſe, and thoſe of adamant with difficulty; but it is not becauſe the latter have more ſolidity than the former, but becauſe the power of coheſion, whatever it may be, operates upon them with greater force. Solidity is an attribute of a whole; hardneſs and ſoftneſs reſult from the coheſion of parts. We do not at all perceive the propriety of the ſimile of the horſe pulling a load, and afterwards pulling againſt another horſe. Is it becauſe both horſes are *active* that one of them cannot prevail againſt the other, and becauſe the load is *inactive* that either of them may drag along a maſs of iron of half a ton weight? If ſo, double or triple the maſs, and a very ſtrange phenomenon will be the reſult; for we ſhall have an active whole compounded of two or three inactive parts, even though thoſe parts ſhould not be in contact!

In two chapters, which might eaſily have been compreſſed into one not ſo long as the ſhorteſt of them, our author analyſes *atoms* or the primary particles of matter, and ſtrenuouſly oppoſes their impenetrability. He allows that there are atoms of matter not diviſible by any known force; but as theſe, however ſmall, muſt ſtill be conceived as having extenſion, each of them muſt be compoſed of parts held together by the ſame power which binds together many atoms in the ſame body. This power, indeed, he acknowledges to operate much more forcibly when it cements the parts of a primary atom than when it makes many atoms cohere in one maſs; but ſtill it operates in the ſame manner: and as the ideal analyſis may be carried on *ad infinitum*, the only poſitive idea which is ſuggeſted by atoms, or the parts of atoms, is the idea of a reſiſting power. That this power of reſiſtance, which conſtitutes what is vulgarly called the ſolidity of bodies, may not be abſolutely impenetrable, he attempts to prove, by ſhowing that reſiſtance does in fact take place in caſes where impenetrability, and even ſolidity, are not ſuppoſed by any man.

"Let us endeavour (ſays he) to bring together two like poles of a magnet, and we ſhall experience a reſiſtance to their approximation. Why, then, may not a piece of iron, which between our fingers reſiſts their coming together, reſiſt by an efficacy perfectly ſimilar, though more ſtrongly exerted? If magnetiſm were to act upon our bodies as upon iron, we ſhould feel it; or were magnets endowed with ſenſation, they would feel that which reſiſts their nearer approach. The reſiſting extenſion between the two magnets is permeable to all the rays of light, and, reflecting none, is therefore unſeen; but it is eaſy to conceive that the ſame power which reſiſts the approach of the iron might reſiſt and reflect ſome rays of light. We ſhould then have a viſible object interpoſed between the two magnets, as we have before ſuppoſed it might be a tangible one. It is likewiſe eaſy to conceive that which is tangible and viſible ſo applied to our organs of taſting, of ſmelling, and of hearing, as to excite ideas of flavours, odours, and ſounds. Thus we ſee that an action, in which no ſuppoſition of ſolidity or impenetrability is involved, may be conceived to aſſume all the qualities of matter, by only ſuppoſing a familiar effect extended in its operation."

This reaſoning is exceedingly ingenious, though perhaps not original; but, what is of more importance, it does not approach ſo near to demonſtration as the author ſeems to imagine. If magnets operate by means of a fluid iſſuing from them (ſee MAGNETISM, chap. 3.), thoſe who hold the ſolidity or impenetrability of matter will maintain, that each atom of the magnetic fluid is ſolid and impenetrable. That we do not ſee nor feel theſe atoms, will be conſidered as no argument that they do not exiſt; for we do not ſee, nor in a cloſe room feel, the atoms of the ſurrounding atmoſphere; which yet Mr. Young will acknowledge to have a real exiſtence, and to be capable of operating upon our ſenſes of hearing and ſmelling. Let us however ſuppoſe, that by this reaſoning he has eſtabliſhed the non-exiſtence of every thing in the primary atoms of matter but active powers of reſiſtance, and let us ſee how he conceives the actions of theſe powers to conſtitute what gives us the notion of inert and ſolid body; for that we have ſuch a notion cannot be denied.

To ACT he allows to be an attribute, and juſtly obſerves, that we cannot conceive an attribute to exiſt without a ſubſtance. "But (ſays he) we have traced all phenomena to action as to a generic idea, comprehending under it all forms of matter and motion as ſpecies of that genus. By this analyſis, that complex idea we have uſually denominated matter, and conſidered as the ſuſtance or ſubſtratum to which motion appertained as an attribute, is found to change its character, and to be itſelf an attribute of a ſubſtance eſſentially active, of which one modification of motion produces matter and another generates motion." The action of this ſubſtance Mr. Young determines to be motion (ſee MOTION); and he proceeds to inquire by what kind of motion it produces matter, or inert and reſiſting atoms.

"Whatever portion of the ACTIVE SUBSTANCE is given to form an atom, the following things are neceſſary to be united in ſuch portion of active ſubſtance: *1ſt*, It muſt in ſome reſpect continually move; for otherwiſe it would loſe its nature, and ceaſe to be active. *2dly*, It muſt alſo in ſome other reſpect be at reſt, for otherwiſe it could not form an inactive atom. *3dly*, It muſt preſerve unity within itſelf." The author's proof of the firſt of theſe poſitions we have given elſewhere. The ſecond he holds to be ſelf-evident; and the third he thinks eſtabliſhed by the following reaſoning: "Solidity is the reſult of thoſe actions among the parts of any whole, whereby the unity of the whole is preſerved within itſelf. Several uncohering things may be united by an external bond: this does not conſtitute theſe one ſolid; it may be one bundle: but if ſeveral things cohere, and have a unity preſerved within themſelves, they become one ſolid. An atom is the leaſt and moſt ſimple ſolid."

Having thus proved the neceſſity of theſe three requiſites to the formation of an atom, he obſerves, that "the two firſt can only be united in a rotation of the portion of active ſubſtance about a centre or axis at reſt. By ſuch a motion *all the parts* ſucceſſively occupy *different places* in the orbit of rotation, and therefore move; the centre round which they revolve being at reſt, the *whole portion* is alſo at reſt; and thus the portion is at once moving and quieſcent, as is required. The ſame kind of motion will alſo fulfil the terms of the third requiſite; for a ſubſtance having a revolving motion around its own centre, preſerves its unity by reaſon of all the parts preſerving the ſame relation to the centre: and further, a motion of the active ſubſtance about a centre or axis will be an activity in the ſame orbit, which will act upon and reſiſt whatever ſhall interfere to oppoſe its activity, or deſtroy the unity of the ſphere, by diverting the courſe of the revolving motions. The activity or motion of a portion of ACTIVE SUBSTANCE about a centre will, therefore, give ſolidity to ſuch portion; for it will give it unity and reſiſtance, and in a manner tie together all the parts, forming them into one maſs about their common centre: for they move or are active not *towards* the centre, in which caſe they would be loſt in non-extenſion; nor *from* the centre, where they would diſſipate in boundleſs ſpace; but *about* the centre, preſerving the ſame limits of extenſion: and being in this way active, they in this way reſiſt any other activity oppoſed to them; that is, they reſiſt any action which tends to penetrate or divide this ſphere of revolving activity. Therefore, ſince any portion of active ſubſtance does, by revolving about a centre, become an united, reſiſting, and quieſcent whole, the ſmalleſt portions of the ACTIVE SUBSTANCE which have ſuch motions will become *atoms*, or make the ſmalleſt portions of matter."

Having thus ſhown to his own ſatisfaction how atoms of matter are formed, he next explains, what at firſt he confeſſes may have appeared a paradox, "how the ACTIVE SUBSTANCE, retaining its own nature and eſſential properties, continuing immaterial, unſolid, and active, puts on at the ſame time the form of matter, and becomes material, ſolid, and inert. A ſphere of revolving active ſubſtance as it revolves continually about a centre, and as parts of the ſubſtance, are conſidered as ſucceſſively paſſing through every point in the orbit; conſidered thus in its parts, and in its motions, it is ACTIVE SUBSTANCE, immaterial, and unſolid; but the whole ſphere, conſidered unitically, collectively, and as quieſcent, is in this point of view a ſolid atom, material, and inert."

Such is the ACTIVE SUBSTANCE of Mr. Young, and ſuch his theory of the formation of matter. That he has not with ſervility copied from the ancients, every reader of his book, who is not an abſolute ſtranger to Greek and Roman literature, will readily acknowledge; and yet, if his theory be well founded, he has diſcovered a middle ſubſtance between mind and matter, more properly *plaſtic* than Ariſtotle or Plato, Cudworth or Berkeley, ever conceived. But truth compels us to add, that to us his theory appears to labour under inſuperable objections. That there *may* be in the univerſe a ſubſtance eſſentially active, and at the ſame time not intelligent, is a propoſition which we are by no means inclined to controvert. Various phenomena, both in vegetable and animal life, lead us to ſuſpect that there is ſuch a ſubſtance; but it does not follow that we are inclined to adopt our author's doctrine reſpecting the formation of matter. He conceives his proof, indeed, to be "in its nature not at all imperfect, or to fall ſhort of demonſtration; and if any one refuſe it, he thinks it will be neceſſary for him to ſhow, either that the explanation offered is not ſufficient, or that ſome other explanation will ſerve equally well."

To ſhow that the explanation offered is not ſufficient, will not, we apprehend, be a very arduous taſk; but we have no inclination to attempt ourſelves another explanation, becauſe we believe, that, of the formation of matter, no other account can be given than that which reſolves it into the *fiat* of the Creator. That it cannot be formed by the motion of an immaterial ſubſtance, in the manner which our author has very clearly deſcribed, ſeems to be a truth ſo evident as not to admit of proof; for, if motion be, as he defines it, a change of place, every thing that is moved muſt have the quality of extenſion. But all the parts of this active ſubſtance which are given to form an atom move round a centre, and are expreſsly ſaid to occupy ſucceſſively different *places* in the orbit of rotation. Every one of theſe parts, therefore, is an extended being; and ſince, according to our author, ſolidity is nothing but an *active power of reſiſtance*, and the parts of this active ſubſtance, in their rotation round their centre, *act upon* and *reſiſt* whatever interferes to oppoſe their activity, it follows that each of theſe parts is likewiſe a *ſolid being*. But, in the opinion of Mr. Young himſelf, and of all mankind, whatever is extended and ſolid is material. This theory, therefore, exhibits a proceſs in which atoms are formed of a ſubſtance, which, though it is ſaid to be *active*, *immaterial*, and *unſolid*, appears, when narrowly inſpected, to be nothing elſe than a collection of thoſe very atoms of which the author pretends to explain the formation. Mr. Young, who examines and very freely cenſures ſome of the doctrines of Newton and others, is too much a man of ſcience to be offended at us for ſtating objections to a theory which is quite new, to a tranſformation which he himſelf acknowledges may to many "appear not only problematical and difficult to conceive, but wholly impoſſible, and implying contradictions abſolutely and for ever irreconcileable." Whether this be a juſt character of it our readers muſt determine; but if we did not believe the author to be a man of ingenuity, we ſhould not have introduced him or his work to their acquaintance.

PLASTIC *Art*, the art of repreſenting all ſorts of figures by the means of moulds. This term is derived from the Greek word πλαϛικη, which ſignifies the "art of forming, modelling, or caſting, in a mould." A mould in general is a body that is made hollow for that purpoſe. The artiſt makes uſe of them to form figures in bronze, lead, gold, ſilver, or any other metal or fuſible ſubſtance. The mould is made of clay, ſtucco, or other compoſition, and is hollowed into the form of the figure that is to be produced; they then apply the jet, which is a ſort of funnel, through which the metal is poured that is to form the figures, and that is called *running the metal into the mould*.

It is in this manner, but with much practice and attention, that the artiſt forms, 1. Equeſtrian and pedeſtrian ſtatues of every kind; 2. Groups; 3. Pedeſtals; 4. Bas-reliefs; 5. Medallions; 6. Cannons, mortars, and other pieces of artillery; 7. Ornaments of architecture, as capitals, baſes, &c.; 8. Various ſorts of furniture, as luſtres, branches, &c. in every kind of metal: and in the ſame manner figures are caſt in ſtucco, plaſter, or any other fuſible matter. See PLASTER *of Paris*.

Wax being a ſubſtance that is very eaſily put in fuſion, plaſtics make much uſe of it. There are impreſſions which are highly pleaſing in coloured wax, of medallions, baſſo and alto relievos, and of detached figures; which, however, are ſomewhat brittle. But this matter has been carried too far: they have not only formed moulds to repreſent the likeneſs and the buſt of a living perſon, by applying the plaſter to the face itſelf, and afterwards caſting melted wax into the mould; but they have alſo painted that waxen buſt with the natural colours of the face, and have then applied glaſs eyes and natural hair; to which they have joined a ſtuffed body and limbs, with hands of wax; and have, laſtly, dreſſed their figure in a real habit; and by theſe means have produced an object the moſt ſhocking and deteſtable that it is poſſible to conceive. It is not a ſtatue, a buſt, a natural reſemblance, that they form; but a dead body, a lifeleſs countenance, a mere carcaſe. The ſtiff air, the inflexible muſcles, the haggard eyes of glaſs, all contribute to produce an object that is hideous and diſguſtful to every man of taſte. Figures like theſe offend by affording too exact an imitation of nature. In no one of the polite arts ought imitation ever to approach ſo near the truth as to be taken for nature herſelf. Illuſion muſt have its bounds; without which it becomes ridiculous.

There is another invention far more ingenious and pleaſing, which is that wherein M. Lippart, antiquary and artiſt at Dreſden, has ſo much excelled. He has found the means of reſembling, by indefatigable labour, great expenſe, and infinite taſte, that immenſe number of ſtones, engraved and in camaieu, which are to be ſeen in the moſt celebrated cabinets. He has made choice of thoſe that are the moſt beautiful; and, with a paſte of his own invention, he takes from theſe ſtones an impreſſion that is ſurpriſingly accurate, and which afterwards becomes as marble: theſe impreſſions he calls *paſti*. He then gives them a proper colour, and encloſes each with a gold rim; and, by ranging them in a judicious order, forms of them an admirable ſyſtem. They are fixed on paſteboards, which form ſo many drawers, and are then encloſed in caſes, which repreſent folio volumes, and have titles written on their backs; ſo that theſe fictitious books may conveniently occupy a place in a library. Nothing can be more ingenious than this invention; and, by means of it, perſons of moderate fortune are enabled to make a complete collection of all antiquity has left that is excellent of this kind; and the copies are very little inferior to the originals.

There is alſo another method of taking the impreſſions of camaieus, medals, and coins, which is as follows:—They waſh or properly clean the piece whoſe impreſſion is to be taken, and ſurround it with a border of wax. They then diſſolve iſinglaſs in water, and make a decoction of it, mixing with it ſome vermilion, to give it an agreeable red colour. They pour this paſte, when hot, on the ſtone or medal, to the thickneſs of about the tenth part of an inch; they then leave it expoſed to the ſun, in a place free from duſt. After a few days this paſte becomes hard, and offers to the eye the moſt admirable and faithful repreſentation of the medal that it is poſſible to conceive: they are then carefully placed in drawers; and thouſands of theſe impreſſions, which comprehend many ages, may be included in a ſmall compaſs.

The proficients in plaſtics have likewiſe invented the art of caſting in a mould papier maché, or diſſolved paper, and forming it into figures in imitation of ſculpture, of ornaments and decorations for ceilings, furniture, &c. and which they afterwards paint or gild. There are, however, ſome inconveniences attending this art; as, for example, the imperfections in the moulds, which render the contours of the figures inelegant, and give them a heavy air: theſe ornaments, moreover, are not ſo durable as thoſe of bronze or wood, ſeeing that in a few years they are preyed on by the worm.

The figures that are given to porcelain, Delft ware, &c. belong alſo to plaſtics; for they are formed by moulds, as well as by the art of the ſculptor and turner; and by all theſe arts united are made vaſes of every kind, figures, groups, and other deſigns, either for uſe or ornament.

From this general article the reader is referred to FOUNDERY, CAST, GLAZING, PORCELAIN, PAPIER-*Maché*, POTTERY, DELFT *Ware*.

PLATA, the name of a very great river of South America, running through the province of Paraguay; whence the whole country is ſometimes called *Plata*; though this name is uſually beſtowed only upon a part of Paraguay. In the latter ſenſe it comprehends all that country bounded on the eaſt and ſouth-eaſt by the Atlantic ocean, on the ſouth by Terra Magellanica, on the weſt by Tucuman, and on the north by the provinces of Paraguay Proper and Parana. The great river La Plata, from which the country has its name, was firſt diſcovered, in 1515, by Juan Diaz de Solis; but denominated *La Plata* by Sebaſtian Gabato, from the great quantity of the precious metals he procured from the adjacent inhabitants, imagining it was the produce of the country, though in fact they brought it from Peru.

The country lies between 32° and 37° of ſouth latitude. The climate is pleaſant and healthy. Their winter is in May, June, and July, when the nights are indeed very cold, but the days moderately warm; the froſt is neither violent nor laſting, and the ſnows are very inconſiderable.

The country conſiſts moſtly of plains of a vaſt extent, and exceeding rich ſoil, producing all ſorts of European and American fruits, wheat, maize, cotton, ſugar, honey, &c. and abounding with ſuch excellent paſtures, that the beaſts brought hither from Spain are multiplied to ſuch a degree, that they are all in common, no man claiming any property in them, but every man takes what he hath occaſion for. The number of black cattle, eſpecially, is ſo prodigious, that many thouſands of them are killed merely for their hides, every time the ſhips go for Spain, and their carcaſes left to be devoured by wild beaſts and birds of prey, which are alſo very numerous. Sometimes, when they cannot vend their hides, they will kill them for their tongues; and thoſe who care not to be at the trouble to fetch them from the plains, may buy them for a trifle. There is a curious account in lord Anſon's Voyage of the manner of hunting them on horſeback; and of catching and killing them, by throwing a nooſe on their horns at full gallop, the horſes being trained to the ſpot. Horſes are no leſs numerous, and in common like the other cattle; ſo that a man may have as many as he pleaſes for the catching; and of thoſe that are already broke, one may buy ſome of the beſt, and of the true Spaniſh breed, for a piece of-eight per head. Wild-fowl alſo is in great plenty here: partridges in particular are more numerous, and as large and tame as our hens, ſo that one may kill them with a ſtick. Their wheat makes the fineſt and whiteſt of bread; and, in a word, they ſeem to want for nothing here, eſpecially the natives, but ſalt and fuel. The former the Spaniards have brought to them from other parts; and the latter they ſupply themſelves with, by planting vaſt numbers of almond, peach, and other trees, which require no other trouble than putting the kernels into the ground, and by the next year, we are told, they begin to bear fruit. The return for European commodities is ſo great here, that it almoſt exceeds belief; an ordinary two-penny knife fetching a crown, and a gun of the value of 10 or 12 ſhillings 20 or 30 crowns, and ſo of the reſt.

The river Plata riſes in Peru, and receives a great many others in its courſe, the chief of which is the Paraguay. The water of it is ſaid to be very clear and ſweet, and to petrify wood; and contains ſuch plenty and variety of fiſh, that the people catch great quantities of them without any other inſtrument than their hands. It runs moſtly to the ſouth and ſouth-eaſt, and is navigable the greater part of its courſe by the largeſt veſſels, and full of delightful iſlands. All along its banks are ſeen the moſt beautiful birds of all kinds; but it ſometimes overflows the adjacent country to a great extent, and is infeſted by ſerpents of a prodigious bigneſs. From its junction with the Paraguay to its mouth is above 200 leagues. We may form ſome judgement of its largeneſs by the width of its mouth, which is ſaid to be about 70 leagues. Before it falls into the Paraguay it is called *Panama*. See PANAMA.

PLATÆÆ (anc. geog.), a very ſtrong town of Bœotia, in its ſituation expoſed to the north wind (Theophraſtus); burnt to the ground by Xerxes (Herodotus, Juſtinus); mentioned much in the courſe of the Perſian war; famous for the defeat of Mardonius, the Perſian general, and for the moſt ſignal victory of the Lacedemonians and other Greeks under Pauſanias the Lacedemonian, and Ariſtides an Athenian general (Nepos, Diodorus, Plutarch); in memory of which the Greeks erected a temple to Jupiter Eleutherius, and inſtituted games which they called *Eleutheria*; and there they ſhow the tombs of thoſe who fell in that battle (Strabo). It ſtood at the foot of Mount Cithæron, between that and Thebes to the north, on the road to Athens and Megara, and on the confines of Attica and Megaris. Now in ruins.

PLATALEA, the SPOONBILL, in ornithology, a genus belonging to the order of grallæ. See Pl. 3. The beak is plain, and dilates towards the point into an orbicular form; the feet have three toes, and are half palmated. There are three ſpecies diſtinguiſhed by their colour: and of theſe ſpecies there are three varieties; two of what is called the *white* ſpecies, and one of the *roſeate*.

1. The white ſpecies, which Linnæus calls *platalea leucorodia*, is about the ſize of a heron, but ſomewhat ſhorter in the neck and legs. The bill is more than half a foot long, and, like that of the reſt of the genus, is ſhaped like a ſpoon: the colour of the bill is very various, being in ſome birds black, in others brown, and ſometimes ſpotted; from the baſe to two thirds of its length ſeveral indentations croſs it, the riſing parts of which are of a dark colour: the tongue is ſhort and heart-ſhaped: the irides are grey: the ſkin of the lore round the eyes and of the throat is bare and black: the plumage is entirely white, though there have been ſpecimens where the quills were tipped with black; the legs are generally either black or of a greyiſh brown colour; between the toes there is a membrane connected to the outer one as far as the ſecond, and to the inner as far as the firſt joint.

"This bird (ſays Mr. Latham) is found in various parts of the old continent, and from the Ferro iſles near Iceland to the Cape of Good Hope. It frequents the neighbourhood of the ſea, and has been met with on the coaſts of France; at

Sevenhuys, near Leyden, once in great plenty, annually breeding in a wood there. The neſt is placed on high trees near the ſea-ſide. The female lays three or four white eggs, powdered with a few pale red ſpots, and of the ſize of thoſe of a hen. They are very noiſy during breeding-time, like our rooks; are ſeldom found high up the rivers, chiefly frequenting the mouths of them. Their food is fiſh, which they are ſaid not unfrequently to take from other birds, in the manner of the bald eagle; alſo muſſels and other ſhell-fiſh, being found in greateſt numbers where theſe are plenty; and they will alſo devour frogs and ſnakes, and even graſs and weeds, which grow in the water, as well as the roots of reeds. They are migratory, retiring to the warmer parts as the winter approaches, and are rarely ſeen in England. Their fleſh is ſaid to have the flavour of a gooſe, and is eaten by ſome, and the young birds have been thought good food. By many authors they are called *pelicans*."

The two varieties of this ſpecies are equal in ſize to the roſeate ſpecies. The bill of the firſt is reddiſh; the plumage moſtly white; the feathers of the wings partly white and partly black, and the legs reddiſh. The plumage of the other is entirely white, not excepting even the quills. It has a creſt of feathers whoſe webs are very looſe, and ſeparated from one another; the bill is of a rufous grey colour, having red edges, and the legs are of a dull pale red. They both inhabit the *Philippine iſlands*.

2. The roſeate ſpecies, or *platalea ajaja*, is but a little leſs than the white. The bill is marked all round with a furrow parallel to the edge, and is of a greyiſh white colour, ſo tranſparent as to ſhow the ramification of the blood-veſſels belonging to it: the forehead is of a whitiſh colour between the bill, and eyes, and throat: the plumage is a fine roſe-colour, deepeſt on the wings: the legs are grey; the claws blackiſh; and the toes have membranes as in the laſt ſpecies. The variety of this ſpecies is entirely of a beautiful red colour, having a collar of black at the lower part of the neck; the irides are red. Mr. Latham imagines it is the roſeate in full plumage. It is ſaid to be of a blackiſh cheſtnut the firſt year, becomes roſe-coloured the ſecond, and of a deep ſcarlet the third. It lives on ſmall fiſh.

3. The dwarf ſpecies, or *platalea pigmea*, is about the ſize of a ſparrow. The bill is black, longer than the head, flat at the end, and nearly of a rhomboidal form; the angles and top of the upper mandible are white; the tongue is ſmooth; the body is brown above and white beneath; the quills have white ſhafts; the tail is rounded, ſhort, and of a browniſh white colour; the feet have four toes, are cloven, and the claws are pointed. It inhabits Surinam and Guiana.

PLATANUS, the PLANE-TREE; a genus of the polyandria order, belonging to the monœcia claſs of plants.

The ſpecies are, 1. The *orientalis*, oriental or eaſtern plane-tree, riſes with a very ſtraight ſmooth branching ſtem to a great height. It has palmated leaves, ſix or eight inches long and as much broad, divided into five large ſegments, having the ſide ones cut into two ſmaller, green above, and pale underneath; and long pendulous pedunculi, each ſuſtaining ſeveral round heads of cloſe-ſitting very ſmall flowers; ſucceeded by numerous downy ſeeds, collected into round, rough, hard balls. It is a native of Aſia and many parts of the eaſt, and grows in great plenty in the Levant. 2. The *occidentalis*, occidental or weſtern plane-tree, riſes with a ſtraight ſmooth ſtem to a great height, branching widely round: it has lobated leaves, ſeven or eight inches long, and from nine or ten to twelve or fourteen broad, divided into three large lobes; and very ſmall flowers, collected into round heads, ſucceeded by round rough balls of ſeed. It is a native of Virginia and other parts of North America, where it attains an enormous ſize, and is remarkable for having its ſtem all of an equal girt for a conſiderable length: we have an account of ſome trees being eight or nine yards in circumference, and which, when felled, afforded 20 loads of wood. The varieties of theſe two ſpecies are the Spaniſh or middle plane-tree, having remarkably large leaves of three or five narrower ſegments; and the maple-leaved plane-tree, having ſmaller leaves ſomewhat lobated into five ſegments, reſembling the maple-tree leaf.

All theſe elegant trees are of hardy temperature, ſo as to proſper here in any common ſoil and expoſure in our open plantations, &c. and are ſome of the moſt deſirable trees of the deciduous tribe. They were in ſingular eſteem among the ancients of the eaſt for their extraordinary beauty, and the delightful ſhade they afforded by their noble foliage. The leaves commonly expand in May, and fall off early in autumn; and the flowers appear in ſpring, a little before the leaves, being ſucceeded by ſeeds, which in fine ſeaſons frequently ripen here in September. Theſe fine trees are ſingularly fitted for all ornamental plantations. Their ſtraight growth, regular branching heads, and the lofty ſtature they attain, together with the extraordinary breadth of their luxuriant leaves, render them extremely deſirable furniture to adorn avenues, lawns, parks, and woods; ſome diſpoſed in ranges, ſome as ſingle ſtandards, others in clumps, ſome in groves, &c. They are moſt excellent for ſhade; for it is obſervable, that no tree is better calculated to defend us from the heat in ſummer, by its noble ſpreading foliage, and to admit the ſun's rays more freely in winter, on account of the diſtance of its branches, which is always in proportion to the ſize of the leaves. They may alſo be employed in the collection of foreſt-trees, in woods, to grow up to timber, in which caſe they will alſo prove advantageous in time. In ſhort, theſe noble trees claim the eſteem of every one concerned in plantations of every kind, but more particularly in extenſive ones, where they may be ſo variouſly diſpoſed as to have a charming effect.

The *propagation* of theſe trees is by ſeed, layers, and cuttings. The ſeeds frequently ripen in theſe parts, and are alſo procured from other countries, and may be obtained of the nurſerymen or ſeedſmen. The beſt ſeaſon for ſowing them is autumn, if they can be then poſſibly procured. Chooſe a ſomewhat ſhady moiſt ſoil; and having dug the ground, and raked it fine, form it into four-feet-wide beds, and either ſcatter the ſeeds evenly on the ſurface and rake them in, or previouſly with the back of a rake turn the earth off the ſurface near half an inch deep into the alleys; then ſow the ſeed, and directly, with the rake turned the proper way, draw the earth evenly over the ſeeds, and trim the ſurface ſmooth: many of the plants will riſe in ſpring, and probably may not till the ſpring following. When they are one or two years old, plant them out in nurſery rows, two or three feet aſunder, and about half that diſtance in the lines; here to remain till of a proper ſize for final tranſplantation. The method of propagation by layers is very commonly practiſed in the nurſeries, in default of ſeed, and by which they moſt readily grow; for which purpoſe, ſome ſtout plants for ſtools muſt be planted, which in a year after muſt be headed down near the bottom, that they may throw out many ſhoots near the ground convenient for laying; which, in the autumn after they are produced, lay by for ſlit-laying; and by autumn after they will be well rooted, and form plants two or three feet high, ſo may be ſeparated, and planted in nurſery-rows like the ſeedlings. All the ſorts will take tolerably by cutting off the ſtrong young ſhoots; but the *platanus occidentalis* more freely than the oriental kind. Autumn is the beſt ſeaſon: as ſoon as the leaf falls, chooſe ſtrong young ſhoots, and plant them in a moiſt ſoil; many of them will grow, and make tolerable plants by next autumn. It ſhould be remarked, that, in order to continue the diſtinction of the varieties more effectually, they ſhould be propagated either by layers or cuttings; for, when raiſed from ſeed, thoſe of the reſpective ſpecies generally vary.

PLATBAND, in gardening, a border or bed of flowers, along a wall, or the ſide of a parterre, frequently edged with box, &c.

Platband of a door or window, is uſed for the lintel, where that is made ſquare, or not much arched.

PLATE, a term which denotes a piece of wrought ſilver, ſuch as the ſhallow veſſel off which meat is eaten. It is likewiſe uſed by our ſportſmen to expreſs the reward given to the beſt horſe at our races.

The winning a plate is not the work of a few days to the owner of the horſe; but great care and preparation is to be made for it, if there is any great dependence on the ſucceſs. A month is the leaſt time that can be allowed to draw the horſe's body clear, and to refine his wind to that degree of perfection that is attainable by art.

It is firſt neceſſary to take an exact view of his body, whether he be low or high in fleſh; and it is alſo neceſſary to conſider whether he be dull and heavy, or briſk and lively, when abroad. If he appear dull and heavy, and there is reaſon to ſuppoſe it is owing to too hard riding, or, as the jockeys expreſs it, to ſome greaſe that has been diſſolved in hunting, and has not been removed by ſcouring, then the proper remedy is half an ounce of diapente given in a pint of good ſack; this will at once remove the cauſe, and revive the creature's ſpirits. After this, for the firſt week of the month, he is to be fed with oats, bread, and ſplit beans, giving him ſometimes the one and ſometimes the other as he likes beſt, and always leaving ſome in the locker, that he may feed at leiſure when he is left alone. When the groom returns at the feeding-time, whatever is left of this muſt be removed, and freſh given; by this means the creature will ſoon become high-ſpirited, wanton, and full of play. Every day he muſt be rode out an airing, and every other day it will be proper to give him a little more exerciſe, but not ſo much as to make him ſweat too much. The beans and oats in this caſe are to be put into a bag, and beaten till the hulls are all off, and then winnowed clean; and the bread, inſtead of being chipped in the common way, is to have the cruſt clean cut off. If the horſe be in good fleſh and ſpirits when taken up for its month's preparation, the diapente muſt be omitted, and the chief buſineſs will be to give him good food, and ſo much exerciſe as will keep him in wind, without overſweating him or tiring his ſpirits. When he takes larger exerciſes afterwards, towards the end of the month, it will be proper to have ſome horſes in the place to run againſt him. This will put him upon his mettle, and the beating them will give him ſpirits. This, however, is to be cautiouſly obſerved, that he has not a bloody heat given him for ten days or a fortnight before the plate is to be run for, and that the laſt heat that is given him the day before the race muſt be in his clothes: this will make him run with greatly more vigour when ſtripped for the race, and feeling the cold wind on every part.

In the ſecond week, the horſe ſhould have the ſame food, and more exerciſe. In the laſt fortnight he muſt have dried oats, that have been hulled by beating. After this they are to be wetted in a quantity of whites of eggs beaten up, and then laid out in the ſun to dry; and when as dry as before, the horſe is to have them. This ſort of food is very light of digeſtion, and very good for the creature's wind. The beans in this time ſhould be given more ſparingly, and the bread ſhould be made of three parts wheat and one part beans. If he ſhould become coſtive under this courſe, he muſt then have ſome ale and whites of eggs beaten together; this will cool him, and keep his body moiſt.

In the laſt week the maſh is to be omitted, and barley-water given him in its place every day till the day before the race: he ſhould have his fill of hay; then he muſt have it given him more ſparingly, that he may have time to digeſt it; and in the morning of the race-day he muſt have a toaſt or two of white bread ſoaked in ſack, and the ſame juſt before he is let out to the field. This is an excellent method, becauſe the two extremes of fulneſs and faſting are at this time to be equally avoided; the one hurting his wind, and the other occaſioning faintneſs that may make him loſe. After he has had his food, the litter is to be ſhook up, and the ſtable kept quiet, that he may be diſturbed by nothing till he is taken out to run.

PLATFORM, in the military art, an elevation of earth, on which cannon is placed to fire on the enemy; ſuch are the mounts in the middle of curtins. On the ramparts there is always a platform, where the cannon are mounted. It is made by the heaping up of earth on the rampart, or by an arrangement of madriers, riſing inſenſibly, for the cannon to roll on, either in a caſemate or on attack in the outworks. All practitioners are agreed, that no ſhot can be depended on, unleſs the piece can be placed on a ſolid platform; for, if the platform ſhakes with the firſt impulſe of the powder, the piece muſt likewiſe ſhake; which will alter its direction, and render the ſhot uncertain.

Platform, in architecture, is a row of beams which ſupport the timber-work of a roof, and lie on the top of a wall where the entablature ought to be raiſed. This term is alſo uſed for a kind of *terrace* or broad ſmooth open walk at the top of a building, from whence a fair proſpect may be taken of the adjacent country. Hence an edifice is ſaid to be covered with a platform, when it is flat at top, and has no ridge. Moſt of the oriental buildings are thus covered, as were all thoſe of the ancients.

Platform, or *Orlop*, in a man of war, a place on the lower deck, abaft the main-maſt, between it and the cockpit, and round about the main capſtan, where proviſion is made for the wounded men in time of action.

PLATINA is a metallic ſubſtance not long diſcovered. The name, which has an alluſion to its colour, is a diminutive of *plata*, and ſignifies "little ſilver." From its great ſpecific gravity, and other reſemblances which it has to gold, it has been called *or blanc*, or *white gold*; from its refractory nature, *diabolus metallorum*; from ſome doubts entertained of its character as a metal, *juan blanco*, *white jack*, *white rogue*, or *white mock metal*. It has alſo received the appellation of the *eighth metal*; and, probably from ſome diſtrict which affords it, has gotten the name of *platina del Pinto*.

The firſt in Europe who mentioned it by its preſent name was Don Antonio Ulloa, a Spaniſh mathematician, who in 1735 accompanied the French academicians that were ſent by their ſovereign to determine the figure of the earth by meaſuring a degree of the meridian in Peru. In the relation of his voyage, which was publiſhed at Madrid in 1748, he ſays, that the golden mines in the territory of Choco had been abandoned on account of platina; which he repreſents as a hard ſtone not eaſily broken by a blow on the anvil, which could not be ſubdued by calcination, and from which the gold could not be extracted without much labour, much expenſe, and great difficulty.

The particular places of Choco where it is found are Novita and Citara; but in what quantity it is there to be met with is not aſcertained. The miners, diſcovering at an early period that it was a metal, had begun to employ it in adulterating their gold; and the court of Spain, it is ſaid, dreading the conſequences, took meaſures not only to prevent its exportation, but partly to conceal the knowledge of it from the world. It is reported in the Chemical Annals for July 1792, that when the gold is brought from Choco to be coined in the two mints of Santa-fé, in that of Bogota and Popayan, the gold undergoes a new examination, the platina that remains is carefully ſeparated; and being given to officers appointed by the king, they, as ſoon as a certain quantity is collected, carry it away, and before witneſſes throw it into the river Bogota, at two leagues diſtance from Santa-fé, or into the Cauca, about one league diſtant from Popayan.

In the Phyſical Journals for November 1785 we are told, that the primitive mines which produced it have not yet been diſcovered in any part of the globe, and that thoſe which furniſh it at preſent are of the ſecondary kind, being ſtrata of looſe earth waſhed down from the higher grounds. In theſe ſtrata the particles are reported to be from the ſize of a millet ſeed to that of a pea. The author of the account ſays, that he had ſome pieces which weighed from 15 to 20 grains; and adds, that on trying ſome of them between ſteel rollers in the preſence of Meſſrs. Darcet and Tillet at Paris, they were perfectly laminated. He ſays alſo, that a native piece of platina was found nearly of a ſquare figure, and almoſt as large as a pigeon's egg, which was depoſited in the Royal Society of Biſcay. M. de Buffon, however, ſays expreſsly, that "a perſon of credit had aſſured him that platina is ſometimes found in large maſſes; and that he had ſeen a lump of it weighing no leſs than 20lb. which had not been melted, but taken in that ſtate out of the mine." As to the ſmall particles, they are of a whiter colour than iron, with a ſmooth ſurface. Their figure is generally of an oblong form, very flat, rounded in the edge, and has been aſcribed to the hammering of the mills in which the gold is amalgamated.

The heterogeneous ſubſtances with which the platina is generally mixed are particles of gold, grains of quartz or cryſtal, ſome ſand of a browniſh hue, and ſome duſt of a dark colour obedient to the magnet, and which ſeems to be fragments of other irregular dark coloured particles, which reſemble pieces of emery or loadſtone. Dr. Ingenhouſz, however, ſays, that every particle even of ſome fine platina which he examined obeyed the magnet more or leſs, excepting ſome that were tranſparent and ſtony; and that theſe were all magnets in themſelves, or that each of theſe particles had two poles, which he could change at pleaſure by magnetic bars. In about 72 pounds weight of platina which was brought from Spaniſh America, M. Magellan found not only a large quantity of ferruginous ſand, but many pieces of vegetable ſtalks, a number of ſeeds, and ſome very ſmall red cryſtals like rubies. Theſe cryſtals being ſent to M. Achard of Berlin, he tried them as far as their minuteneſs and ſmall quantity would permit, and at laſt concluded that they really were rubies. As for the mercurial globules which are ſometimes intermixed with the particles of platina, they are entirely foreign to its mines. They are now generally thought to be part of the mercury that has been employed in amalgamation; and which could not be brought from a place leſs diſtant than Guancavelica, about 900 miles from the province of Choco where the platina is found.

This metal, though not under its preſent name, which was firſt mentioned by Don Ulloa, has perhaps been known in Europe ſince 1741. At that period Charles Wood found in Jamaica ſome platina which was brought from Carthagena. He even made ſome chemical trials of it. Among others, he attempted to cupel it; and obſerves, in the account which he gave of it in 1749, that the Spaniards had a method of caſting it into different ſorts of toys, which are common enough in the Spaniſh Weſt Indies. It was probably, too, imported into Spain ſoon after its diſcovery in America. It is ſaid that Rudenſcheel carried ſome of it from Spain to Stockholm in 1745; and the firſt important ſet of experiments that appeared on the ſubject were thoſe of Scheffer, one of the members of the Swediſh Academy. They were publiſhed in 1752; and gave this information, that platina is eaſily fuſible with arſenic, but when alone remains unchanged by the moſt violent heat of the furnace. Two years after Dr. Lewis publiſhed ſome papers concerning this metal in the Royal Philoſophical Tranſactions of London. This eminent chemiſt, in the courſe of his experiments, had examined it both in the dry and the wet way; diſcovered a number of its relative affinities; mixed it in different proportions with different metals; and had fuſed it with arſenic, though he did not afterwards attempt to ſeparate them.

In 1757 Margraaf publiſhed ſeveral very intereſting obſervations about the method of ſeparating it from the iron which always accompanies it.

In 1758 and 1763 Macquer and Beaumé made upon it a conſiderable number of experiments together, and formed of it at laſt a concave mirror.

And it was in 1780 that the *Journaux de Phyſique* gave an account of the labours of Bergman on the ſame ſubject.

The platina of which the toys were made in the Spaniſh Weſt Indies was found by Dr. Lewis to be always mixed with ſome other metals. What theſe particular mixtures were is not well known; but many of the allays formed by Dr. Lewis himſelf have promiſed to be both ornamental and uſeful. He found that platina, which is $\frac{1}{5}$ of the whole maſs, will render gold no paler than a guinea, which contains only $\frac{1}{12}$ of ſilver. He found that copper was much improved by allaying it with platina in certain proportions; and that equal parts of platina and braſs formed a compound not ſubject to tarniſh, and which might be employed with great advantage for the ſpeculums of teleſcopes.

Beſides allaying it with the different metals, it was an object equally intereſting to the chemiſts and ſociety that platina ſhould be obtained pure and unmixed; and that means ſhould be contrived to render it fuſible, malleable, and ductile. We are now to ſee what the chemiſts have done to accompliſh theſe ends. They readily ſaw that it would be neceſſary, in the firſt place, to bring it to a ſtate of ultimate diviſion, and that this ſhould be tried in one or other of theſe two ways; by diſſolving it in acids, or by fuſing it along with ſome other metal; for by itſelf it had hitherto proved abſolutely unfuſible, except when expoſed to the focus of a large burning-glaſs, or the kindled ſtream of dephlogiſticated or vital air. Among the methods which they employed to ſeparate it from gold, the principal were the following: The firſt was by uniting the mixture of platina and gold with mercury, and grinding the amalgam for a conſiderable time with water; in which proceſs the platina was gradually thrown out, and the gold retained by the quickſilver. Another method was by mixing a few drops of a ſolution of platina with above a hundred times the quantity of a ſolution of gold, and gradually adding a pure fixed alkaline ſalt as long as it occaſioned any efferveſcence or precipitation. The remaining liquor in this caſe was ſo yellow, that it has been judged the platina would diſcover itſelf, though its proportion had been leſs than a thouſandth part of that of gold. A third mode of ſeparating platina and gold was that of precipitation, by means of mineral fixed alkali: for, when this alkali is mixed with a ſolution of gold containing platina, the gold alone is precipitated, and all the platina remains diſſolved. Another method was by precipitation of the platina with ſal ammoniac. For this purpoſe, to a ſolution of the metal in aqua regia a ſmall quantity of the ſolution of ſal ammoniac in water was added; and if the gold contained any platina, the liquor inſtantly grew turbid, and a fine yellow or reddiſh precipitate quickly fell to the bottom; if the gold was pure, no precipitation or change of tranſparency enſued. The fifth method of ſeparation was by means of inflammable liquors. The compound to be examined was diſſolved in aqua regia: the ſolution mingled with twice its quantity or more of rectified ſpirit of wine, and the mixture ſuffered to ſtand for ſome days in a glaſs ſlightly covered, the gold roſe to the ſurface, leaving the platina diſſolved. Otherwiſe, to the ſolution of the metal in aqua regia about half its quantity of any colourleſs eſſential oil was added: the two were ſhaken well together, and ſuffered to reſt: upon which the oil roſe immediately to the ſurface, carrying the gold with it, and leaving the platina diſſolved in the acid under it. Or, the gold was taken up ſtill more readily and more perfectly by ether, or the ethereal ſpirit of wine. But, after all, the moſt effectual and advantageous method of ſeparating platina from gold was founded on a property which gold has, and not platina, of being capable of precipitation from aqua regia by martial vitriol; and upon a property which platina has, and not gold, of being capable of precipitation from aqua regia by ſal ammoniac. When therefore we would diſcover if gold be allayed with platina, let it be diſſolved in aqua regia; and to this ſolution, which will contain both metals, let ſome ſal ammoniac diſſolved in water be added; upon which the platina will be precipitated in form of a brick-coloured ſediment. If, on the other ſide, we would know if platina contain any gold, let this platina be diſſolved in aqua regia, and to the ſolution add a ſolution of martial vitriol in water; upon which the liquor will become turbid, and the gold will form a precipitate which may be eaſily ſeparated by decanting and filtrating the liquor. This property which platina poſſeſſes of being precipitated by martial vitriol was firſt diſcovered by M. Scheffer.

With reſpect to the iron contained among the platina, M. de Buffon ſeparated, by means of a magnet, ſix parts out of ſeven of a parcel of platina. He diſtinguiſhed two different matters in platina; of which one was black, friable, and attractable by magnets; and the other conſiſted of larger grains, was of a livid white or yellowiſh colour, much leſs attractable, and was extenſible. Between theſe two different matters were many intermediate particles, ſome partaking more of the former, and ſome of the latter. He thought that the black matter was chiefly iron; and ſays, that he had obſerved a ſimilar black powder in many ores of iron.

M. Morveau found, that a Pruſſian blue could be obtained from the black part of the platina, by pouring upon it ſpirit of nitre, and afterwards adding to the ſolution diluted ſome phlogiſticated alkali; and that the particles of platina which could not be attracted by magnets, did not by this method ſhow any ſign of their containing iron.

But the moſt important diſcovery concerning the ſeparation of platina from other metals was a method of melting it, by which it became a perfect metal, malleable, and denſer than gold. It was in 1773 and 1774 that M. de Liſle effected this, by diſſolving crude platina in aqua regia, precipitating it from the acid menſtruum by ſal ammoniac, and by fuſing this precipitate, without addition, in a double crucible, expoſed to the intenſe heat of a forge fire excited by double bellows. M. Morveau has repeated the experiment, and found that he could melt the precipitate with ſeveral fluxes; he found likewiſe that by means of white glaſs, borax, and charcoal, he could melt even crude platina, and could allay together platina and ſteel in various proportions.

M. de Sickengen was the inventor of another method: he diſſolved his platina in aqua regia, and precipitated the iron by the pruſſiate of potaſh. In evaporating this liquor he obtained ſmall octaedral cryſtals of the colour of rubies; which, being expoſed to a ſtrong heat, yielded a metal which bore eaſily the ſtroke of the hammer, which could be readily drawn into wire, and was extremely malleable.

In attempting to refine platina by the dry way, cupellation was a method to which the chemiſts early had recourſe; but, notwithſtanding their utmoſt endeavours, it has not been attended with all the ſucceſs which could have been wiſhed. It was found that the ſcorification proceeded as well at the beginning of the operation as when gold and ſilver are cupelled: but the cupellation afterwards became more and more difficult; becauſe, as the quantity of lead diminiſhed, the matter became leſs and leſs fuſible, and at laſt ceaſed to be fluid, notwithſtanding the moſt violent heat; and alſo becauſe, when the quantity of platina was greater than that of the lead, this latter metal was protected, and not converted into litharge. Hence the regulus obtained was always dark-coloured, rough, adhering to the cupel, brittle, and weighing more than the platina originally employed, from the lead which remained united with it. Meſſ. Macquer and Beaumé appear nevertheleſs to have carried this experiment further: they kept the matter expoſed to a violent fire during a longer time; that is, about 50 hours ſucceſſively: and therefore, although their platina was tarniſhed and rough on its ſurface, it was internally white and ſhining, eaſily ſeparable from the cupel, and a little diminiſhed in weight; a certain proof that no lead remained in it. This platina was alſo ductile, and capable of extenſion under the hammer.

Cupellation, therefore, though not the beſt, is at leaſt a certain method of applying platina to uſe, and of forming it into utenſils.

What has been thought a preferable method, is firſt to fuſe the platina with arſenic, and afterwards diſſipate this laſt metal by a ſtrong heat: by this means Achard and Rochon were able to obtain a pure platina; of which the former made ſome ſmall crucibles, and the latter, by allaying it with copper and tin, ſome large mirrors for reflecting teleſcopes.

Jeanety of Paris has gone ſtill farther: beſides ſnuff-boxes, watch-chains, and a coffee-pot of platina prepared by this artiſt, the world has ſeen a lens weighing ſix pounds, a ball weighing nine, and two bars 19 feet long, and weighing no leſs than 11 pounds each. This gentleman has the merit of being the firſt who wrought this metal in the great way. The method he employed was far from being new; it had been ſuggeſted by Scheffer, by Willis, by Margraaf, and was afterwards practiſed by Achard, Morveau, and a great many others, but who always prepared it in very ſmall quantities. In the Chemical Annals for July 1792, the following account of it is given by himſelf:

The platina is firſt pounded in water to diſengage it from the ferruginous and other heterogeneous particles that are mixed with it. "This being done, I take (ſays he) one pound and a half of platina, two pounds of white arſenic in powder, and one pound of purified potaſh. I mix the whole: I put a crucible in the fire capable of containing about 20 pounds; when my furnace and crucible are well heated, I throw into the crucible one-third of the mixture, and apply a good heat: I then add a ſecond quantity and a third, and ſo on, always taking care at every time to mix the whole with a rod of platina. I give now a conſiderable force to the fire; and when I am certain that the whole is completely in a ſtate of fuſion, I withdraw my crucible and leave it to cool. After breaking it, I find a button that is well formed and attractable by the magnet. I bruiſe this button into ſmall pieces, and fuſe it a ſecond time in the ſame manner: if this ſecond fuſion, which it generally is, be not ſufficient to effect the ſeparation of the iron from the platina, I fuſe it a third time; but if I be obliged to do it a third time, I always put two buttons together, to ſave at once a crucible and charcoal.

This firſt operation being finiſhed, I take a crucible with a flat bottom and of a circumference to give to the button about three inches and a quarter in diameter. I make this crucible red hot, and throw into it one pound and a half of the platina which has been already fuſed with the arſenic after it was broken into ſmall pieces; to this I add a quantity of arſenic of the ſame weight, and about half a pound of refined potaſh. I give to the fire a conſiderable force; and when I am certain that the whole is completely in a ſtate of fuſion, I withdraw my crucible and leave it to cool, taking care always to place it horizontally, that the button may be of an equal thickneſs. After breaking the crucible, I find a button clear and ſonorous, and weighing commonly about 1 pound and 11 ounces. I have remarked, that in proportion to the quantity of arſenic combined with the platina, the purification always ſucceeds with the more or leſs promptneſs and eaſe; and the greater the proportion ſo much the better. In this ſtate I put my button into a furnace under a muffle, which ought not to be higher than the edge of the button lying on its flat ſide, and inclining a little to the walls of the muffle. In this manner I place three buttons on each ſide of the muffle, and apply fire to my furnace, that the muffle may be equally heated throughout: as ſoon as the buttons begin to evaporate I ſhut the doors of my furnace, that the heat may be kept up to the ſame degree: this ought always to be carefully attended to even to the end of the operation; for even a temporary exceſs of heat might ſpoil the whole of my paſt operations and render them abortive. I cauſe my buttons to volatilize during ſix hours, always taking care to change their ſituation, that every part may receive an equal portion of heat: I then put them in common oil, and for a like time keep them in a fire ſufficient to diſſipate the oil in ſmoke. I continue this operation as long as the button emits vapours; and when the evaporation has ceaſed I puſh the fire as far as it will go by means of the oil. Theſe arſenical vapours have a bright ſhining metallic appearance, which I never can obtain any other way, and without which I have never been able to render platina perfectly malleable.

"If theſe ſteps which are here pointed out be properly followed, the operation laſts only eight days. My buttons are then thrown into the nitrous acid, and afterwards boiled in diſtilled water, till no part of the acid remains with them: I now heap them together one above another, apply the ſtrongeſt poſſible heat, and beat them with a hammer, taking always care at the firſt heat to make them red hot in the crucible, that no foreign bodies may mix with them, as before this compreſſion they are only ſo many ſpongy maſſes. I afterwards heat them in a naked ſtate *(les chauffe à nud)*; and bringing them to a ſquare form, I hammer them on all ſides for a ſhorter or longer time according to their bulk."

Such is the proceſs obſerved by Jeanety in fuſing platina; but he thinks that the working of this metal is ſuſceptible of ſtill greater improvement. In 1788 it was accordingly propoſed by ſome of the French chemiſts to fuſe platina by mixing it with charcoal and phoſphoric glaſs, and afterwards to expoſe the phoſphure of platina to a heat ſufficient to volatilize and diſſipate the phoſphorus. This method ſucceeded remarkably well with M. Pelletier; but, beſides being tedious, it is difficult to ſeparate the laſt portions of the phoſphorus; and as theſe operations are always coſtly, there are few artiſts who are willing to undertake them. M. de Morveau has alſo fuſed platina with his vitreous flux, made of pounded glaſs, borax, and charcoal: and Beaumé has adviſed to fuſe it with a ſlight addition of lead, biſmuth, antimony, or arſenic, and by keeping the alloy in the fire a long time to diſſipate the metals which have facilitated the fuſion. Platina may likewiſe be fuſed with a metal ſoluble in an acid: the mixture being pulverized, the alloyed metal may be diſſolved, and the powder of platina may then be fuſed with the flux of De Morveau; or, inſtead of a ſoluble metal, a calcinable metal may be employed, and heated as before.

The colour of platina, when properly refined, is ſomething between that of iron and ſilver; it has no ſmell, and is the heavieſt body yet known in nature. According to Mr. Kirwan, its ſpecific gravity is to that of water as 23 to 1. It may likewiſe be ſaid to be the moſt durable of all the metals: it is harder than iron; it undergoes no alteration in the air, and fire alone does not even appear to poſſeſs the power of changing it; for which reaſon it forms the beſt of all crucibles that have yet been invented. It reſiſts the action of acids, alkalis, and ſulphurs: it may be rolled into plates as fine as leaves of gold which are uſed in gilding; it is likewiſe extremely ductile: and Dr. Withering tells us, that a wire of platina is ſtronger than a wire of gold or ſilver of the ſame thickneſs; it is preferable to gold by the property which it has of ſoldering or welding without mixture; and it unites, ſays Chaptal, two qualities never before found in one and the ſame ſubſtance. When formed into a mirror, it reflects but one image, at the ſame time that it is as unchangeable as a mirror of glaſs.

As thoſe motives which at firſt prepoſſeſſed the court of Spain againſt this metal no longer exiſt, it is to be hoped that the decree which was paſſed againſt it will ſoon be revoked, and that the Spaniſh monarch will neither deſpiſe ſo rich a treaſure as his mines of platina, nor refuſe to the world the numerous advantages that may be derived from a ſubſtance that promiſes to be of ſo much importance in commerce and the arts.

PLATING, is the art of covering baſer metals with a thin plate of ſilver either for uſe or for ornament. It is ſaid to have been invented by a ſpur-maker, not for ſhow but for real utility. Till then the more elegant ſpurs in common uſe were made of ſolid ſilver, and from the flexibility of that metal they were liable to be bent into inconvenient forms by the ſlighteſt accident. To remedy this defect, a workman at Birmingham contrived to make the branches of a pair of ſpurs hollow, and to fill that hollow with a ſlender rod of ſteel or iron. Finding this a great improvement, and being deſirous to add cheapneſs to utility, he continued to make the hollow larger, and of courſe the iron thicker and thicker, till at laſt he diſcovered the means of coating an iron ſpur with ſilver in ſuch a manner as to make it equally elegant with thoſe which were made wholly of that metal. The invention was quickly applied to other purpoſes; and to numberleſs utenſils which were formerly made of braſs or iron are now given the ſtrength of theſe metals, and the elegance of ſilver, for a ſmall additional expence.

The ſilver plate is generally made to adhere to the baſer metal by means of ſolder; which is of two kinds, the *ſoft* and the *hard*, or the *tin* and *ſilver* ſolders. The former of theſe conſiſts of tin alone, the latter generally of three parts of ſilver and one of braſs. When a buckle, for inſtance, is to be plated by means of the ſoft ſolder, the ring, before it is bent, is firſt tinned, and then the ſilver-plate is gently hammered upon it. the hammer employed being always covered with a piece of cloth. The ſilver now forms, as it were, a mould to the ring, and whatever of it is not intended to be uſed is cut off. This mould is faſtened to the ring of the buckle by two or three cramps of ſmall iron-wire; after which the buckle, with the plated ſide undermoſt, is laid upon a plate of iron ſufficiently hot to melt the tin, but not the ſilver. The buckle is then covered with powdered reſin, or anointed with turpentine; and leſt there ſhould be a deficiency of tin, a ſmall portion of melted tin is likewiſe melted on it. The buckle is now taken off with a tongs, and commonly laid on a bed of ſand, where the plate and the ring, while the ſolder is yet in a ſtate of fuſion, are more cloſely compreſſed by a ſmart ſtroke with a block of wood. The buckle is afterwards bent and finiſhed.

Sometimes the melted tin is poured into the ſilver mould, which has been previouſly rubbed over with ſome flux. The buckle ring is then put among the melted tin, and the plating finiſhed. This is called by the workmen *filling up*.

When the hard ſolder is employed, the proceſs is in many reſpects different. Before the plate is fitted to the iron or other metal, it is rubbed over with a ſolution of borax. Stripes of ſilver are placed along the joinings of the plate; and inſtead of two or three cramps, as in the former caſe, the whole is wrapped round with ſmall wire; the ſolder and joinings are again rubbed with the borax, and the whole put into a charcoal fire till the ſolder be in fuſion. When taken out the wire is inſtantly removed, the plate is cleaned by the application of ſome acid, and afterwards made ſmooth by the ſtrokes of a hammer.

Metal plating is when a bar of ſilver and copper are taken of at leaſt one equal ſide. The equal ſides are made ſmooth, and the two bars faſtened together by wire wrapped round them. Theſe bars are then ſweated in a charcoal fire; and after ſweating, they adhere as cloſely together as if they were ſoldered. After this they are flattened into a plate between two rollers, when the copper appears on one ſide and the ſilver on the other. This ſort of plate is named *plated metal.*

French plating is when ſilver leaf is burniſhed on a piece of metal in a certain degree of heat.

When ſilver is diſſolved in aquafortis, and precipitated upon another metal, the proceſs is called *ſilvering.* See SOLDERING.

PLATO, an illuſtrious philoſopher of antiquity, was by deſcent an Athenian, though the place of his birth was the Iſland of Egina. His lineage through his father is traced back to Codrus the laſt king of Athens, and through his mother to Solon the celebrated legiſlator. The time of his birth is commonly placed in the beginning of the 88th Olympiad; but Dr. Enfield thinks it may be more accurately fixed in the third year of the 87th Olympiad, or 430 years before the Chriſtian era. He gave early indications of an extenſive and original genius, and had an education ſuitable to his high rank, being inſtructed in the rudiments of letters by the grammarian Dionyſius, and trained in athletic exerciſes by Ariſto of Argos. He applied with great diligence to the ſtudy of the arts of painting and poetry; and made ſuch proficiency in the latter, as to produce an epic poem, which, upon comparing it with the poems of Homer, he committed to the flames. At the age of 20 he compoſed a dramatic piece; but after he had given it to the performers, happening to attend upon a diſcourſe of Socrates, he was ſo captivated by his eloquence, that he reclaimed his tragedy without ſuffering it to be acted, renounced the muſes, burnt all his poems, and applied himſelf wholly to the ſtudy of wiſdom.

It is thought that Plato's firſt maſters in philoſophy were Cratylus and Hermogenes, who taught the ſyſtems of Heraclitus and Parmenides; but when he was 20 years old, he attached himſelf wholly to Socrates, with whom he remained eight years in the relation of a ſcholar. During this period, he frequently diſpleaſed his companions, and ſometimes even his maſter, by grafting upon the Socratic ſyſtem opinions which were taken from ſome other ſtock. It was the practice of the ſcholars of Socrates to commit to writing the ſubſtance of their maſter's diſcourſes. Plato wrote them in the form of dialogues; but with ſo great additions of his own, that Socrates, hearing him recite his Lyſis, cried out, "O Hercules! how many things does this young man feign of me!"

Plato, however, retained the warmeſt attachment to his maſter. When that great and good man was ſummoned before the ſenate, his illuſtrious ſcholar undertook to plead his cauſe, and began a ſpeech in his defence; but the partiality and violence of the judges would not permit him to proceed. After the condemnation, he preſented his maſter with money ſufficient to redeem his life; which, however, Socrates refuſed to accept. During his impriſonment, Plato attended him, and was preſent at a converſation which he held with his friends concerning the immortality of the ſoul; the ſubſtance of which he afterwards committed to writing in the beautiful dialogue entitled *Phædo*, not, however, without interweaving his own opinions and language.

The philoſophers who were at Athens were ſo alarmed at the death of Socrates, that moſt of them fled from the city to avoid the injuſtice and cruelty of the government. Plato, whoſe grief upon this occaſion is ſaid by Plutarch to have been exceſſive, retired to Megara; where he was friendly entertained by Euclid, who had been one of Socrates's firſt ſcholars, till the ſtorm was over. Afterwards he determined to travel in purſuit of knowledge; and from Megara he went to Italy, where he conferred with Eurytus, Philolaus, and Archytas. Theſe were the moſt celebrated of the followers of Pythagoras, whoſe doctrine was then become famous in Greece; and from theſe the Pythagoreans have affirmed that he had all his natural philoſophy. He dived into the moſt profound and myſterious ſecrets of the Pythagoric doctrines; and perceiving other knowledge to be connected with them, he went to Cyrene, where he learned geometry of Theodorus the mathematician. From thence he paſſed into Egypt, to acquaint himſelf with the theology of their prieſts, to ſtudy more nicely the proportions of geometry, and to inſtruct himſelf in aſtronomical obſervations; and having taken a full ſurvey of all the country, he ſettled for ſome time in the province of Sais, learning of the wiſe men there what they held concerning the univerſe, whether it had a beginning, whether it moved wholly or in part, &c.; and Pauſanias affirms, that he learned from theſe the immortality, and alſo the tranſmigration, of ſouls. Some of the fathers will have it, that he had communication with the books of Moſes, and that he ſtudied under a learned Jew of Heliopolis; but there is nothing that can be called evidence for theſe aſſertions. St. Auſtin once believed that Plato had ſome conference with Jeremiah; but afterwards diſcovered, that that prophet muſt have been dead at leaſt 60 years before Plato's voyage to Egypt.

Plato's curioſity was not yet ſatisfied. He travelled into Perſia to conſult the magi about the religion of that country: and he deſigned to have penetrated even to the Indies, and to have learned of the Brachmans their manners and cuſtoms; but the wars in Aſia hindered him.

"He then returned into Italy, to the Pythagorean ſchool at Tarentum, where he endeavoured to improve his own ſyſtem, by incorporating with it the doctrine of Pythagoras, as it was then taught by Archytas, Timæus, and others. And afterwards, when he viſited Sicily, he retained ſuch an attachment to the Italic ſchool, that, through the bounty of Dionyſius, he purchaſed at a vaſt price ſeveral books which contained the doctrine of Pythagoras, from Philolaus, one of his followers.

"Returning home richly ſtored with knowledge of various kinds, Plato ſettled in Athens, and executed the deſign, which he had doubtleſs long had in contemplation, of forming a new ſchool for the inſtruction of youth in the principles of philoſophy. The place which he made choice of for this purpoſe was a public grove, called the *Academy*, from Hecademus, who left it to the citizens for the purpoſe of gymnaſtic exerciſes. Adorned with ſtatues, temples, and ſepulchres, planted with lofty plane-trees, and interſected by a gentle ſtream, it afforded a delightful retreat for philoſophy and the muſes. Of this retreat Horace ſpeaks:

> *Atque inter ſylvas Academi quærere verum,*
>
> ''Midſt Academic groves to ſearch for truth.'

Within this encloſure he poſſeſſed, as a part of his humble patrimony, purchaſed at the price of three thouſand drachmas, a ſmall garden, in which he opened a ſchool for the reception of thoſe who might be inclined to attend his inſtructions. How much Plato valued mathematical ſtudies, and how neceſſary a preparation he thought them for higher ſpeculations, appears from the inſcription which he placed over the door of his ſchool: Ουδεις αγεωμετρητος εισιτω. ‘Let no one who is unacquainted with geometry enter here.’

“This new ſchool ſoon became famous, and its maſter was ranked among the moſt eminent philoſophers. His travels into diſtant countries, where learning and wiſdom flouriſhed, gave him celebrity among his brethren of the Socratic ſect. None of theſe had ventured to inſtitute a ſchool in Athens except Ariſtippus; and he had confined his inſtructions almoſt entirely to ethical ſubjects, and had brought himſelf into ſome diſcredit by the freedom of his manners. Plato alone remained to inherit the patrimony of public eſteem which Socrates had left his diſciples; and he poſſeſſed talents and learning adequate to his deſign of extending the ſtudy of philoſophy beyond the limits within which it had been encloſed by his maſter. The conſequence was, not only that young men crowded to his ſchool from every quarter, but that people of the firſt diſtinction in every department frequented the academy. Even females, diſguiſed in men's clothes, often attended his lectures. Among the illuſtrious names which appear in the catalogue of his followers are Dion the Syracuſan prince, and the orators Hyperides, Lycurgus, Demoſthenes, and Iſocrates.

“Greatneſs was never yet exempted from envy. The diſtinguiſhed reputation of Plato brought upon him the hatred of his former companions in the ſchool of Socrates, and they loaded him with detraction and obloquy. It can only be aſcribed to mutual jealouſy, that Xenophon and he, though they relate the diſcourſes of their common maſter, ſtudiouſly avoid mentioning one another. Diogenes the Cynic ridiculed Plato's doctrine of ideas and other abſtract ſpeculations. In the midſt of theſe private cenſures, however, the public fame of Plato daily increaſed; and ſeveral ſtates, among which were the Arcadians and Thebans, ſent ambaſſadors with earneſt requeſts that he would come over, not only to inſtruct the young men in philoſophy, but alſo to preſcribe them laws of government. The Cyrenians, Syracuſans, Cretans, and Eleans, ſent alſo to him: he did not go to any of them, but gave laws and rules of governing to all. He lived ſingle, yet ſoberly and chaſtely. He was a man of great virtues, and exceedingly affable; of which we need no greater proof, than his civil manner of converſing with the philoſophers of his own times, when pride and envy were at their height. His behaviour to Diogenes is always mentioned in his hiſtory. The Cynic was vaſtly offended, it ſeems, at the politeneſs and fine taſte of Plato, and uſed to catch all opportunities of ſnarling at him. He dined one day at his table with other company, and, trampling upon the tapeſtry with his dirty feet, uttered this brutiſh ſarcaſm, ‘I trample upon the pride of Plato;’ to which Plato wiſely reparteed, ‘With greater pride.’”

The fame of Plato drew diſciples to him from all parts: among whom were Speuſippus an Athenian, his ſiſter's ſon, whom he appointed his ſucceſſor in the academy, and the great Ariſtotle.

The admiration of this illuſtrious man was not confined to the breaſts of a few philoſophers. He was in high eſteem with ſeveral princes, particularly Archelaus king of Macedon, and Dionyſius tyrant of Sicily. At three different periods he viſited the court of this latter prince, and made ſeveral bold but unſucceſsful attempts to ſubdue his haughty and tyrannical ſpirit. A brief relation of the particulars of theſe viſits to Sicily may ſerve to caſt ſome light upon the character of our philoſopher; and we ſhall give it in the words of Dr. Enfield, from whoſe elegant hiſtory of philoſophy we have extracted by much the moſt valuable parts of this article.

“The profeſſed object of Plato's firſt viſit to Sicily, which happened in the 40th year of his age, during the reign of the elder Dionyſius the ſon of Hermocrates, was, to take a ſurvey of the iſland, and particularly to obſerve the wonders of Mount Ætna. Whilſt he was reſident at Syracuſe, he was employed in the inſtruction of Dion, the king's brother-in-law, who poſſeſſed excellent abilities, though hitherto reſtrained by the terrors of a tyrannical government, and relaxed by the luxuries of a licentious court. Diſguſted by the debauched manners of the Syracuſans, he endeavoured to reſcue his pupil from the general depravity. Nor did Dion diſappoint his preceptor's expectations. No ſooner had he received a taſte of that philoſophy which leads to virtue, than he was fired with an ardent love of wiſdom. Entertaining a hope that philoſophy might produce the ſame effect upon Dionyſius, he took great pains to procure an interview between Plato and the tyrant. In the courſe of the conference, whilſt Plato was diſcourſing on the ſecurity and happineſs of virtue, and the miſeries attending injuſtice and oppreſſion, Dionyſius, perceiving that the philoſopher's diſcourſe was levelled againſt the vices and cruelties of his reign, diſmiſſed him with high diſpleaſure from his preſence, and conceived a deſign againſt his life. It was not without great difficulty that Plato, by the aſſiſtance of Dion, made his eſcape. A veſſel which had brought over Pollis, a delegate from Sparta, was fortunately at that time returning to Greece. Dion engaged Pollis to take the charge of the philoſopher, and land him ſafely in his native country; but Dionyſius diſcovered the deſign, and obtained a promiſe from Pollis, that he would either put him to death or ſell him as a ſlave upon the paſſage. Pollis accordingly ſold him in the iſland of Ægina; the inhabitants of which were then at war with the Athenians. Plato could not long remain unnoticed: Anicerris, a Cyrenaic philoſopher, who happened to be at that time in the iſland, diſcovered the ſtranger, and thought himſelf happy in an opportunity of ſhowing his reſpect for ſo illuſtrious a philoſopher: he purchaſed his freedom for 30 minæ, or 84l. 10s. ſterling money, and ſent him home to Athens. Repayment being afterwards offered to Anicerris by Plato's relations, he refuſed the money, ſaying, with that generous ſpirit which true philoſophy always inſpires, that he ſaw no reaſon why the relations of Plato ſhould engroſs to themſelves the honour of ſerving him.”

After a ſhort interval, Dionyſius repented of his ill-placed reſentment, and wrote to Plato, earneſtly requeſting him to repair his credit by returning to Syracuſe; to which Plato gave this high-ſpirited anſwer, that philoſophy would not allow him leiſure to think of Dionyſius. He was, however, prevailed upon by his friend Dion to accept of the tyrant's invitation to return to Syracuſe, and take upon him the education of Dionyſius the younger, who was heir apparent to the monarchy. He was received by Dionyſius the reigning ſovereign with every poſſible appearance of reſpect; but after ſeeing his friend baniſhed, and being himſelf kept as a priſoner at large in the palace, he was by the tyrant ſent back into his own country, with a promiſe that both he and Dion ſhould be recalled at the end of the war in which the Sicilians were then engaged. This promiſe was not fulfilled. The tyrant wiſhed for the return of Plato; but could not reſolve to recall Dion. At laſt, however, having probably promiſed that the philoſopher ſhould meet his friend at the court of Syracuſe, he prevailed upon Plato to viſit that capital a third time. When he arrived, the king met him in a magnificent chariot, and conducted him to his palace. The Sicilians too rejoiced in his return; for they hoped that the wiſdom of Plato would at length triumph over the tyrannical ſpirit of the prince. Dionyſius ſeemed wholly diveſted of his former reſentments, liſtened with apparent pleaſure to the philoſopher's doctrine, and, among other expreſſions of regard, preſented him with eighty talents of gold. In the midſt of a numerous train of philoſophers, Plato now poſſeſſed the chief influence and authority in the court of Syracuſe. Whilſt Ariſtippus was enjoying himſelf in ſplendid luxury; whilſt Diogenes was freely indulging his acrimonious humour; and whilſt Æſchines was gratifying his thirſt after riches; Plato ſupported the credit of philoſophy with an air of dignity, which his friends regarded as an indication of ſuperior wiſdom, but which his enemies imputed to pride. After all, it was not in the power of Plato to prevail upon Dionyſius to adopt his ſyſtem of policy, or to recall Dion from his exile. Mutual diſtruſt, after a ſhort interval, aroſe between the tyrant and the philoſopher; each ſuſpected the other of evil deſigns, and each endeavoured to conceal his ſuſpicion under the diſguiſe of reſpect. Dionyſius attempted to impoſe upon Plato by condeſcending attentions, and Plato, to deceive Dionyſius by an appearance of confidence. At length, the philoſopher became ſo much diſſatisfied with his ſituation, that he earneſtly requeſted permiſſion to return to Greece; which was at laſt granted him, and he was ſent home loaded with rich preſents. On his way to Athens, paſſing through Elis during the celebration of the Olympic games, he was preſent at this general aſſembly of the Greeks, and engaged univerſal attention.

From this narrative it appears, that if Plato viſited the courts of princes, it was chiefly from the hope of ſeeing his ideal plan of a republic realized; and that his talents and attainments rather qualified him to ſhine in the academy than in the council or the ſenate.

Plato, now reſtored to his country and his ſchool, devoted himſelf to ſcience, and ſpent the laſt years of a long life in the inſtruction of youth. Having enjoyed the advantage of an athletic conſtitution, and lived all his days temperately, he arrived at the 81ſt, or according to ſome writers the 79th, year of his age, and died, through the mere decay of nature, in the firſt year of the hundred and eighth Olympiad. He paſſed his whole life in a ſtate of celibacy, and therefore left no natural heirs, but transferred his effects by will to his friend Adiamantus. The grove and garden, which had been the ſcene of his philoſophical labours, at laſt afforded him a ſepulchre. Statues and altars were erected to his memory; the day of his birth long continued to be celebrated as a feſtival by his followers; and his portrait is to this day preſerved in gems: but the moſt laſting monuments of his genius are his writings, which have been tranſmitted without material injury to the preſent times.

The character of this philoſopher has always been high. Beſides the advantages of a noble birth, he had a large and comprehenſive underſtanding, a vaſt fund of wit and good taſte, great evenneſs and ſweetneſs of temper, all cultivated and refined by education and travel; ſo that it is no wonder if he was honoured by his countrymen, eſteemed by ſtrangers, and adored by his ſcholars. The ancients thought more highly of Plato than of all their philoſophers: they always called him the *Divine Plato*; and they ſeemed reſolved that his deſcent ſhould be more than human. "There are (ſays Apuleius) who aſſert Plato to have ſprung from a more ſublime conception; and that his mother Perictione, who was a very beautiful woman, was impregnated by Apollo in the ſhape of a ſpectre." Plutarch, Suidas, and others, affirm this to have been the common report at Athens. When he was an infant, his father Ariſto went to Hymettus, with his wife and child, to ſacrifice to the Muſes; and while they were buſied in the divine rites, a ſwarm of bees came and diſtilled their honey upon his lips. This, ſays Tully, was conſidered as a preſage of his future eloquence. Apuleius relates, that Socrates, the night before Plato was recommended to him, dreamed that a young ſwan fled from Cupid's altar in the academy, and ſettled in his lap; thence ſoared to heaven, and delighted the gods with its muſic: and when Ariſto the next day preſented Plato to him, "Friends (ſays Socrates), this is the ſwan of Cupid's academy." The Greeks loved fables: they ſhow however, in the preſent caſe, what exceeding reſpect was paid to the memory of Plato. Tully perfectly adored him; tells us, how he was juſtly called by Panætius, the *divine*, the *moſt wiſe*, the *moſt ſacred*, the *Homer of philoſophers*; entitled him to Atticus, *Deus ille noſter*; thinks, that if Jupiter had ſpoken Greek, he would have ſpoken in Plato's language; and made him ſo implicitly his guide in wiſdom and philoſophy, as to declare, that he had rather err with Plato than be right with any one elſe. But, panegyric aſide, Plato was certainly a very wonderful man, of a large and comprehenſive mind, an imagination infinitely fertile, and of a moſt flowing and copious eloquence. Nevertheleſs, the ſtrength and heat of fancy prevailing in his compoſition over judgment, he was too apt to ſoar beyond the limits of earthly things, to range in the imaginary regions of general and abſtracted ideas; and on which account, though there is always a greatneſs and ſublimity in his manner, he did not philoſophize ſo much according to truth and nature as Ariſtotle, though Cicero did not ſcruple to give him the preference.

The writings of Plato are all in the way of dialogue, where he ſeems to deliver nothing from himſelf, but every thing as the ſentiments and opinions of others, of Socrates chiefly, of Timæus, &c. He does not mention himſelf anywhere, except once in his Phædo, and another time in his Apology for Socrates. His ſtyle, as Ariſtotle obſerved, is betwixt proſe and verſe: on which account, ſome have not ſcrupled to rank him with the poets. There is a better reaſon for ſo doing than the elevation and grandeur of his ſtyle: his matter is oftentimes the offspring of imagination, inſtead of doctrines or truths deduced from nature. The firſt edition of Plato's works in Greek was put out by Aldus at Venice in 1513; but a Latin verſion of him by Marſilius Ficinus had been printed there in 1491. They were reprinted together at Lyons in 1588, and at Francfort in 1602. The famous printer Henry Stephens, in 1578, gave a moſt beautiful and correct edition of Plato's works at Paris, with a new Latin verſion by Serranus, in three volumes folio; and this deſervedly paſſes for the beſt edition of Plato: yet Serranus's verſion is very exceptionable, and in many reſpects, if not in all, inferior to that of Ficinus.

PLATONIC, ſomething that relates to Plato, his ſchool-philoſophy, opinions, or the like. Thus, platonic love denotes a pure ſpiritual affection, for which Plato was a great advocate, ſubſiſting between the different ſexes, abſtracted from all carnal appetites, and regarding no other object but the mind and its beauties; or it is even a ſincere diſintereſted friendſhip ſubſiſting between perſons of the ſame ſex, abſtracted from any ſelfiſh views, and regarding no other object than the perſon, if any ſuch love or friendſhip has aught of a foundation in nature.

PLATONIC *Year*, or the *Great Year*, is a period of time determined by the revolution of the equinoxes, or the ſpace wherein the ſtars and conſtellations return to their former places, in reſpect of the equinoxes. The platonic year, according to Tycho Brahe, is 25816, according to Ricciolus 25920, and according to Caſſini 24800 years. This period once accompliſhed, it was an opinion among the ancients that the world was to begin anew, and the ſame ſeries of things to turn over again.

PLATONISM, the philoſophy of Plato, which was divided into three branches, *theology*, *phyſics*, and *mathematics*. Under *theology* were comprehended metaphyſics and ethics, or that which in modern language is called *moral* philoſophy. Plato wrote likewiſe on *dialectics*, but with ſuch inferiority to his pupil Ariſtotle, that his works in that department of ſcience are ſeldom mentioned.

The ancient philoſophers always began their theological ſyſtems with ſome diſquiſition on the nature of the gods, and the formation of the world; and it was a fundamental doctrine with them, that *from nothing nothing can proceed*. We are not to ſuppoſe that this general axiom implied nothing more than that for every effect there muſt be a cauſe; for this is a propoſition which no man will controvert who underſtands the terms in which it is expreſſed: but the ancients believed that a proper creation is impoſſible even to Omnipotence, and that to the production of any thing a *material* is not leſs *neceſſary* than an *efficient* cauſe. (See METAPHYSICS.) That with reſpect to this important queſtion Plato agreed with his predeceſſors and contemporaries, appears evident to us from the whole tenor of his *Timæus*. We agree with Dr. Enfield in thinking, that in this dialogue, which comprehends his whole doctrine on the ſubject of the formation of the univerſe, matter is ſo manifeſtly ſpoken of as eternally co-exiſting with God, that this part of his doctrine could not have been miſtaken by ſo many learned and able writers, had they not been ſeduced by the deſire of eſtabliſhing a coincidence of doctrine between the writings of Plato and Moſes. It is certain that neither Cicero, nor Apuleius, nor Alcinous, nor even the later commentator Chalcidius, underſtood their maſter in any other ſenſe than as admitting two primary and incorruptible principles, God and matter; to which we ſhall afterwards ſee reaſon to add a third, namely ideas. The paſſages quoted by thoſe who maintain the contrary opinion are by no means ſufficient for their purpoſe. Plato, it is true, in his Timæus, calls God the *parent of the univerſe*, and in his Sophiſta ſpeaks of him as "forming animate and inanimate beings, which did not before exiſt:" but theſe expreſſions do not neceſſarily imply that this offspring of Deity was produced from nothing, or that no prior matter exiſted from which theſe new beings were formed. Through the whole dialogue of the Timæus, Plato ſuppoſes two eternal and independent cauſes of all things; one, that by which all things are made, which is God; the other, that from which all things are made, which is matter. He diſtinguiſhes between God, matter, and the univerſe, and ſuppoſes the Architect of the world to have formed it out of a maſs of pre-exiſtent matter. Matter, according to Plato, is an eternal and infinite principle. His doctrine on this head is thus explained by Cicero: "Matter, from which all things are produced and formed, is a ſubſtance without form or quality, but capable of receiving all forms, and undergoing every kind of change; in which, however, it never ſuffers annihilation, but merely a ſolution of its parts, which are in their nature infinitely diviſible, and move in portions of ſpace which are alſo infinitely diviſible. When that principle which we call quality is moved, and acts upon matter, it undergoes an entire change, and thoſe forms are produced, from which ariſes the diverſified and coherent ſyſtem of the univerſe." This doctrine Plato unfolds at large in his Timæus, and particularly inſiſts upon the notion, that matter has originally no form, but is capable of receiving any. He calls it the mother and receptacle of forms, by the union of which with matter the univerſe becomes perceptible to the ſenſes; and maintains, that the viſible world owes its forms to the energy of the divine intellectual nature.

Our author is ſupported in drawing this inference by the teſtimony of Diogenes Laertius, who ſurely underſtood the language and dogmas of Plato better than the moſt accompliſhed modern ſcholar can pretend to do; yet Dr. Ogilvie has lately expreſſed great ſurpriſe that any one ſhould conſider matter as having been, in Plato's opinion, uncreated; and he boldly affirms, that Laertius, inſtead of aſſerting that ſpirit and matter were the principles of all things, ought to have ſaid that God alone, in Plato's eſtimation, was their original. To prove this, he gives from the Timæus a quotation, in which the founder of the Academy declares that God *framed* heaven and earth, and the inferior deities; and that as he *faſhioned*, ſo he pervades all nature. He obſerves, that Cicero denominates the god of Plato the *maker*, and the god of Ariſtotle only the *governor*, of the world. And to ſatisfy thoſe who may demand a particular proof of Plato's having taught a real creation, he affirms that his writings abound with declarations on the ſubject, of which the meaning cannot be miſapprehended. "With this purpoſe (ſays he) Plato denominates at one time the principles or ſubſtance of all things, *Γενοματα θεου Δημιουργου*, the productions of the efficient Deity, and at others enters more particularly into the queſtion. Thus, he obſerves, that many perſons are ignorant of the nature and power of mind or intellect, 'as having exiſted at the beginning, antecedent to all bodies.' Of this mind, he obſerves, that it is without exception *παντων πρεσβυτατος, of all things the moſt ancient;* and he ſubjoins, in order to remove all doubt of his purpoſe, that it is alſo *αρχη κινησεως, the cauſe or principle of motion.*"

With all poſſible reſpect for Dr. Ogilvie, of whoſe piety and erudition we are thoroughly convinced, we muſt take the liberty to ſay, that to us the declarations of Plato on this ſubject appear much leſs preciſe and explicit than they appear to him; and that the inference which he would draw from the *words* of Cicero ſeems not to flow neceſſarily from the *ſenſe* of thoſe words. That Plato believed God to have *framed* the heaven and the earth, and to have *faſhioned* all nature, is a poſition which, as far as we know, has never been controverted; but between *framing* or *faſhioning* the chaos or ὑλη πρωτη, and calling the univerſe into exiſtence from non-entity, there is an infinite and an obvious difference. The diſtinction made by Cicero between the God of Plato and the God of Ariſtotle is a juſt diſtinction, but it will not bear the ſuperſtructure which the learned Doctor builds upon it. Ariſtotle maintained the eternity of the world in its preſent form. Plato certainly taught that the firſt matter was in time reduced from a chaotic ſtate into *form* by the power of the Demiurgus; but we have ſeen nothing in his writings which explicitly declares his belief that the *firſt matter* was itſelf *created*.

The learned Cudworth, who wiſhed, like Dr. Ogilvie, to find a coincidence of doctrine between the theology of Plato and that of the Goſpel, ſtrained all his faculties to prove that his favourite philoſopher taught a proper creation; but he laboured in vain. He gives a number of quotations in ſupport of his poſition; of which we ſhall here inſert only thoſe two upon which Dr. Ogilvie ſeems to lay the greateſt ſtreſs. Plato, ſays the author of the Intellectual Syſtem, calls the one God* *ὁς γην, ουρανον, και θεους, και παντα τα εν ουρανω και τα εν ἀδῃ, και ὑπο γης ἁπαντα εργαζεται—He that makes earth, and heaven, and the gods, and doth all things both in heaven, and hell, and under the earth.* And again, "he by whoſe efficiency the things of the world (*ὑστερον εγενετο, προτερον ουκ οντα*) *were afterwards made when they were not before.*" Both Cudworth and Ogilvie think this laſt ſentence an explicit declaration of Plato's belief in the creative power of God: but that they are miſtaken has been evinced by Moſheim with a force of argument which will admit of no reply. In that part of *the Sophiſt* from which the quotation is taken, Plato conſiders the δυναμιν ποιητικην, of which he is treating, as belonging both to God and to man; and he defines it in general to be "a certain power which is the cauſe that things may afterwards be which were not before." Cudworth wiſhes to confine this definition to the divine power; and adds from himſelf to the text which he quotes the following words, which are not in Plato, OR FROM AN ANTECEDENT NON-EXISTENCE BROUGHT FORTH INTO BEING! That the incomparable author intended to deceive his reader, we are far from imagining: his zeal for Platoniſm had deceived himſelf. Plato's definition comprehends the δυναμιν ποιητικην as well of man as of God; and therefore cannot infer a creative power any where, unleſs the father of the academy was ſo very abſurd as to ſuppoſe human artiſts the creators of thoſe machines which they have invented and made! Moſheim thinks that Cudworth was miſled by too implicit a confidence in *Ficinus*; and it is not impoſſible that Dr. Ogilvie may have been ſwayed by the authority, great indeed, of the author of the Intellectual Syſtem.

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* Moſheim affirms that this quotation is nowhere to be found in the writings of Plato. He therefore at firſt ſuſpected that the learned author, in looking haſtily over Plato's 10th book *De Legibus*, had transferred to God what is there ſaid of the *anima mundi*, leading by its own motions every thing in the heaven, the earth, and the ſea, and that he had added ſomething of his own. He dropped that opinion, however, when he found Plato, in the 10th book of his Republic, declaring it to be as "eaſy for God to produce the ſun, moon, ſtars, and earth, &c. from himſelf, as it is for us to produce the image of ourſelves, and whatever elſe we pleaſe, only by interpoſing a looking-glaſs." In all this power, however, there is nothing ſimilar to that of creation.

That intellect exiſted antecedent to all bodies is indeed a Platonic dogma, from which Dr. Ogilvie, after Cudworth, wiſhes to infer that the doctrine of the creation was taught in the academy; but Dr. Ogilvie knows, and no man knew better than Cudworth, that Plato, with every other Greek philoſopher, diſtinguiſhed between *body* and *matter*; and that though he held the priority of intellect to the former, it by no means follows that he believed it to have exiſted antecedent to the latter. That he believed *mind*, or rather *ſoul* (for he diſtinguiſhes between the two), to be the cauſe or principle of motion, cannot be denied; but we are not therefore authoriſed to conclude that he likewiſe believed it to be the cauſe of the exiſtence of matter. That he believed mind to be the moſt ancient of *all things*, taking the word *things* in the moſt abſolute ſenſe, cannot be true, ſince by Dr. Ogilvie's own acknowledgment he held the exiſtence and eternity of *ideas*, not to add that he believed το ἑν or τ'αγαθον—the firſt hypoſtaſis in his trinity, to be ſuperior to mind and prior to it, though not in time, yet in the order of nature. When therefore he calls mind the moſt ancient of *all things*, he muſt be ſuppoſed to mean only that it is more ancient than *all bodies* and inferior ſouls. It is no reflection on the character of Plato that he could not, by the efforts of his own reaſon, acquire any notion of a proper creation; ſince we, who have the advantage of his writings, and of writings infinitely more valuable, to inſtruct us, find it extremely difficult, if not impoſſible, to conceive how any thing can begin to be. We believe the fact on the authority of revelation; but ſhould certainly never have agitated ſuch a queſtion, had it not been ſtated to us by writers inſpired with celeſtial wiſdom.

In the Platonic coſmogony we cannot therefore doubt but that the eternity of the ὑλη πρωτη was taken for granted. Whether it was an eternal and neceſſary emanation from an eternal mind, is not perhaps quite ſo evident, though our own opinion is, that it was believed to be ſelf-exiſtent. But be this as it may, which is not worth diſputing, one thing is certain, that Plato did not believe it to have a ſingle form or quality which it did not receive either from the *Demiurgus* or the *Pſyche*—the ſecond or third perſon of his trinity. Except Ariſtotle, all the Greek philoſophers, who were not materialiſts, held nearly the ſame opinions reſpecting the origin of the world; ſo that in examining their ſyſtems we ſhall be greatly miſled if we underſtand the terms *incorporeal* and *immaterial* as at all ſynonymous. It was alſo a doctrine of Plato, that there is in matter a neceſſary but blind and refractory force; and that hence ariſes a propenſity in matter to diſorder and deformity, which is the cauſe of all the imperfection which appears in the works of God, and the origin of evil. On this ſubject Plato writes with wonderful obſcurity: but, as far as we are able to trace his conceptions, he appears to have thought, that matter, from its nature, reſiſts the will of the Supreme Artificer, ſo that he cannot perfectly execute his deſigns; and that this is the cauſe of the mixture of good and evil which is found in the material world.

Plato, however, was no materialiſt. He taught, that there is an intelligent cauſe, which is the origin of all ſpiritual being, and the former of the material world. The nature of this great being he pronounced it difficult to diſcover, and when diſcovered impoſſible to divulge. The exiſtence of God he inferred from the marks of intelligence, which appear in the form and arrangement of bodies in the viſible world: and from the unity of the material ſyſtem he concluded, that the mind by which it was formed muſt be one. God, according to Plato, is the ſupreme intelligence, incorporeal, without beginning, end, or change, and capable of being perceived only by the mind. He certainly diſtinguiſhed the Deity not only from body, and whatever has corporeal qualities, but from matter itſelf, from which all things are made. He alſo aſcribed to him all thoſe qualities which modern philoſophers aſcribe to immaterial ſubſtance; and conceived him to be in his nature ſimple, uncircumſcribed in ſpace, the author of all regulated motion, and, in fine, poſſeſſed of intelligence in the higheſt perfection.

His notions of God are indeed exceedingly refined, and ſuch as it is difficult to ſuppoſe that he could ever have acquired but from ſome obſcure remains of primeval tradition, gleaned perhaps from the prieſts of Egypt or from the philoſophers of the Eaſt. In the Divine Nature he certainly believed that there are two, and probably that there are three, *hypoſtaſes*, whom he called το ον and το ἑν, νους and ψυχη. The firſt he conſidered as ſelf exiſtent, and elevated far above all mind and all knowledge; calling him, by way of eminence, the *being*, or *the one*. The only attribute which he acknowledged in this perſon was goodneſs; and therefore he frequently ſtyles him το αγαθον—*the good*, or *eſſential goodneſs*. The ſecond he conſidered as mind, the *wiſdom* or *reaſon* of the firſt, and the *maker of the world*; and therefore he ſtyles him νους, λογος, and δημιουργος. The third he always ſpeaks of as the *ſoul of the world*; and hence calls him ψυχη, or ψυχη του κοσμου. He taught that the *ſecond* is a neceſſary emanation from the *firſt*, and the *third* from the *ſecond*, or perhaps from the *firſt* and *ſecond*.

Some have indeed pretended, that the *Trinity*, which is commonly called *Platonic*, was a fiction of the later Platoniſts, unknown to the founder of the ſchool: but any perſon who ſhall take the trouble to ſtudy the writings of Plato, will find abundant evidence that he really aſſerted a triad of divine hypoſtaſes, all concerned in the formation and government of the world. Thus, in his 10th book of Laws, where he undertakes to prove the exiſtence of a Deity in oppoſition to atheiſts, he aſcends no higher in the demonſtration than to the ψυχη or mundane ſoul, which he held to be the immediate and proper cauſe of all the motion that is in the world. But in other parts of his writings he frequently aſſerts, as ſuperior to the ſelf-moving principle, an immoveable νους or intellect, which was properly the *demiurgus* or framer of the world; and above this *hypoſtaſis* one moſt ſimple and abſolutely perfect being, who is conſidered in his *Theology* as αυτοθεος the *original deity*, in contradiſtinction from the others, who are only θεοι εκ θεου. Theſe doctrines are to be gathered from his works at large, particularly from the *Timæus*, *Philebus*, *Sophiſta*, and *Epinomis*: but there is a paſſage in his ſecond epiſtle to Dionyſius, apparently written in anſwer to a letter in which that monarch had required him to give a more explicit account than he had formerly done of the nature of God, in which the doctrine of a Trinity ſeems to be directly aſſerted. "After having ſaid that he meant to wrap up his meaning in ſuch obſcurity, as that an adept only ſhould fully comprehend it, he adds expreſſions to the following import: ‘The Lord of Nature is ſurrounded on all ſides by his works: whatever is, exiſts by his permiſſion: he is the fountain and ſource of excellence: around the ſecond perſon are placed things of the ſecond order; and around the third thoſe of the third degree[*].” Of this obſcure paſſage a very ſatisfactory explanation is given in Dr. Ogilvie's *Theology of Plato*, to which the narrow limits preſcribed to ſuch articles as this compel us to refer the reader. We ſhall only ſay, that the account which we have given of the Platonic Trinity is ably ſupported by the Doctor.

In treating of the eternal emanation of the ſecond and third hypoſtaſes from the firſt, the philoſophers of the academy compare them to light and heat proceeding from the ſun. Plato himſelf, as quoted by Dr. Cudworth, illuſtrates his doctrine by the ſame compariſon. For “τ'αγαθον, or the firſt hypoſtaſis, is in the intellectual world the ſame (he ſays) to intellect and intelligibles that the ſun is in the corporeal world to viſion and viſibles; for, as the ſun is not viſion itſelf, but the cauſe of viſion, and as that light by which we ſee is not the ſun, but only a thing like the ſun; ſo neither is the Supreme or Higheſt Good properly knowledge, but the cauſe of knowledge; nor is intellect, conſidered as ſuch, the beſt and moſt perfect being, but only a being having the form of perfection.” Again, “as the ſun cauſes other things not only to become viſible, but alſo to be generated; ſo the Supreme Good gives to things not only their capability of being known, but alſo their very eſſences by which they ſubſiſt; for this fountain of the Deity, this higheſt good, is not itſelf properly eſſence, but above eſſence, tranſcending it in reſpect both of dignity and of power.”

The reſemblance which this trinity of Plato bears to that revealed in the goſpel muſt be obſerved by every attentive reader; but the two doctrines are likewiſe in ſome reſpects exceedingly diſſimilar. The third hypoſtaſis in the Platonic ſyſtem appears in no point of view co-ordinate with the firſt or ſecond. Indeed, the firſt is elevated far above the ſecond, and the third ſunk ſtill further beneath it, being conſidered as a mere ſoul immerſed in matter, and forming with the corporeal world, to which it is united, one compound animal. Nay, it does not appear perfectly clear, that Plato conſidered his ψυχη του κοσμου as a pure ſpirit, or as having ſubſiſted from eternity as a diſtinct *hypoſtaſis*. “This governing ſpirit, of whom the earth, properly ſo called, is the body, conſiſted, according to our author's philoſophy, of the ſame and the other; that is, of the firſt matter, and of pure intelligence, framed to actuate the machinery of nature. The Supreme Being placed him in the middle of the earth; which, in the vivid idea of Plato, ſeemed itſelf to live, in conſequence of an influence that was felt in every part of it. From this ſeat his power is repreſented as being extended on all ſides to the utmoſt limit of the heavens; conferring life, and preſerving harmony in the various and complicated parts of the univerſe. Upon this being God is ſaid to have looked with peculiar complacency after having formed him as an image of himſelf, and to have given beauty and perfect proportion to the manſion which he was deſtined to occupy. According to the doctrine of Timæus, the Supreme Being ſtruck out from this original mind innumerable ſpirits of inferior order, endowed with principles of reaſon: and he committed to divinities of ſecondary rank the taſk of inveſting theſe in material forms, and of diſperſing them as inhabitants of the ſun, moon, and other celeſtial bodies. He taught alſo, that at death the human ſoul is reunited to the ψυχη του κοσμου, as to the ſource from which it originally came.”

Such is the third perſon of the Platonic triad, as we find his nature and attributes very accurately ſtated by Dr. Ogilvie; and the Chriſtian philoſopher, who has no particular ſyſtem to ſupport, will not require another proof that the triad of Plato differs exceedingly from the Trinity of the Scriptures. Indeed the third hypoſtaſis in this triad has ſo much the appearance of all that the ancients could mean by that which we call a *creature*, that the learned Cudworth, who wiſhed, it is difficult to conceive for what reaſon, to find the ſublimeſt myſtery of the Chriſtian faith explicitly taught in the writings of a pagan philoſopher, was forced to ſuppoſe that Plato held a double ψυχη or ſoul, one εγκοσμιον incorporated with the material world, and the other ὑπερκοσμιον or *ſupramundane*, which is not the ſoul but the governor of the univerſe. We call this a mere hypotheſis; for, though the author diſplays vaſt erudition, and adduces many quotations in which this double *pſyche* is plainly mentioned, yet all thoſe quotations are taken from Platoniſts who lived after the propagation of the goſpel, and who, calling themſelves *eclectics*, freely ſtole from every ſect ſuch dogmas as they could incorporate with their own ſyſtem, and then attributed thoſe dogmas to their maſter. In the writings of Plato himſelf, there is not ſo much as an alluſion to this ſupramundane *pſyche*; and it is for this reaſon (the ψυχη of which he treats being ſo very inferior to the δημιουργος and αγαθον) that we have expreſſed with heſitation his belief of *three* hypoſtaſes in the divine nature. Yet that he did admit ſo many, ſeems more than probable both from the paſſage illuſtrated by Dr. Ogilvie, and from the attempt of Plotinus, one of his followers, to demonſtrate that the number can be neither greater nor leſs. That his doctrine on this ſubject ſhould be inaccurate and erroneous, can excite no wonder; whilſt it muſt be confeſſed to have ſuch a reſemblance to the truth, and to be ſo incapable of being proved by reaſoning from effects to cauſes, that we could not doubt of his having inherited it by tradition, even though we had not complete evidence that ſomething very ſimilar to it was taught long before him, not only by Pythagoras and Parmenides, but by the philoſophers of the eaſt.

We have ſaid that the Demiurgus was the maker of the world from the firſt matter which had exiſted from eternity; but in Plato's coſmogony there is another principle, more myſterious, if poſſible, than any thing which we have yet mentioned. This is his intellectual ſyſtem of *ideas*, which it is not eaſy to collect from his writings, whether he conſidered as *independent* exiſtences, or only as archetypal *forms*, which had ſubſiſted from eternity in the λογος or divine intellect. On this ſubject he writes with ſuch exceeding obſcurity, that men of the firſt eminence, both among the ancients and the moderns, have differed about his real meaning. Some have ſuppoſed, that by *ideas* he meant real beings ſubſiſting from eternity, independent of all minds, and ſeparate from all matter; and that of theſe ideas he conceived ſome to be living and others to be without life. In this manner his doctrine is interpreted by Tertullian among the ancients, and by the celebrated Brucker among the moderns; and not by them only, but by many others equally learned, candid, and acute. Cudworth, on the other hand, with his annotator Moſheim, contends, that by his ideal world Plato meant nothing more than that there exiſted from eternity in the λογος or mind of God a notion or conception of every thing which was in time to be made. This is certainly much more probable in itſelf, than that a man of enlarged underſtanding ſhould have ſuppoſed, that there are ſomewhere in extramundane ſpace real living incorporeal beings eating and drinking, which are the *ideas* of all the animals which ever have been or ever will be eating and drinking in this world. Yet Moſheim candidly acknowledges, that if the controverſy were to be decided by the votes of the learned, he is doubtful whether it would be given for or againſt him; and Cudworth, though he pleads the cauſe of his maſter with much ingenuity, owns, that on this ſubject his language cannot be vindicated. This indeed is moſt true; for Plato contends, that his ideas are not only the objects of ſcience, but alſo the proper or phyſical cauſes of all things here below; that the *idea* of ſimilitude is the *cauſe* of the reſemblance between two globes; and the *idea* of diſſimilitude the cauſe that a globe does not reſemble a pyramid: he likewiſe calls them *ουσιας*, *eſſences* or *ſubſtances*, and many of his followers have pronounced them to be *animals*.

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[*] “Περι των παντων βασιλεια, παντ' εϛι, και εκεινου ενεκα παντα. Εκεινος αιτια παντων των καλων. Δευτερον δε περι τα δευτερα, και τριτον περι τα τριτα.” Oper. p. 1269.

Theſe wonderful expreſſions incline us to adopt with ſome heſitation the opinion ſtated by Dr. Enfield. This hiſtorian of philoſophy having obſerved, that ſome of the admirers of Plato contend, that by ideas exiſting in the reaſon of God, nothing more is meant than conceptions formed in the Divine mind, controverts this opinion with much effect. "By ideas, Plato (ſays he) appears to have meant ſomething much more myſterious; namely, patterns or archetypes ſubſiſting by themſelves, as real beings, *οντως οντα* in the Divine reaſon, as in their original and eternal region, and iſſuing thence to give form to ſenſible things, and to become objects of contemplation and ſcience to rational beings. It is the doctrine of the Timæus, that *ὁ λογισμος τȣ Θεȣ*, the reaſon of God, comprehends exemplars of all things, and that this reaſon is one of the primary cauſes of things. Plutarch ſays, that Plato ſuppoſes three principles, God, Matter, and Idea. Juſtin Martyr, Pſeudo-Origen, and others, aſſert the ſame thing.

"That this is the true Platonic doctrine of ideas will appear probable, if we attend to the manner in which Plato framed his ſyſtem of opinions concerning the origin of things. 'Having been from his youth (ſays Ariſtotle) converſant with Cratylus, a diſciple of Heraclitus, and inſtructed in the doctrine of that ſchool, that all ſenſible things are variable, and cannot be proper objects of ſcience, he reaſonably concluded, that if there be any ſuch thing as ſcience, there muſt exiſt, beſides ſenſible objects, certain permanent natures, perceptible only by the intellect.' Such natures, divine in their origin, and eternal and immutable in their exiſtence, he admitted into his ſyſtem, and called them *ideas*. Viſible things were regarded by Plato as fleeting ſhades, and ideas as the only permanent ſubſtances. Theſe he conceived to be the proper objects of ſcience to a mind raiſed by divine contemplation above the perpetually varying ſcenes of the material world."

It was a fundamental doctrine in the ſyſtem of Plato, that the Deity formed the material world after a perfect model, conſiſting of thoſe ideas which had eternally ſubſiſted in his own reaſon: and yet, with ſome appearance of contradiction, he calls this model "*ſelf*-exiſtent, indiviſible, and eternally *generated*." Nay, he talks of it as being intelligent as well as eternal, and wholly different from the tranſcripts, which are ſubjected to our inſpection. There is ſo much myſtery, confuſion, and apparent abſurdity, in the whole of this ſyſtem, as it has come down to us, that we muſt ſuppoſe the friends of Plato to have been intruſted with a key to his eſoteric doctrines, which has long been loſt; otherwiſe it would be difficult to conceive how that philoſopher could have had ſo many admirers.

With almoſt every ancient theiſt of Greece, the founder of the academy believed in an order of beings called *dæmons*, which were ſuperior to the ſouls of men, and ſtruck off by the Demiurgus from the ſoul of the world. Of theſe the reader will find ſome account elſewhere. (See DÆMON and POLYTHEISM.) We mention them at preſent becauſe they make an important appearance in Plato's ſyſtem of Phyſics, which was built upon them, and upon the doctrine which has been ſtated concerning God, matter, and ideas. He taught, that the viſible world was formed by the Supreme Architect uniting eternal and immutable ideas to the firſt matter; that the univerſe is one animated being, including within its limits all animated natures; that, in the formation of the viſible and tangible world, fire and earth were firſt formed, and were afterwards united by means of air and water; that from perfect parts one perfect whole was produced, of a ſpherical figure, as moſt beautiful in itſelf, and beſt ſuited to contain all other figures; that the elementary parts of the world are of regular geometrical forms, the particles of earth being cubical, thoſe of fire pyramidical, thoſe of air in the form of an octahedron, and thoſe of water in that of an icoſahedron; that theſe are adjuſted in number, meaſure, and power, in perfect conformity to the geometrical laws of proportion; that the ſoul which pervades this ſphere is the cauſe of its revolution round its centre; and, laſtly, that the world will remain for ever, but that, by the action of its animating principle, it accompliſhes certain periods, within which every thing returns to its ancient place and ſtate. This periodical revolution of nature is called the *Platonic* or *great year*. See the preceding article.

The metaphyſical doctrines of Plato, which treat of the human ſoul, and the principles of his ſyſtem of ethics, have been detailed in other articles (ſee METAPHYSICS, and MORAL *Philoſophy*): but it is worthy of obſervation in this place, that, preparatory to the ſtudy of all philoſophy, he required from his diſciples a knowledge of the elements of mathematics. In his Republic, he makes Glaucus, one of the ſpeakers, recommend them for their uſefulneſs in human life. "Arithmetic for accounts and diſtributions; geometry for incampments and menſurations; muſic for ſolemn feſtivals in honour of the gods; and aſtronomy for agriculture, for navigation, and the like. Socrates, on his part, denies not the truth of all this, but ſtill inſinuates that they were capable of anſwering an end more ſublime. 'You are pleaſant (ſays he) in your ſeeming to fear the multitude, leſt you ſhould be thought to enjoin certain ſciences that are uſeleſs. 'Tis indeed no contemptible matter, though a difficult one, to believe, that through theſe particular ſciences the ſoul has an organ purified and enlightened, which is deſtroyed and blinded by ſtudies of other kinds; an organ better worth ſaving than a thouſand eyes, in as much as *truth* becomes viſible through *this alone*.'

"Concerning policy, Plato has written at large in his Republic and in his Dialogue on Laws. He was ſo much enamoured with his own conceptions on this ſubject, that it was chiefly the hope of having an opportunity to realiſe his plan of a republic which induced him to viſit the court of Dionyſius. But they who are converſant with mankind, and capable of calmly inveſtigating the ſprings of human actions, will eaſily perceive that his projects were chimerical, and could only have originated in a mind replete with philoſophical enthuſiaſm. Of this nothing can be a clearer proof than the deſign of admitting in his republic a community of women, in order to give reaſon an entire controul over deſire. The main object of his political inſtitutions appears to have been, the ſubjugation of the paſſions and appetites, by means of the abſtract contemplation of ideas. A ſyſtem of policy, raiſed upon ſuch fanciful grounds, cannot merit a more diſtinct conſideration."

Such is genuine Platoniſm as it was taught in the old academy by the founder of the ſchool and his immediate followers; but when Arceſilaus was placed at the head of the academies, great innovations were introduced both into their doctrines and into their mode of teaching. This man was therefore conſidered as the founder of what was afterwards called the *middle* academy. Being a profeſſed ſceptic, he carried his maxim of uncertainty to ſuch a height, as to alarm the general body of philoſophers, offend the governors of the ſtate, and bring juſt odium upon the very name of the academy. At length *Carneades*, one of the diſciples of this ſchool, relinquiſhing ſome of the more obnoxious tenets of Arceſilaus, founded what has been called the *new* academy with very little improvement on the principles of the middle. See Carneades.

Under one or other of theſe forms Platoniſm found its way into the Roman republic. Cicero was a Platoniſt, and one of the greateſt ornaments of the ſchool. A ſchool of Platoniſts was likewiſe founded in Alexandria in the ſecond century of the Chriſtian æra; but their doctrines differed in many particulars from thoſe taught in the three academies. They profeſſed to ſeek truth wherever they could find it, and to collect their dogmas from every ſchool. They endeavoured to bend ſome of the principles of Plato into a conformity with the doctrines of the goſpel; and they incorporated with the whole many of the maxims of Ariſtotle and Zeno, and not a few of the fictions of the eaſt. Their ſyſtem was therefore extremely heterogeneous, and ſeldom ſo rational as that of the philoſopher after whoſe name they were called, and of whoſe doctrines we have given ſo copious a detail. See Ammonius, Eclectics, and Plotinus.

PLAUTUS (Marcus Accius), a comic writer of ancient Rome, born in Umbria, a province of Italy. His proper name was *Marcus Accius*, and he is ſuppoſed to have acquired the ſurname of *Plautus* from having ſplay feet. His parentage appears to have been mean; ſo that ſome have thought he was the ſon of a ſlave. Aulus Gellius ſays that Plautus was diſtinguiſhed for his poetry on the theatre, and Cato for his eloquence in the Forum, at the ſame time; and obſerves elſewhere from Varro, that he was ſo well paid for his plays as to double his ſtock in trading, in which he loſt all he gained by the muſes. He is ſaid to have been reduced to work at a mill for his ſubſiſtence; but Varro adds, that his wit was his beſt ſupport, as he compoſed three of his plays during this drudgery. He died in the firſt year of the elder Cato's cenſorſhip, about the year of Rome 569, and 184 B. C. We have 20 of his plays extant, though not all of them entire. Five of them, comedies, have been elegantly tranſlated into Engliſh by Mr. B. Thornton, and publiſhed in 2 vols. 8vo. 1767.

PLAYS. See PLAY house.

PLAY-house. See Theatre, Amphitheatre, &c. The moſt ancient Engliſh play houſes were the Curtain in Shoreditch and the Theatre In the time of Shakeſpeare, who commenced a dramatic writer in 1592, there were no leſs than 10 theatres open. Four of theſe were private houſes, viz. that in Blackfriars, the Cockpit or Phœnix in Drury-lane, a theatre in Whitefriars, and one in Saliſbury-court. The other ſix were called public theatres, viz. the Globe, the Swan, the Roſe, and the Hope, on the Bank-ſide; the Red Bull, at the upper end of St. John's ſtreet, and the Fortune in White-croſs-ſtreet. The two laſt were chiefly frequented by citizens. Mr. Malone gives us a pretty copious account of theſe play-houſes, in a ſupplement to his laſt edition of Shakeſpeare, which we ſhall here inſert.

" Moſt, if not all (ſays he) of Shakeſpeare's plays were performed either at the Globe or at the Theatre in Blackfriars. It appears that they both belonged to the ſame company of comedians, viz. his majeſty's ſervants, which title they aſſumed, after a licence had been granted to them by king James in 1603, having before that time been called the ſervants of the lord chamberlain.

" The theatre in Blackfriars was a private houſe; but the peculiar and diſtinguiſhing marks of a private play-houſe it is not eaſy to aſcertain. It was very ſmall, and plays were there uſually repreſented by candle light. The Globe, ſituated on the ſouthern ſide of the river Thames, was a hexagonal building, partly open to the weather, partly covered with reeds. It was a public theatre, and of conſiderable ſize, and there they always acted by day-light. On the roof of the Globe, and the other public theatres, a pole was erected, to which a flag was affixed. Theſe flags were probably diſplayed only during the hours of exhibition; and it ſhould ſeem from a paſſage in one of the old comedies that they were taken down during Lent, in which ſeaſon no plays were preſented. The Globe, though hexagonal at the outſide, was probably a rotunda within, and perhaps had its name from its circular form. It might, however, have been denominated only from its ſign, which was a figure of Hercules ſupporting the Globe. This theatre was burnt down in 1613; but it was rebuilt in the following year, and decorated with more ornament than had been originally beſtowed upon it. The exhibitions at the Globe ſeem to have been calculated chiefly for the lower claſs of people; thoſe at Blackfriars for a more ſelect and judicious audience.

" A writer informs us, that one of theſe theatres was a winter and the other a ſummer houſe. As the Globe was partly expoſed to the weather, and they acted there uſually by daylight, it was probably the ſummer theatre. The exhibitions here ſeem to have been more frequent than at Blackfriars, at leaſt till the year 1604 or 1605, when the Bank-ſide appears to have become leſs faſhionable and leſs frequented than it formerly had been. Many of our ancient dramatic pieces were performed in the yards of carriers inns; in which, in the beginning of queen Elizabeth's reign, the comedians, who then firſt united themſelves in companies, erected an occaſional ſtage. The form of theſe temporary play-houſes ſeems to be preſerved in our modern theatre. The galleries are in both ranged over each other on three ſides of the building. The ſmall rooms under the loweſt of theſe galleries anſwer to our preſent boxes; and it is obſervable that theſe, even in theatres which were built in a ſubſequent period expreſsly for dramatic exhibitions, ſtill retained their old name, and are frequently called rooms by our ancient writers. The yard bears a ſufficient reſemblance to the pit, as at preſent in uſe. We may ſuppoſe the ſtage to have been raiſed in this area, on the fourth ſide, with its back to the gateway of the inn, at which the money for admiſſion was taken. Hence, in the middle of the Globe, and I ſuppoſe of the other public theatres, in the time of Shakeſpeare, there was an open yard or area, where the common people ſtood to ſee the exhibition; from which circumſtance they are called by our author groundlings, and by Ben Jonſon 'the underſtanding gentlemen of the ground.'

" In the ancient play-houſes there appears to have been a private box, of which it is not eaſy to aſcertain the ſituation. It ſeems to have been placed at the ſide of the ſtage towards the rear, and to have been at a lower price: in this ſome people ſat, either from economy or ſingularity. The galleries, or ſcaffolds as they are ſometimes called, and that part of the houſe which in private theatres was named the pit, ſeem to have been at the ſame price; and probably in houſes of reputation, ſuch as the Globe, and that in Blackfriars, the price of admiſſion into thoſe parts of the theatre was 6d. while in ſome meaner play-houſes it was only 1d. in others only 2d. The price of admiſſion into the beſt rooms or boxes was, I believe, in our author's time, 1s.; though afterwards it appears to have riſen to 2s. and half-a crown.

" From ſeveral paſſages in our old plays, we learn, that ſpectators were admitted on the ſtage, and that the critics and wits of the time uſually ſat there. Some were placed on the ground; others ſat on ſtools, of which the price was either 6d. or 1s. according, I ſuppoſe, to the commodiouſneſs of the ſituation; and they were attended by pages, who furniſhed them with pipes and tobacco, which was ſmoked here as well as in other parts of the houſe; yet it ſhould ſeem that perſons were ſuffered to ſit on the ſtage only in the private play-houſes, ſuch as Blackfriars, &c. where the audience was more ſelect, and of a higher claſs; and that in the Globe and other public theatres no ſuch licence was permitted.

"The ſtage was ſtrewed with ruſhes, which, as we learn from Hentzner and Caius de Ephemera, was, in the time of Shakeſpeare, the uſual covering of floors in England. The curtain which hangs in the front of the preſent ſtage, drawn up by lines and pulleys, though not a modern invention, for it was uſed by Inigo Jones in the maſques at court, was yet an apparatus to which the ſimple mechaniſm of our ancient theatres had not arrived; for in them the curtains opened in the middle, and were drawn backwards and forwards on an iron rod. In ſome play houſes they were woollen, in others made of ſilk.—Towards the rear of the ſtage there appears to have been a balcony, the platform of which was probably eight or ten feet from the ground. I ſuppoſe it to have been ſupported by pillars. From hence, in many of our old plays, part of the dialogue was ſpoken; and in the front of this balcony curtains likewiſe were hung.

" A doubt has been entertained whether in our ancient theatres there were ſide and other ſcenes. The queſtion is involved in ſo much obſcurity, that it is very difficult to form any decided opinion upon it. It is certain, that in the year 1605 Inigo Jones exhibited an entertainment at Oxford, in which moveable ſcenes were uſed; but he appears to have introduced ſeveral pieces of machinery in the maſques at court, with which undoubtedly the public theatres were unacquainted. A paſſage which has been produced from one of the old comedies, proves, it muſt be owned, that even theſe were furniſhed with ſome pieces of machinery, which were uſed when it was requiſite to exhibit the deſcent of ſome god or ſaint; but, from all the contemporary accounts, I am inclined to believe that the mechaniſm of our ancient ſtage ſeldom went beyond a painted chair or a trap-door, and that few, if any of them, had any moveable ſcenes. When king Henry VIII. is to be diſcovered by the dukes of Suffolk and Norfolk, reading in his ſtudy, the ſcenical direction in the firſt folio, 1623, (which was printed apparently from play-houſe copies,) is, 'the king draws the curtain, (*i. e.* draws it open,) and ſits reading penſively;' for, beſides the principal curtains that hung in the front of the ſtage, they uſed others as ſubſtitutes for ſcenes. If a bed-chamber is to be exhibited, no change of ſcene is mentioned; but the property man is ſimply ordered to thruſt forth a bed. When the fable requires the Roman capitol to be exhibited, we find two officers enter, ' to lay cuſhions, as it were, in the capitol,' &c. On the whole, it appears, that our ancient theatres, in general, were only furniſhed with curtains, and a ſingle ſcene compoſed of tapeſtry, which were ſometimes perhaps ornamented with pictures; and ſome paſſages in our old dramas incline one to think, that when tragedies were performed the ſtage was hung with black.

" In the early part, at leaſt, of our author's acquaintance with the theatre, the want of ſcenery ſeems to have been ſupplied by the ſimple expedient of writing the names of the different places where the ſcene was laid in the progreſs of the play, which were diſpoſed in ſuch a manner as to be viſible to the audience. The invention of trap-doors, however, appears not to be modern; for in an old *morality*, entitled *All for Money*, we find a marginal direction which implies that they were very early in uſe. The covering, or internal roof of the ſtage, was anciently termed the heavens. It was probably painted of a ſky-blue colour, or perhaps pieces of drapery tinged with blue were ſuſpended acroſs the ſtage to repreſent the heavens.

" It is probable that the ſtage was formerly lighted by two large branches, of a form ſimilar to thoſe now hung in churches. They gave place in a ſubſequent period to ſmall circular wooden frames furniſhed with candles, eight of which were hung on the ſtage, four at either ſide; and theſe within a few years were wholly removed by Mr. Garrick, who, on his return from France, firſt introduced the preſent commodious method of illuminating the ſtage by lights not viſible to the audience. Many of the companies of players were formerly ſo thin, that one perſon played two or three parts; and a battle on which the fate of an empire was ſuppoſed to depend was decided by half a dozen combatants. It appears to have been a common practice in their mock engagements to diſcharge ſmall pieces of ordnance on the ſtage. Before the exhibition began, three flouriſhes or pieces of muſic were played, or, in the ancient language, there were three ſoundings. Muſic was likewiſe played between the acts. The inſtruments chiefly uſed were trumpets, cornets, and hautboys. The band, which did not conſiſt of more than five or ſix performers, ſat in an upper balcony, over what is now called the ſtage-box.

" The perſon who ſpoke the prologue was uſhered in by trumpets, and uſually wore a long black velvet cloak, which, I ſuppoſe, was conſidered as beſt ſuited to a ſupplicatory addreſs. Of this cuſtom, whatever might have been its origin, ſome traces remained till very lately, a black coat having been, if I miſtake not, within theſe few years, the conſtant ſtage habiliment of our modern prologue ſpeakers The dreſs of the ancient prologue-ſpeaker is ſtill retained in the play exhibited in Hamlet before the king and court of Denmark. The performers of male characters generally wore periwigs, which in the age of Shakeſpeare were not in common uſe. It appears from a paſſage in Puttenham's *Art of Engliſh Poeſy*, 1589, that vizors were on ſome occaſions uſed by the actors of thoſe days; and it may be inferred, from a ſcene in one of our author's comedies, that they were ſometimes worn in his time by thoſe who performed female characters; but this I imagine was very rare. Some of the female part of the audience likewiſe appeared in maſks. The ſtage-dreſſes, it is reaſonable to ſuppoſe, were much more coſtly at ſome theatres than at others; yet the wardrobe of even the king's ſervants at the Globe and Blackfriars was, we find, but ſcantily furniſhed; and our author's dramas derived very little aid from the ſplendor of exhibition.

" It is well known, that in the time of Shakeſpeare, and for many years afterwards, female characters were repreſented by boys or young men. Sir William D'Avenant, in imitation of the foreign theatres, firſt introduced females in the ſcene, and Mrs. Betterton is ſaid to have been the firſt woman that appeared on the Engliſh ſtage. Andrew Pennycuike played the part of Matilda in a tragedy of Davenport's in 1655; and Mr. Kynaſton acted ſeveral female parts after the Reſtoration. Downes, a contemporary of his, aſſures us, ' that being then very young he made a complete ſtage beauty, performing his parts ſo well, particularly Arthiope and Aglaura, that it has ſince been diſputable among the judicious, whether any woman that ſucceeded him touched the audience ſo ſenſibly as Kynaſton did.'

" Both the prompter, or book-holder, as he was ſometimes called, and the property-man appear to have been regular appendages of our ancient theatres. No writer that I have met with intimates, that in the time of Shakeſpeare it was cuſtomary to exhibit more than a ſingle dramatic piece on one day. The Yorkſhire tragedy, or *All's One*, indeed, appears to have been one of four pieces repreſented on the ſame day; and Fletcher has alſo a piece called *Four Plays in One:* but probably theſe were either exhibited on ſome particular occaſion, or were ineffectual efforts to introduce a new ſpecies of amuſement; for we do not find any other inſtances of the ſame kind. Had any ſhorter pieces been exhibited after the principal performance, ſome of them probably would have been printed: but there are none extant of an earlier date than the time of the Reſtoration. The practice, therefore, of exhibiting two dramas ſucceſſively in the ſame evening, we may be aſſured was not eſtabliſhed before that period. But though the audiences in the time of our author were not gratified by the repreſentation of more than one drama in the ſame day, the entertainment was diverſified, and the populace diverted, by vaulting, tumbling, ſlight of hand, and morris-dancing; a mixture not much more heterogeneous than that with which we are daily preſented, a tragedy and a farce.

" The amuſements of our anceſtors, before the commencement of the play, were of various kinds, ſuch as reading, playing at cards, drinking ale, or ſmoking tobacco. It was a common practice to carry table-books to the theatre, and either from curioſity or enmity to the author, or ſome other motive, to write down paſſages of the play that was repreſented: and there is reaſon to believe that the imperfect and mutilated copies of ſome of Shakeſpeare's dramas, which are yet extant, were taken down in ſhort hand during the exhibition. At the end of the piece, the actors, in noblemen's houſes and in taverns, where plays were frequently performed, prayed for the health and proſperity of their patrons; and in the public theatres for the king and queen. This prayer ſometimes made part of the epilogue. Hence, probably, as Mr. Steevens has obſerved, the addition of *Vivant rex et regina* to the modern play-bills.

" Plays, in the time of our author, began at one o'clock in the afternoon; and the exhibition was uſually finiſhed in two hours. Even in 1667 they commenced at three. When Goſſon wrote his *School of Abuſe* in 1579, it ſeems the dramatic entertainments were uſually exhibited on Sundays. Afterwards they were performed on that and other days indiſcriminately. It appears from a contemporary writer, that exhibiting plays on Sunday had not been aboliſhed in the third year of king Charles I.

" The modes of conveyance to the theatre, anciently as at preſent, ſeem to have been various; ſome going in coaches, others on horſeback, and many by water. To the Globe play-houſe the company probably were conveyed by water; to that in Blackfriars the gentry went either in coaches or on horſeback, and the common people on foot. In an epigram to Sir John Davis, the practice of riding to the theatre is ridiculed as a piece of affectation or vanity, and therefore we may preſume it was not very general.

" The long and whimſical titles that are prefixed to the quarto copies of our author's plays, I ſuppoſe to have been tranſcribed from the play-bills of the time. A contemporary writer has preſerved ſomething like a play-bill of thoſe days, which ſeems to corroborate this obſervation; for, if it were diveſted of rhime, it would bear no very diſtant reſemblance to the title pages that ſtand before ſome of our author's dramas:

" ————Prithee, what's the play?
" (The firſt I viſited this twelvemonth day)
" They ſay—' A new-invented play of Purle,
" That jeoparded his neck to ſteal a girle
" Of twelve; and lying faſt impounded for't,
" Has hither ſent his bearde to act his part,
" Againſt all thoſe in open malice bent,
" That would not freely to the theft conſent:
" Feigns all to 's wiſh, and in the epilogue
" Goes out applauded for a famous rogue.'
" —Now hang me if I did not look at firſt
" For ſome ſuch ſtuff, by the fond people's thruſt."

" It is uncertain at what time the uſage of giving authors a benefit on the third day of the exhibition of their pieces commenced. Mr. Oldys, in one of his manuſcripts, intimates that dramatic poets had anciently their benefit on the firſt day that a new play was repreſented; a regulation which would have been very favourable to ſome of the ephemeral productions of modern times. But for this there is not, I believe, any ſufficient authority. From D'Avenant, indeed, we learn, that in the latter part of the reign of queen Elizabeth the poet had his benefit on the ſecond day. As it was a general practice in the time of Shakeſpeare to ſell the copy of the play to the theatre, I imagine in ſuch caſes an author derived no other advantage from his piece than what aroſe from the ſale of it. Sometimes, however, he found it more beneficial to retain the copyright in his own hands; and when he did ſo, I ſuppoſe he had a benefit. It is certain that the giving authors the profit of the third exhibition of their play, which ſeems to have been the uſual mode during almoſt the whole of the laſt century, was an eſtabliſhed cuſtom in the year 1612; for Decker, in the prologue to one of his comedies printed in that year, ſpeaks of the poet's third day. The unfortunate Otway had no more than one benefit on the production of a new play; and this too, it ſeems, he was ſometimes forced to mortgage before the piece was acted. Southerne was the firſt dramatic writer who obtained the emoluments ariſing from two repreſentations; and to Farquhar, in the year 1700, the benefit of a third was granted. When an author ſold his piece to the ſharers or proprietors of a theatre, it remained for ſeveral years unpubliſhed; but when that was not the caſe, he printed it for ſale, to which many ſeem to have been induced, from an apprehenſion that an imperfect copy might be iſſued from the preſs without their conſent. The cuſtomary price of the copy of a play in the time of Shakeſpeare appears to have been twenty nobles, or ſix pounds thirteen ſhillings and four pence. The play when printed was ſold for ſixpence; and the uſual preſent from a patron in return for a dedication was forty ſhillings. On the firſt day of exhibiting a new play, the prices of admiſſion appear to have been raiſed; and this ſeems to have been occaſionally practiſed on the benefit-nights of authors to the end of the laſt century. The cuſtom of paſſing a final cenſure on plays at their firſt exhibition is as ancient as the time of our author; for no leſs than three plays of his rival Ben Jonſon appear to have been damned; and Fletcher's Faithful Shepherdeſs, and the Knight of the Burning Peſtle, written by him and Beaumont, underwent the ſame fate.

" It is not eaſy to aſcertain what were the emoluments of a ſucceſsful actor in the time of Shakeſpeare. They had not then annual benefits as at preſent. The performers at each theatre ſeem to have ſhared the profits ariſing either from each day's exhibition or from the whole ſeaſon among them. From Ben Jonſon's Poetaſter we learn, that one of either the performers or proprietors had ſeven ſhares and a half; but of what integral ſum is not mentioned. From the prices of admiſſion into our ancient theatres, which have been already mentioned, I imagine the utmoſt that the ſharers of the Globe play-houſe could have received on any one day was about 35l. So lately as the year 1685, Shadwell received by his third day on the repreſentation of the Squire of Alſatia, 130l.; which Downes the prompter ſays was the greateſt receipt that had been ever taken at Drury-lane playhouſe at ſingle prices. It appears from the MSS. of lord Stanhope, treaſurer of the chambers to king James I. that the cuſtomary ſum paid to John Heminge and his company for the performance of a play at court was twenty nobles, or ſix pounds thirteen ſhillings and four pence. And Edward Alleyn mentions in his Diary, that he once had ſo ſlender an audience in his theatre called the *Fortune*, that the whole receipts of the houſe amounted to no more than three pounds and ſome odd ſhillings.

" Thus ſcanty and meagre were the apparatus and accommodations of our ancient theatres, on which thoſe dramas were firſt exhibited, that have ſince engaged the attention of ſo many learned men, and delighted ſo many thouſand ſpectators.

Yet even then, we are informed by a writer of that age, 'dramatic poeſy was ſo livelily expreſſed and repreſented on the public ſtages and theatres of this city, as Rome in the age of her pomp and glory never ſaw it better performed; in reſpect of the action and art, not of the coſt and ſumptuouſneſs."

PLEA, in law, is what either party alleges for himſelf in court, in a cauſe there depending; and in a more reſtrained ſenſe, it is the defendant's anſwer to the plaintiff's declaration. Pleas are uſually divided into thoſe of the crown and common pleas. Pleas of the crown are all ſuits in the king's name, or in the name of the attorney-general in behalf of the king, for offences committed againſt his crown and dignity, and againſt his peace; as treaſon, murder, felony, &c. See ARRAIGNMENT. *Common* pleas are ſuch ſuits as are carried on between common perſons in civil caſes. Theſe pleas are of two ſorts; *dilatory* pleas, and pleas *to the action*. Dilatory pleas are ſuch as tend merely to delay or put off the ſuit, by queſtioning the propriety of the remedy, rather than by denying the injury: pleas to the action are ſuch as diſpute the very cauſe of ſuit.

(1.) *Dilatory* pleas are, 1. To the juriſdiction of the court; alleging, that it ought not to hold plea of this injury, it ariſing in Wales or beyond ſea; or becauſe the land in queſtion is of ancient demeſne, and ought only to be demanded in the lord's court, &c. 2. To the diſability of the plaintiff, by reaſon whereof he is incapable to commence or continue the ſuit; as, that he is an alien enemy, outlawed, excommunicated, attainted of treaſon or felony, under a præmunire, not *in rerum natura* (being only a fictitious perſon), an infant, a feme-covert, or a monk profeſſed. 3. In abatement: which abatement is either of the writ, or the count, for ſome defect in one of them; as by miſnaming the defendant, which is called a *miſnomer*; giving him a wrong addition, as eſquire inſtead of knight; or other want of form in any material reſpect. Or, it may be that the plaintiff is dead; for the death of either party is at once an abatement of the ſuit.

Theſe pleas to the juriſdiction, to the diſability, or in abatement, were formerly very often uſed as mere dilatory pleas, without any foundation in truth, and calculated only for delay; but now by ſtat. 4 & 5 Ann. c. 16. no dilatory plea is to be admitted without affidavit made of the truth thereof, or ſome probable matter ſhown to the court to induce them to believe it true. And with reſpect to the pleas themſelves, it is a rule, that no exception ſhall be admitted againſt a declaration or writ, unleſs the defendant will in the ſame plea give the plaintiff a better; that is, ſhow him how it might be amended, that there may not be two objections upon the ſame account.

All pleas to the juriſdiction conclude to the cognizance of the court; praying "judgment whether the court will have further cognizance of the ſuit." Pleas to the diſability conclude to the perſon; by praying "judgment, if the ſaid A the plaintiff ought to be anſwered." And pleas in abatement (when the ſuit is by original) conclude to the writ or declaration; by praying "judgment of the writ or declaration, and that the ſame may be quaſhed," *caſſetur*, made void, or abated: but if the action be by bill, the plea muſt pray "judgment of the bill," and not of the declaration; the bill being here the original, and the declaration only a copy of the bill.

When theſe dilatory pleas are allowed, the cauſe is either diſmiſſed from that juriſdiction, or the plaintiff is ſtayed till his diſability be removed; or he is obliged to ſue out a new writ, by leave obtained from the court, or to amend and new-frame his declaration. But when, on the other hand, they are over-ruled as frivolous, the defendant has judgment of *reſpondeat ouſter*, or to anſwer over in ſome better manner. It is then incumbent on him to plead.

(2.) A plea *to the action*; that is, to anſwer to the merits of the complaint. This is done by confeſſing or denying it.

A confeſſion of the whole complaint is not very uſual; for then the defendant would probably end the matter ſooner, or not plead at all, but ſuffer judgment to go by default. Yet ſometimes, after tender and refuſal of a debt, if the creditor haraſſes his debtor with an action, it then becomes neceſſary for the defendant to acknowledge the debt, and plead the tender; adding, that he has always been ready, *tout temps priſt*, and is ſtill ready, *uncore priſt*, to diſcharge it: for a tender by the debtor and refuſal by the creditor will in all caſes diſcharge the coſts, but not the debt itſelf; though in ſome particular caſes the creditor will totally loſe his money. But frequently the defendant confeſſes one part of the complaint (by a *cognovit actionem* in reſpect thereof), and traverſes or denies the reſt; in order to avoid the expence of carrying that part to a formal trial, which he has no ground to litigate. A ſpecies of this ſort of confeſſion is the *payment of money into court*: which is for the moſt part neceſſary upon pleading a tender, and is itſelf a kind of tender to the plaintiff; by paying into the hands of the proper officer of the court as much as the defendant acknowledges to be due, together with the coſts hitherto incurred, in order to prevent the expence of any further proceedings. This may be done upon what is called a *motion*; which is an occaſional application to the court by the parties or their counſel, in order to obtain ſome rule or order of court, which becomes neceſſary in the progreſs of a cauſe; and it is uſually grounded upon an *affidavit* (the perfect tenſe of the verb *affido*), being a voluntary oath before ſome judge or officer of the court, to evince the truth of certain facts upon which the motion is grounded: though no ſuch affidavit is neceſſary for payment of money into court. If, after the money is paid in, the plaintiff proceeds in his ſuit, it is at his own peril: for, if he does not prove more due than is ſo paid into court, he ſhall be nonſuited and pay the defendant's coſts; but he ſhall ſtill have the money ſo paid in, for that the defendant has acknowledged to be his due. To this head may alſo be referred the practice of what is called a *ſet-off*; whereby the defendant acknowledges the juſtice of the plaintiff's demand on the one hand; but, on the other, ſets up a demand of his own, to counterbalance that of the plaintiff, either in the whole or in part; as, if the plaintiff ſues for ten pounds due on a note of hand, the defendant may ſet off nine pounds due to himſelf for merchandize ſold to the plaintiff; and, in caſe he pleads ſuch ſet-off, muſt pay the remaining balance into court.

Pleas that totally deny the cauſe of complaint are either the general iſſue, or ſpecial plea in bar.

1. The *general iſſue*, or general plea, is what traverſes, thwarts, and denies at once, the whole declaration, without offering any ſpecial matter whereby to evade it. As in treſpaſs either *vi et armis*, or on the caſe, "*non culpabilis*, not guilty;" in debt upon contracts "*nihil debet*, he owes nothing;" in debt on bond, "*non eſt factum*, it is not his deed;" on an *aſſumpſit*, "*non aſſumpſit*, he made no ſuch promiſe." Or in real actions, "*nul tort*, no wrong done; *nul diſſeiſin*, no diſſeiſin;" and in a writ of right, the miſe or iſſue is, that "the tenant has more right to hold than the demandant has to demand." Theſe pleas are called the *general iſſue*, becauſe, by importing an abſolute and general denial of what is alleged in the declaration, they amount at once to an iſſue; by which we mean a fact affirmed on one ſide and denied on the other.

2. *Special* pleas in bar of the plaintiff's demands are very various, according to the circumſtances of the defendant's caſe. As, in real actions, a geneal releaſe or a fine; both of which may deſtroy and bar the plaintiff's title. Or, in perſonal actions, an accord, arbitration, conditions performed, nonage of the defendant, or ſome other fact which precludes the plaintiff from his action. A *juſtification* is likewiſe a ſpecial plea in bar; as in actions of aſſault and battery, *ſon aſſault demeſne*, that it

was the plaintiff's own original aſſault; in treſpaſs, that the defendant did the thing complained of in right of ſome office which warranted him ſo to do; or, in an action of ſlander, that the plaintiff is really as bad a man as the defendant ſaid he was.

Alſo a man may plead the ſtatutes of limitation in bar; or the time limited by certain acts of parliament, beyond which no plaintiff can lay his cauſe of action. This, by the ſtatute of 32 Hen. VIII. c. 2. in a writ of right is 60 years: in aſſiſes, writs of entry, or other poſſeſſory actions real, of the ſeiſin of one's anceſtors in lands; and either of their ſeiſin, or one's own, in rents, ſuits, and ſervices, 50 years: and in actions real for lands grounded upon one's own ſeiſin or poſſeſſion, ſuch poſſeſſion muſt have been within 30 years. By ſtatute 1 Mar. ſt. 2. c. 5. this limitation does not extend to any ſuit for advowſons. But by the ſtatute 21 Jac. I. c. 2. a time of limitation was extended to the caſe of the king; viz. 60 years precedent to 19th Feb. 1623: but, this becoming ineffectual by efflux of time, the ſame date of limitation was fixed by ſtatute 9 Geo. III. c. 16. to commence and be reckoned backwards, from the time of bringing any ſuit or other proceſs to recover the thing in queſtion; ſo that a poſſeſſion for 60 years is now a bar even againſt the prerogative, in derogation of the ancient maxim, *Nullum tempus occurrit regi.* By another ſtatute, 21 Jac. I. c. 16. 20 years is the time of limitation in any writ of formedon: and, by a conſequence, 20 years is alſo the limitation in every action of ejectment; for no ejectment can be brought, unleſs where the leſſor of the plaintiff is entitled to enter on the lands; and by the ſtatute 21 Jac. I. c. 16. no entry can be made by any man, unleſs within 20 years after his right ſhall accrue. Alſo all actions of treſpaſs (*quare clauſum fregit*, or otherwiſe), detinue, trover, replevin, account, and caſe (except upon accounts between merchants), debt on ſimple contract, or for arrears of rent, are limited by the ſtatute laſt mentioned to ſix years after the cauſe of action commenced: and actions of aſſault, menace, battery, mayhem, and impriſonment, muſt be brought within four years, and actions for words two years, after the injury committed. And by the ſtatute 31 Eliz. c. 5. all ſuits, indictments, and informations, upon any penal ſtatutes, where any forfeiture is to the crown, ſhall be ſued within two years, and where the forfeiture is to a ſubject, within one year, after the offence committed, unleſs where any other time is ſpecially limited by the ſtatute. Laſtly, by ſtatute 10 W. III. c. 14. no writ of error, *ſcire facias*, or other ſuit, ſhall be brought to reverſe any judgment, fine, or recovery, for error, unleſs it be proſecuted within 20 years. The uſe of theſe ſtatutes of limitation is to preſerve the peace of the kingdom, and to prevent thoſe innumerable perjuries which might enſue if a man were allowed to bring an action for any injury committed at any diſtance of time. Upon both theſe accounts the law therefore holds, that *intereſt reipublicæ ut ſit finis litium*: and upon the ſame principle the Athenian laws in general prohibited all actions where the injury was committed five years before the complaint was made. If therefore, in any ſuit, the injury, or cauſe of action, happened earlier than the period expreſsly limited by law, the defendant may plead the ſtatutes of limitation in bar: as upon an *aſſumpſit*, or promiſe to pay money to the plaintiff. the defendant may plead, *Non aſſumpſit infra ſex annos*, He made no ſuch promiſe within ſix years; which is an effectual bar to the complaint.

An *eſtoppel* is likewiſe a ſpecial plea in bar; which happens where a man hath done ſome act, or executed ſome deed, which eſtops or precludes him from averring any thing to the contrary. As if a tenant for years (who hath no freehold) levies a fine to another perſon. Though this is void as to ſtrangers, yet it ſhall work as an eſtoppel to the cognizor; for, if he afterwards brings an action to recover theſe lands, and his fine is pleaded againſt him, he ſhall thereby be eſtopped from ſaying, that he had no freehold at the time, and therefore was incapable of levying it.

The conditions and qualities of a plea (which, as well as the doctrine of eſtoppels, will alſo hold equally, *mutatis mutandis*, with regard to other parts of pleading) are, 1. That it be ſingle, and containing only one matter; for duplicity begets confuſion. But by ſtatute 4 and 5 Ann. c. 16. a man, with leave of the court, may plead two or more diſtinct matters or ſingle pleas; as in an action of aſſault and battery, theſe three, Not guilty, *ſon aſſault demeſne*, and the ſtatute of limitations. 2. That it be direct and poſitive, and not argumentative. 3. That it have convenient certainty of time, place, and perſons. 4. That it anſwer the plaintiff's allegations in every material point. 5. That it be ſo pleaded as to be capable of trial.

Special pleas are uſually in the affirmative, ſometimes in the negative, but they always advance ſome new fact not mentioned in the declaration; and then they muſt be averred to be true in the common form: "And this he is ready to verify." This is not neceſſary in pleas of the general iſſue, thoſe always containing a total denial of the facts before advanced by the other party, and therefore putting him upon the proof of them. See PLEADINGS.

PLEA *to Indictment*, the defenſive matter alleged by a criminal on his indictment: (ſee ARRAIGNMENT.) This is either, 1. A plea to the juriſdiction; 2. A demurrer; 3. A plea in abatement; 4. A ſpecial plea in bar; or, 5. The general iſſue.

I. A plea to the *juriſdiction*, is where an indictment is taken before a court that hath no cognizance of the offence; as if a man be indicted for a rape at the ſheriff's tourn, or for treaſon at the quarter-ſeſſions: in theſe or ſimilar caſes, he may except to the juriſdiction of the court, without anſwering at all to the crime alleged.

II. A *demurrer* to the indictment, is incident to criminal caſes, as well as civil, when the fact as alleged is allowed to be true, but the priſoner joins iſſue upon ſome point of law in the indictment, by which he inſiſts, that the fact, as ſtated, is no felony, treaſon, or whatever the crime is alleged to be. Thus, for inſtance, if a man be indicted for feloniouſly ſtealing a greyhound, which is an animal in which no valuable property can be had, and therefore it is not felony, but only a civil treſpaſs to ſteal it; in this caſe the party indicted may demur to the indictment; denying it to be felony, though he confeſſes the act of taking it. Some have held, that if, on demurrer, the point of law be adjudged againſt the priſoner, he ſhall have judgment and execution, as if convicted by verdict. But this is denied by others, who hold, that in ſuch caſe he ſhall be directed and received to plead the general iſſue, Not guilty, after a demurrer determined againſt him. Which appears the more reaſonable, becauſe it is clear, that if the priſoner freely diſcovers the fact in court, and refers it to the opinion of the court whether it be felony or no; and upon the fact thus ſhown, it appears to be felony, the court will not record the confeſſion, but admit him afterwards to plead Not guilty. And this ſeems to be a caſe of the ſame nature, being for the moſt part a miſtake in point of law, and in the conduct of his pleading; and though a man by miſpleading may in ſome caſes loſe his property, yet the law will not ſuffer him by ſuch niceties to loſe his life. However, upon this doubt, demurrers to indictments are ſeldom uſed: ſince the ſame advantages may be taken upon a plea of not guilty; or afterwards, in arreſt of judgment, when the verdict has eſtabliſhed the fact.

III. A plea in *abatement* is principally for a *miſnomer*, a wrong name, or a falſe addition to the priſoner. As, if James Allen, gentleman, is indicted by the name of *John Allen, eſquire*, he may plead that he has the name of *James*, and not of *John*;

and that he is a *gentleman*, and not an *eſquire*. And, if either fact is found by a jury, then the indictment ſhall be abated, as writs or declarations may be in civil actions. But, in the end, there is little advantage accruing to the priſoner by means of theſe dilatory pleas; becauſe, if the exception be allowed, a new bill of indictment may be framed, according to what the priſoner in his plea avers to be his true name and addition. For it is a rule, upon all pleas in abatement, that he who takes advantage of a flaw, muſt at the ſame time ſhow how it may be amended. Let us therefore next conſider a more ſubſtantial kind of plea, *viz.*

IV. Special pleas in *bar*; which go to the merits of the indictment, and give a reaſon why the priſoner ought not to anſwer it at all, nor put himſelf upon his trial for the crime alleged. Theſe are of four kinds; a former acquittal, a former conviction, a former attainder, or a pardon. There are many other pleas which may be pleaded in bar of an appeal: but theſe are applicable to both appeals and indictments.

1. Firſt, the plea of *auterfoits acquit*, or a former acquittal, is grounded on this univerſal maxim of the common law of England, that no man is to be brought into jeopardy of his life more than once for the ſame offence. And hence it is allowed as a conſequence, that when a man is once fairly found not guilty upon an indictment, or other proſecution, before any court having competent juriſdiction of the offence, he may plead ſuch acquittal in bar of any ſubſequent accuſation for the ſame crime.

2. Secondly, the plea of *auterfoits convict*, or a former conviction for the ſame identical crime, though no judgment was ever given, or perhaps will be (being ſuſpended by the benefit of clergy or other cauſes), is a good plea in bar to an indictment. And this depends upon the ſame principle as the former, that no man ought to be twice brought in danger of his life for one and the ſame crime.

3. Thirdly, the plea of *auterfoits attaint*, or a former attainder, is a good plea in bar, whether it he for the ſame or any other felony. For wherever a man is attainted of felony, by judgment of death either upon a verdict or confeſſion, by outlawry, or heretofore by abjuration, and whether upon an appeal or an indictment; he may plead ſuch attainder in bar to any ſubſequent indictment or appeal, for the ſame or for any other felony. And this becauſe, generally, ſuch proceeding on a ſecond proſecution cannot be to any purpoſe; for the priſoner is dead in law by the firſt attainder, his blood is already corrupted, and he hath forfeited all that he had: ſo that it is abſurd and ſuperfluous to endeavour to attaint him a ſecond time. Though to this general rule, as to all others, there are ſome exceptions; wherein, *ceſſante ratione, ceſſat et ipſa lex*.

4. Laſtly, a pardon may be pleaded in bar; as at once deſtroying the end and purpoſe of the indictment, by remitting that puniſhment which the proſecution is calculated to inflict. There is one advantage that attends pleading a pardon in bar, or in arreſt of judgment, before ſentence is paſt; which gives it by much the preference to pleading it after ſentence or attainder. This is, that by ſtopping the judgment it ſtops the attainder, and prevents the corruption of the blood; which, when once corrupted by attainder, cannot afterwards be reſtored otherwiſe than by act of parliament.

V. The *general iſſue*, or plea of Not guilty, upon which plea alone the priſoner can receive his final judgment of death. In caſe of an indictment of felony or treaſon, there can be no ſpecial juſtification put in by way of plea. As, on an indictment for murder, a man cannot plead that it was in his own defence againſt a robber on the highway, or a burglar; but he muſt plead the general iſſue, Not guilty, and give this ſpecial matter in evidence. For, (beſides that theſe pleas do in effect amount to the general iſſue; ſince, if true, the priſoner is moſt clearly not guilty) as the facts in treaſon are laid to be done *proditorie et contra ligeantiæ ſuæ debitum*; and, in felony, that the killing was done *felonice*; theſe charges, of a traitorous or felonious intent, are the points and very *giſt* of the indictment, and muſt be anſwered directly, by the general negative, Not guilty; and the jury upon the evidence will take notice of any defenſive matter, and give their verdict accordingly as effectually as if it were or could be ſpecially pleaded. So that this is, upon all accounts, the moſt advantageous plea for the priſoner.

When the priſoner hath thus pleaded Not guilty, *non culpabilis*, or *nient culpable*; which was formerly uſed to be abbreviated upon the minutes, thus, *Non* (or *nient*) *cul.* the clerk of the aſſize, or clerk of arraigns, on behalf of the crown replies, that the priſoner is guilty, and that he is ready to prove him ſo. This is done by two monoſyllables in the ſame ſpirit of abbreviation, *Cul. prit.*; which ſignifies firſt that the priſoner is guilty, (*cul. culpable*, or *culpabilis*); and then that the king is ready to prove him ſo, (*prit, præſto ſum*, or *paratus, verificare*). By this replication the king and the priſoner are therefore at iſſue: for, when the parties come to a fact which is affirmed on one ſide and denied on the other, then they are ſaid to be at iſſue in point of fact: which is evidently the caſe here, in the plea of *Non cul.* by the priſoner; and the replication of *Cul.* by the clerk.

How the courts came to expreſs a matter of this importance ſo ſo odd and obſcure a manner, can hardly be pronounced with certainty. It may perhaps, however, be accounted for by ſuppoſing, that theſe were at firſt ſhort notes, to help the memory of the clerk, and remind him what he was to reply; or elſe it was the ſhort method of taking down in court, upon the minutes, the replication and averment; *cul. prit.*; which afterwards the ignorance of ſucceeding clerks adopted for the very words to be by them ſpoken*.

But however it may have ariſen, the joining of iſſue ſeems to be clearly the meaning of this obſcure expreſſion; which has puzzled our moſt ingenious etymologiſts, and is commonly underſtood as if the clerk of the arraigns, immediately on plea pleaded, had fixed an opprobrious name on the priſoner, by aſking him, "*Culprit*, how wilt thou be tried?" for immediately upon iſſue joined it is inquired of the priſoner, by what trial he will make his innocence appear. This form has at preſent reference to appeals and approvements only, wherein the appellee has his choice, either to try the accuſation by BATTLE or by JURY. But upon indictments, ſince the abolition of ORDEAL, there can be no other trial but by jury, *per pais*, or by the country: and therefore, if the priſoner refuſes to put himſelf upon the inqueſt in the uſual form, that is, to anſwer that he will be tried by God and the country, if a commoner; and, if a peer, by God and his peers; the indictment, if in treaſon, is taken *pro confeſſo*; and the priſoner, in caſes of felony, is judged to ſtand mute, and, if he perſeveres in his obſtinacy, ſhall now be convicted of the felony.

When the priſoner has thus put himſelf upon his trial, the clerk anſwers in the humane language of the law, which always hopes that the party's innocence rather than his guilt may appear, 'God ſend thee a good deliverance!' And then they proceed, as ſoon as conveniently may be, to the trial. See the article TRIAL.

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* Of this ignorance we may ſee daily inſtances, in the abuſe of two legal terms of ancient French: one, the prologue to all proclamations, "*Oyez*, or Hear ye," which is generally pronounced, moſt unmeaningly, "O yes!" The other, a more pardonable miſtake, viz. when a jury are all ſworn, the officer bids the crier number them, for which the word in law French is, "*Countez*;" but we now hear it pronounced in very good Engliſh, "Count theſe."

PLEADINGS, in law, are the mutual altercations between the plaintiff and defendant. See SUIT, WRIT, and PROCESS. They form the third part or ſtage of a ſact; and at preſent are ſet down and delivered into the proper office in writing, though formerly they were uſually put in by their counſel *ore tenus*, or *viva voce*, in court, and then minuted down by the chief clerks or prothonotaries; whence, in our old law French, the pleadings are frequently denominated the *parol*.

The firſt of theſe is the *declaration, narratio*, or *count*, anciently called the *tale*; in which the plaintiff ſets forth his cauſe of complaint at length: being indeed only an amplification or expoſition of the original writ upon which his action is founded, with the additional circumſtances of time and place, when and where, the injury was committed.

In *local* actions, where poſſeſſion of land is to be recovered, or damages for an actual treſpaſs, or for waſte, &c. affecting land, the plaintiff muſt lay his declaration, or declare his injury to have happened in the very county and place that it really did happen; but in *tranſitory* actions, for injuries that might have happened anywhere, as debt, detinue, ſlander, and the like, the plaintiff may declare in what county he pleaſes, and then the trial muſt be in that county in which the declaration is laid. Though, if the defendant will make affidavit that the cauſe of action, if any, aroſe not in that but another county, the court will direct a change of *the venue* or *viſne* (that is, the *vicinia* or neighbourhood in which the injury is declared to be done), and will oblige the plaintiff to declare in the proper county. For the ſtatute 6 Ric. II. c. 2. having ordered all writs to be laid in their proper counties, this, as the judges conceived, impowered them to change the *venue*, if required, and not to inſiſt rigidly on abating the writ: which practice began in the reign of James I. And this power is diſcretionally exerciſed, ſo as not to cauſe but prevent a defect of juſtice. Therefore the court will not change the *venue* to any of the four northern counties previous to the ſpring circuit; becauſe there the aſſizes are holden only once a-year, at the time of ſummer circuit. And it will ſometimes remove the *venue* from the proper juriſdiction (eſpecially of the narrow and limited kind), upon a ſuggeſtion, duly ſupported, that a fair and impartial trial cannot be had therein.

It is generally uſual, in actions upon the caſe, to ſet forth ſeveral caſes, by different counts in the ſame declaration; ſo that, if the plaintiff fails in the proof of one, he may ſucceed in another. As in an action on the caſe upon an ASSUMPSIT for goods ſold and delivered, the plaintiff uſually counts or declares, firſt, upon a ſettled and agreed price between him and the defendant; as, that they bargained for 20l.: and leſt he ſhould fail in the proof of this, he counts likewiſe upon a *quantum valebant*; that the defendant bought other goods, and agreed to pay him ſo much as they were reaſonably worth: and then avers that they were worth other 20l. and ſo on in three or four different ſhapes; and at laſt concludes with declaring, that the defendant had refuſed to fulfil any of theſe agreements, whereby he is endamaged to ſuch a value. And if he proves the caſe laid in any one of his counts, though he fails in the reſt, he ſhall recover proportionable damages. This declaration always concludes with theſe words, "and thereupon he brings ſuit," &c. *inde producit ſectam, &c.* By which words, *ſuit* or *ſecta* (*a ſequendo*), were anciently underſtood the witneſſes or followers of the plaintiff. For, in former times, the law would not put the defendant to the trouble of anſwering the charge till the plaintiff had made out at leaſt a probable caſe. But the actual production of the *ſuit, ſecta*, or *followers*, is now antiquated, and hath been totally diſuſed, at leaſt ever ſince the reign of Edward III. though the form of it ſtill continues.

At the end of the declaration are added alſo the plaintiff's common pledges of proſecution, John Doe and Richard Roe; which, as we elſewhere obſerve, (ſee WRIT,) are now mere names of form; though formerly they were of uſe to anſwer to the king for the amercement of the plaintiff, in caſe he were nonſuited, barred of his action, or had a verdict and judgment againſt him. For, if the plaintiff neglects to deliver a declaration for two terms after the defendant appears, or is guilty of other delays or defaults againſt the rules of law in any ſubſequent ſtage of the action, he is adjudged not to follow or purſue his remedy as he ought to do; and thereupon a *nonſuit*, or *non proſequitur*, is entered, and he is ſaid to be *non-proſ'd*. And for thus deſerting his complaint, after making a falſe claim or complaint (*pro falſo clamore ſuo*), he ſhall not only pay coſts to the defendant, but is liable to be amerced to the king. A *retraxit* differs from a nonſuit, in that the one is negative and the other poſitive: the nonſuit is a default and neglect of the plaintiff, and therefore he is allowed to begin his ſuit again upon payment of coſts; but a *retraxit* is an open and voluntary renunciation of his ſuit in court; and by this he for ever loſes his action. A *diſcontinuance* is ſomewhat ſimilar to a nonſuit; for, when a plaintiff leaves a chaſm in the proceedings of his cauſe, as by not continuing the proceſs regularly from day to day, and time to time, as he ought to do, the ſuit is diſcontinued, and the defendant is no longer bound to attend; but the plaintiff muſt begin again, by ſuing out a new original, uſually paying coſts to his antagoniſt.

When the plaintiff hath ſtated his caſe in the declaration, it is incumbent on the defendant, within a reaſonable time, to make his defence, and to put in a plea; or elſe the plaintiff will at once recover judgment by *default*, or *nihil dicit*, of the defendant.

Defence, in its true legal ſenſe, ſignifies not a juſtification, protection, or guard, which is now its popular ſignification; but merely an *oppoſing* or *denial* (from the French verb *defendre*) of the truth or validity of the complaint. It is the *conteſtatio litis* of the civilians: a general aſſertion that the plaintiff hath no ground of action; which aſſertion is afterwards extended and maintained in his plea.

Before defence made, if at all, cognizance of the ſuit muſt be claimed or demanded; when any perſon or body corporate hath the franchiſe, not only of holding pleas within a particular limited juriſdiction, but alſo of the cognizance of pleas; and that either without any words excluſive of other courts, which entitles the lord of the franchiſe, whenever any ſuit that belongs to his juriſdiction is commenced in the courts at Weſtminſter, to demand the cognizance thereof; or with ſuch excluſive words, which alſo entitle the defendant to plead to the juriſdiction of the court. Upon this claim of cognizance, if allowed, all proceedings ſhall ceaſe in the ſuperior court, and the plaintiff is left at liberty to purſue his remedy in the ſpecial juriſdiction:—as, when a ſcholar or other privileged perſon of the univerſities of Oxford or Cambridge is impleaded in the courts at Weſtminſter, for any cauſe of action whatſoever, unleſs upon a queſtion of freehold. In theſe caſes, by the charter of thoſe learned bodies, confirmed by act of parliament, the chancellor, or vice-chancellor, may put in a claim of cognizance; which, if made in due time and form, and with due proof of the facts alleged, is regularly allowed by the courts. It muſt be demanded before full defence is made or imparlance prayed; for theſe are a ſubmiſſion to the juriſdiction of the ſuperior court, and the delay is a *laches* in the lord of the franchiſe: and it will not be allowed if it occaſions a failure of juſtice, or if an action be brought againſt the perſon himſelf who claims the franchiſe, unleſs he hath alſo a power in ſuch caſe of making another judge.

After defence made, the defendant muſt put in his plea. But before he defends, if the ſuit is commenced by *capias* or *latitat*, without any ſpecial original, he is entitled to demand one *imparlance*, or *licentia loquendi*; and may, before he pleads, have more granted by conſent of the court, to ſee if he can end the matter amicably without further ſuit, by talking with the plaintiff; a practice which is ſuppoſed to have ariſen from a principle of religion, in obedience to that precept of the goſpel, "Agree with thine adverſary quickly, whilſt thou art *in the way* with him." And it may be obſerved, that this goſpel-precept has a plain reference to the Roman law of the twelve tables, which expreſsly directed the plaintiff and defendant to make up the matter whilſt they were in the way, or going to the prætor;—*in via, rem uti pacunt orato.* There are alſo many other previous ſteps which may be taken by a defendant before he puts in his plea. He may, in real actions, demand a view of the thing in queſtion, in order to aſcertain its identity and other circumſtances. He may crave *oyer* of the writ, or of the bond, or other ſpecialty upon which the action is brought; that is, to hear it read to him; the generality of defendants in the times of ancient ſimplicity being ſuppoſed incapable to read it themſelves: whereupon the whole is entered *verbatim* upon the record; and the defendant may take advantage of any condition, or other part of it, not ſtated in the plaintiff's declaration. In real actions alſo the tenant may pray in *aid*, or call for the aſſiſtance of another, to help him to plead, becauſe of the feebleneſs or imbecility of his own eſtate. Thus a tenant for life may pray in aid of him that hath the inheritance in remainder or reverſion; and an incumbent may pray in aid of the patron and ordinary; that is, that they ſhall be joined in the action, and help to defend the title. *Voucher* alſo is the calling in of ſome perſon to anſwer the action, that hath warranted the title to the tenant or defendant. This we ſtill make uſe of in the form of common recoveries, which are grounded on a writ of entry; a ſpecies of action that relies chiefly on the weakneſs of the tenant's title, who therefore vouches another perſon to warrant it. If the vouchee appears, he is made defendant inſtead of the voucher; but if he afterwards makes default, recovery ſhall be had againſt the original defendant; and he ſhall recover an equivalent in value againſt the deficient vouchee. In aſſizes, indeed, where the principal queſtion is, whether the demandant or his anceſtors were or were not in poſſeſſion till the ouſter happened, and the title of the tenant is little (if at all) diſcuſſed, there no voucher is allowed; but the tenant may bring a writ of *warrantia chartæ* againſt the warrantor, to compel him to aſſiſt him with a good plea or defence, or elſe to render damages and the value of the land, if recovered againſt the tenant. In many real actions alſo, brought by or againſt an infant under the age of 21 years, and alſo in actions of debt brought againſt him, as heir to any deceaſed anceſtor, either party may ſuggeſt the nonage of the infant, and pray that the proceedings may be deferred till his full age, or, in our legal phraſe, that the infant may have his age, and that the *parol may demur*, that is, that the pleadings may be ſtaid; and then they ſhall not proceed till his full age, unleſs it be apparent that he cannot be prejudiced thereby. But by the ſtatutes of Weſtm. 1. 3 Edw. I. c. 46 and of Gloceſter, 6 Edw. I. c. 2. in writs of entry *ſur diſſeiſin* in ſome particular caſes, and in actions aunceſtrel brought by an infant, the parol ſhall not demur; otherwiſe he might be deforced of his whole property, and even want a maintenance, till he came of age. So likewiſe in a writ of dower the heir ſhall not have his age; for it is neceſſary that the widow's claim be immediately determined, elſe ſhe may want a preſent ſubſiſtence. Nor ſhall an infant patron have it in a *quare impedit*, ſince the law holds it neceſſary and expedient that the church be immediately filled.

When theſe proceedings are over, the defendant muſt then put in his excuſe or plea. See Plea.

It is a rule in pleading, that no man be allowed to plead ſpecially ſuch a plea as amounts only to the general iſſue, or a total denial of the charge; but in ſuch caſe he ſhall be driven to plead the general iſſue in terms, whereby the whole queſtion is referred to a jury. But if the defendant, in an aſſize or action of treſpaſs, be deſirous to refer the validity of his title to the court rather than the jury, he may ſtate his title ſpecially; and at the ſame time give colour to the plaintiff, or ſuppoſe him to have an appearance or colour of title, bad indeed in point of law, but of which the jury are not competent judges. As, if his own true title is, that he claims by feoffment with livery from A, by force of which he entered on the lands in queſtion, he cannot plead this by itſelf, as it amounts to no more than the general iſſue, *nul tort*, *nul diſſeiſin*, in aſſize, or *not guilty*, in an action of treſpaſs. But he may allege this ſpecially, provided he goes farther, and ſays, that the plaintiff claiming by colour of a prior deed of feoffment, without livery, entered; upon whom he entered; and may then refer himſelf to the judgment of the court, which of theſe two titles is the beſt in point of law.

When the plea of the defendant is thus put in, if it does not amount to an iſſue or total contradiction of the declaration, but only evades it, the plaintiff may plead again, and reply to the defendant's plea: Either traverſing it, that is, totally denying it; as if, on an action of debt upon bond, the defendant pleads *ſolvit ad diem*, that he paid the money when due; here the plaintiff in his replication may totally traverſe this plea, by denying that the defendant paid it: Or he may allege new matter in contradiction to the defendant's plea; as when the defendant pleads no award made, the plaintiff may reply, and ſet forth an actual award, and aſſign a breach: Or the replication may confeſs and avoid the plea, by ſome new matter or diſtinction, conſiſtent with the plaintiff's former declaration; as, in an action for treſpaſſing upon land whereof the plaintiff is ſeiſed, if the defendant ſhows a title to the land by deſcent, and that therefore he had a right to enter, and gives colour to the plaintiff, the plaintiff may either traverſe and totally deny the fact of the deſcent; or he may confeſs and avoid it, by replying, that true it is that ſuch deſcent happened, but that ſince the deſcent the defendant himſelf demiſed the lands to the plaintiff for term of life. To the replication the defendant may *rejoin*, or put in an anſwer called a *rejoinder*. The plaintiff may anſwer the rejoinder by a *ſur-rejoinder*; upon which the defendant may *rebut*, and the plaintiff anſwer him by a *ſur-rebutter*. Which pleas, replications, rejoinders, ſur-rejoinders, rebutters, and ſur-rebutters, anſwer to the *exceptio*, *replicatio*, *duplicatio*, *triplicatio*, and *quadruplicatio*, of the Roman laws.

The whole of this proceſs is denominated the *pleading*; in the ſeveral ſtages of which it muſt be carefully obſerved, not to depart or vary from the title or defence which the party has once inſiſted on. For this (which is called a *departure* in pleading) might occaſion endleſs altercation. Therefore the replication muſt ſupport the declaration, and the rejoinder muſt ſupport the plea, without departing out of it. As in the caſe of pleading no award made in conſequence of a bond of arbitration, to which the plaintiff replies, ſetting forth an actual award; now the defendant cannot rejoin that he hath performed this award, for ſuch rejoinder would be an entire departure from his original plea, which alleged that no ſuch award was made: therefore he has now no other choice, but to traverſe the fact of the replication, or elſe to demur upon the law of it.

Again, all duplicity in pleading muſt be avoided. Every plea muſt be ſimple, entire, connected, and confined to one ſingle point: it muſt never be entangled with a variety of diſtinct independent anſwers to the ſame matter; which muſt require as many different replies, and introduce a multitude of iſſues upon one and the ſame diſpute. For this would often embarraſs the jury, and ſometimes the court itſelf, and at all events would greatly enhance the expenſe of the parties. Yet it frequently is expedient to plead in ſuch a manner as to avoid any implied admiſſion of a fact, which cannot with propriety or ſafety be poſitively affirmed or denied. And this may be done by what is called a *proteſtation*; whereby the party interpoſes an oblique allegation or denial of ſome fact, proteſting (by the gerund *proteſtando)* that ſuch a matter does or does not exiſt; and at the ſame time avoiding a direct affirmation or denial. Sir Edward Coke hath defined a proteſtation (in the pithy dialect of that age) to be, "an excluſion of a concluſion." For the uſe of it is, to ſave the party from being concluded with reſpect to ſome fact or circumſtance which cannot be directly affirmed or denied without falling into duplicity of pleading; and which yet, if he did not thus enter his proteſt, he might be deemed to have tacitly waved or admitted. Thus, while tenure in villainage ſubſiſted, if a villain had brought an action againſt his lord, and the lord was inclined to try the merits of the demand, and at the ſame time to prevent any concluſion againſt himſelf that he had waved his ſigniory; he could not in this caſe both plead affirmatively that the plaintiff was his villain, and alſo take iſſue upon the demand; for then his plea would have been double, as the former alone would have been a good bar to the action: but he might have alleged the villainage of the plaintiff by way of proteſtation, and then have denied the demand. By this means the future vaſſalage of the plaintiff was ſaved to the defendant, in caſe the iſſue was found in his (the defendant's) favour; for the proteſtation prevented that concluſion which would otherwiſe have reſulted from the reſt of his defence, that he had enfranchiſed the plaintiff, ſince no villain could maintain a civil action againſt his lord. So alſo if a defendant, by way of inducement to the point of his defence, alleges (among other matters) a particular mode of ſeiſin or tenure which the plaintiff is unwilling to admit, and yet deſires to take iſſue on the principal point of the defence, he muſt deny the ſeiſin or tenure by way of proteſtation, and then traverſe the defenſive matter. So, laſtly, if an award be ſet forth by the plaintiff, and he can aſſign a breach in one part of it (viz. the non-payment of a ſum of money), and yet is afraid to admit the performance of the reſt of the award, or to aver in general a non-performance of any part of it, leſt ſomething ſhould appear to have been performed; he may ſave to himſelf any advantage he might hereafter make of the general non-performance, by alleging that by proteſtation he can plead only the non-payment of the money.

In any ſtage of the pleadings, when either ſide advances or affirms any new matter, he uſually (as was ſaid) avers it to be true; "and this he is ready to verify." On the other hand, when either ſide traverſes or denies the facts pleaded by his antagoniſt, he uſually tenders an *iſſue*, as it is called; the language of which is different according to the party by whom it is tendered: for, if the traverſe or denial comes from the defendant, the iſſue is tendered in this manner, "And of this he puts himſelf upon the country," thereby ſubmitting himſelf to the judgment of his peers: but if the traverſe lies upon the plaintiff, he tenders the iſſue or prays the judgment of the peers againſt the defendant in another form; thus, "and this he prays may be inquired of by the country."

But if either ſide (as, for inſtance, the defendant) pleads a ſpecial negative plea, not traverſing or denying any thing that was before alleged, but diſcloſing ſome new negative matter; as where the ſuit is on a bond conditioned to perform an award, and the defendant pleads, negatively, that no award was made; he tenders no iſſue upon this plea, becauſe it does not yet appear whether the fact will be diſputed, the plaintiff not having yet aſſerted the exiſtence of any award: but when the plaintiff replies, and ſets forth an actual ſpecific award, if then the defendant traverſes the replication, and denies the making of any ſuch award, he then, and not before, tenders an iſſue to the plaintiff. For when in the courſe of pleading they come to a point which is affirmed on one ſide and denied on the other, they are then ſaid to be at iſſue; all their debates being at laſt contracted into a ſingle point, which muſt now be determined either in favour of the plaintiff or of the defendant. See Issue.

PLEASING, art of. See Politeness.

PLEASURE is a word ſo univerſally underſtood as to need no explanation. Lexicographers, however, who muſt attempt to explain every word, call it "the gratification of the mind or ſenſes." It is directly oppoſite to Pain, and conſtitutes the whole of poſitive happineſs as that does of miſery.

However different and variable the ideas of pleaſure may be among nations and individuals, it ſtill remains a fact, that a certain number of perſons in all civilized ſtates, whether diſtinguiſhed by birth, or rank, or fortune, or talents, as they have nearly the ſame education, ſo they form nearly the ſame ideas of happineſs: but to poſſeſs it, a man muſt give his chief application to the ſtate of his mind; and notwithſtanding all his efforts it is of uncertain duration. Happineſs is the ſunſhine of life: we enjoy it frequently at great intervals; and it is therefore neceſſary to know how to uſe it. All the productions of art periſh; the largeſt fortunes are diſſipated; rank, honour, and dignity paſs away like a fleeting ſhadow; the memory is impaired; all the faculties of the ſoul are extinguiſhed; the body ſinks under the infirmities of old age; and ſcarcely has one reached the boundaries of happineſs marked out by his imagination, when he muſt give place to another, and renounce all his pleaſures, all his hopes, all his illuſions; the fugitive images of which had given happineſs to the mind.

There are pleaſures, however, on which the mind may ſecurely reſt, which elevate man above himſelf, dignify his nature, fix his attention on ſpiritual things, and render him worthy of the care of Providence. Theſe are to be found in true religion; which procures for thoſe who practiſe its duties inexpreſſible happineſs in a better country, and is in this world the ſupport of the weak, and the ſweet conſolation of the unfortunate.

PLEBEIAN, any perſon of the rank of the common people. It is chiefly uſed in ſpeaking of the ancient Romans, who were divided into ſenators, patricians, and plebeians. The diſtinction was made by Romulus, the founder of the city; who confined all dignities, civil, military, and ſacerdotal, to the rank of patricians. But to prevent the ſeditions which ſuch a diſtinction might produce through the pride of the higher order and the envy of the lower, he endeavoured to engage them to one another by reciprocal ties and obligations. Every plebeian was allowed to chooſe, out of the body of the patricians, a protector, who ſhould be obliged to aſſiſt him with his intereſt and ſubſtance, and to defend him from oppreſſion. Theſe protectors were called *patrons*; the protected, *clients*. It was the duty of the patron to draw up the contracts of the clients, to extricate them out of their difficulties and perplexities, and to guard their ignorance againſt the artfulneſs of the crafty. On the other hand, if the patron was poor, his clients were obliged to contribute to the portions of his daughters, the payment of his debts, and the ranſom of him and his children if they happened to be taken in war. The client and patron could neither accuſe nor bear witneſs againſt each other; and if either of them was convicted of having violated this law, the crime was equal to that of treaſon, and any one might with impunity ſlay the offender as a victim devoted to Pluto and the infernal gods. For more than 600 years we find no diſſenſions or jealouſies between the patrons and their clients; not even in the times of the republic, when the people frequently mutinied againſt the great and powerful.

PLECTRANTHUS, in botany: a genus of the gymnoſpermia order, belonging to the didynamia claſs of plants: and in the natural method ranking under the 42d order, *Verticillatæ*. The calyx is monophyllous, ſhort, and bilabiated; the upper lip of which is large, oval, and bent upwards; the inferior lip is quadrifid, and divided into two laciniæ: the corolla is monopetalous, ringent, and turned back; the labiæ look different ways, and from the baſe of the tube there is a nectarium like a ſpur: the filaments are in a declining ſituation, with ſimple antheræ: the ſtylus filiform; the ſtigma bifid. It has four ſeeds covered only by the calyx. There are two ſpecies, viz. 1. The *fruticoſus*, a native of the Cape of Good Hope; 2. *Punctatus*, a native of Africa. The firſt flowers from June to September, the latter from January to May.

PLEDGE (*Plegius*), in common law, a ſurety or gage, either real or perſonal, which the plaintiff or demandant is to find for his proſecuting the ſuit. The word is alſo ſometimes uſed for FRANK *Pledge*, which ſee.

To PLEDGE, in drinking, denotes to warrant, or be ſurety to one, that he ſhall receive no harm while he is taking his draught. The phraſe is referred by our antiquaries to the practice of the Danes, heretofore in England, who frequently uſed to ſtab or cut the throats of the natives while they were drinking.

PLEDGES *of Goods* for money. See PAWN.

PLEDGERY, or PLEGGERY, in law, ſuretiſhip, or an undertaking or anſwering for another.

PLEDGET, BOLSTER, or *Compreſs*, in ſurgery, a kind of flat tent laid over a wound, to imbibe the ſuperfluous humours, and to keep it clean.

PLEIADES, in fabulous hiſtory, the ſeven daughters of Atlas king of Mauritania and Pleione, were thus called from their mother. They were Maia, Electra, Taygete, Aſterope, Merope, Halcyone, and Celœno; and were alſo called *Atlantides*, from their father Atlas. Theſe princeſſes were carried off by Buſiris king of Egypt; but Hercules having conquered him, delivered them to their father: yet they afterwards ſuffered a new perſecution from Orion, who purſued them five years, till Jove, being prevailed on by their prayers, took them up into the heavens, where they form the conſtellation which bears their name.

PLEIADES, in aſtronomy, an aſſemblage of ſeven ſtars, in the neck of the conſtellation Taurus. They are thus called from the Greek πλειν, *navigare*, "to ſail;" as being terrible to mariners, by reaſon of the rains and ſtorms that frequently riſe with them. The Latins called them *vergiliæ* from *ver*, "ſpring;" becauſe of their riſing about the time of the vernal equinox. The largeſt is of the third magnitude, and is called *lucida pleiadum*.

PLENARY, ſomething complete or full. Thus we ſay, the pope grants *plenary* indulgences; *i. e.* full and entire remiſſions of the penalties due to all ſins. See INDULGENCES.

PLENIPOTENTIARY, a perſon veſted with full power to do any thing. See AMBASSADOR.

PLENITUDE, the quality of a thing that is full, or that fills another. In medicine, it chiefly denotes a redundancy of blood and humours.

PLENUM, in phyſics, denotes, according to the Carteſians, that ſtate of things wherein every part of ſpace is ſuppoſed to be full of matter, in oppoſition to a VACUUM, which is a ſpace ſuppoſed devoid of all matter.

PLENUS FLOS, a full flower; a term expreſſive of the higheſt degree of luxuriance in flowers. Such flowers, although the moſt delightful to the eye, are both vegetable monſters, and, according to the ſexualiſts, vegetable eunuchs; the unnatural increaſe of the petals conſtituting the firſt; the conſequent excluſion of the ſtamina or male organs, the latter. The following are well known examples of flowers with more petals than one; ranunculus, anemone, marſh-marygold, columbine, fennel-flower, poppy, pæony, pink, gilliflower, campion, viſcous campion, lily, crown imperial, tulip, narciſſus, rocket, mallow, Syrian mallow, apple, pear, peach, cherry, almond, myrtle, roſe, and ſtrawberry.

Flowers with one petal are not ſo ſubject to fullneſs. The following, however, are inſtances: polyanthus, hyacinth, primroſe, crocus, meadow ſaffron, and thorn-apple, though Kramer has aſſerted that a full flower with one petal is a contradiction in terms. In flowers with one petal, the mode of luxuriance, or impletion, is by a multiplication of the diviſions of the limb or upper part; in flowers with more petals than one, by a multiplication of the petals or nectarium.

To take a few examples. Columbine is rendered full in three different ways: 1. By the multiplication of its petals, and total excluſion of the nectaria; 2. By the multiplication of the nectaria, and excluſion of the petals; or, 3. By ſuch an increaſe of the nectaria only as does not exclude the petals; between each of which are interjected three nectaria, placed one within another. Again, fennel-flower is rendered full by an increaſe of the nectaria only; narciſſus, either by a multiplication of its cup and petals, or of its cup only; lark-ſpur commonly by an increaſe of the petals and excluſion of the ſpur, which is its nectarium. In *ſaponaria concava anglica*, the impletion is attended with the ſingular effect of incorporating the petals, and reducing their number from five to one; and in guelder-roſe, the luxuriance is effected by an increaſe both in magnitude and number of the circumference or margin of the head of flowers, in the plain, wheel ſhaped, barren florets; and an excluſion of all the bell-ſhaped hermaphrodite florets of the centre or diſk.

Hitherto we have treated of plenitude in ſimple flowers only: the inſtance juſt now adduced ſeems to connect the different modes of impletion in them and compound flowers. Before proceeding further, however, it will not be improper to premiſe, that as a ſimple luxuriant flower is frequently, by beginners, miſtaken for a compound flower in a natural ſtate, ſuch flowers may always be diſtinguiſhed with certainty by this rule: That in ſimple flowers, however luxuriant, there is but one piſtillum or female organ; whereas in compound flowers, each floret, or partial flower, is furniſhed with its own proper piſtillum. Thus in hawk-weed, a compound flower, each flat or tongue-ſhaped floret in the aggregate has its five ſtamina and naked ſeed, which laſt is in effect its piſtillum: whereas, in a luxuriant lychnis, which is a ſimple flower, there is found only one piſtillum or female organ common to the whole.

In a compound radiated flower, which generally conſiſts of plain florets in the margin or radius, and tubular or hollow florets in the centre or diſc; plenitude is effected either by an increaſe of the florets in the margin, and a total excluſion of thoſe in the diſc; which mode of luxuriance is termed *impletion by the radius*, and reſembles what happens in the guelder-roſe: or by an elongation of the hollow florets in the centre, and a leſs profound diviſion of their brims; which is termed *impletion by the diſc*. In the firſt mode of luxuriance, the florets in the centre, which are always hermaphrodite or male, are entirely excluded; and in their place ſucceed florets ſimilar in ſex to thoſe of the radius. Now, as the florets in the margin of a radiated compound flower are found to be always either female, that is, furniſhed with the piſtillum only; or neuter, that is, furniſhed with neither ſtamina nor piſtillum; it is evident, that a radiated compound flower, filled by the radius, will either be entirely female, as in feverfew, daiſy, and African marygold; or entirely neuter, as in ſun flower, marygold, and centaury: hence it will always be eaſy to diſtinguiſh ſuch a luxuriant flower from a compound flower with plain florets in a natural ſtate; as theſe flowers are all hermaphrodite, that is, furniſhed with both ſtamina and piſtillum. Thus the full flowers of African marygold have each floret furniſhed with the piſtillum or female organ only: the natural flowers of dandelion, which, like the former, is compoſed of plain florets, are furniſhed with both ſtamina and piſtillum.

In the ſecond mode of luxuriance, termed *impletion by the diſc*, the florets in the margin ſometimes remain unchanged;

but moſt commonly adopt the figure of thoſe in the centre, without, however, ſuffering any alteration in point of ſex; ſo that confuſion is leſs to be apprehended from this mode of luxuriance than from the former: beſides, the length to which the florets in the centre run out is of itſelf a ſufficient diſtinction, and adapted to excite at once an idea of luxuriance. Daiſy, feverfew, and African marygold, exhibit inſtances of this as well as of the former mode of impletion.

In luxuriant compound flowers with plain florets, the *ſemi-floſculoſi* of Tournefort, the ſtigma or ſummit of the ſtyle in each floret is lengthened, and the ſeed buds are enlarged and diverge; by which characters ſuch flowers may always be diſtinguiſhed from flowers of the ſame kind in a natural ſtate. Scorzonera, nipple-wort, and goat's-beard, furniſh frequent inſtances of the plenitude alluded to.

Laſtly, the impletion of compound flowers with tubular or hollow florets, the *floſculoſi* of Tournefort, ſeems to obſerve the ſame rules as that of radiated flowers juſt delivered. In everlaſting-flower, the *xeranthemum* of Linnæus, the impletion is ſingular, being effected by the enlargement and expanſion of the inward chaffy ſcales of the calyx. Theſe ſcales, which become coloured, are greatly augmented in length, ſo as to overtop the florets, which are ſcarce larger than thoſe of the ſame flower in a natural ſtate. The florets too in the margin, which in the natural flower are female, become, by luxuriance, barren; that is, are deprived of the piſtillum; the ſtyle, which was very ſhort, ſpreads, and is of the length of the chaffy ſcales; and its ſummits, formerly two in number, are metamorphoſed into one.

Full flowers are more eaſily referred to their reſpective genera in methods founded upon the calyx, as the flower-cup generally remains unaffected by this higheſt degree of luxuriance.

PLEONASM, a figure in rhetoric, whereby we uſe words ſeemingly ſuperfluous, in order to expreſs a thought with the greater energy; ſuch as, "I ſaw it with my own eyes," &c. See ORATORY.

PLESCOW, a town of Ruſſia, capital of a duchy of the ſame name, with an archbiſhop's ſee, and a ſtrong caſtle. It is a large place, and divided into four parts, each of which is ſurrounded with walls. It is ſeated on the river Muldow, where it falls into the lake Pleſcow, 80 miles ſouth of Narva, and 150 ſouth by weſt of Peterſburg. E. lon. 27. 52. N. lat. 57. 58.

PLESCOW, a duchy in Ruſſia, between the duchies of Novogorod, Lithuania, Livonia, and Ingria.

PLESSIS-LES TOURS, a royal palace of France, within half a league of Tours. It was built by Louis XI. and in it he died in the year 14·3. It is ſituated in a plain ſurrounded by woods, at a ſmall diſtance from the Loire. The building is yet handſome, though built of brick, and converted to purpoſes of commerce.

PLETHORA, in medicine, from πλῆθος "plenitude." A plethora is when the veſſels are too much loaded with fluids. The plethora may be ſanguine or ſerous. In the firſt there is too much craſſamentum in the blood, in the latter too little. In the ſanguine plethora, there is danger of a fever, inflammation, apoplexy, rupture of the blood veſſels, obſtructed ſecretions, &c.: in the ſerous, of a dropſy, &c. A rarefaction of the blood produces all the effects of a plethora; it may accompany a plethora, and ſhould be diſtinguiſhed therefrom. Mr. Bromfield obſerves, that a ſanguine plethora may thus be known to be preſent by the pulſe. An artery overcharged with blood is as incapable of producing a ſtrong full pulſe, as one that contains a deficient quantity; in both caſes there will be a low and weak pulſe. To diſtinguiſh rightly, the pulſe muſt not be felt with one or two fingers on the carpal artery, but if three or four fingers cover a conſiderable length of the artery, and we preſs hard for ſome time on it, and then ſuddenly raiſe all theſe fingers except that which is neareſt to the patient's hand, the influx of the blood, if there is a plethora, will be ſo rapid as to raiſe the other finger, and make us ſenſible of the fulneſs. The ſanguine plethora is relieved by bleeding: the ſerous by purging, diuretics, and ſweating. See MEDICINE.

PLEURA, in anatomy, a thin membrane covering the inſide of the thorax. See ANATOMY.

PLEURITIS, or PLEURISY. See MEDICINE.

PLEURONECTES, in ichthyology, a genus belonging to the order of thoracici. Both eyes are on the ſame ſide of the head; there are from four to five rays in the gill-membrane; the body is compreſſed; the one ſide reſembling the back, the other the belly. There are 17 ſpecies; the moſt remarkable are,

1. The *hyppogloſſus*, or holibut. This is the largeſt of the genus: ſome have been taken in our ſeas weighing from 100 to 300 pounds; but much larger are found in thoſe of Newfoundland, Greenland, and Iceland, where they are taken with a hook and line in very deep water. They are part of the food of the Greenlanders, who cut them into large ſlips, and dry them in the ſun. They are common in the London markets, where they are expoſed to ſale cut into large pieces. They are very coarſe eating, excepting the part which adheres to the ſide fins, which is extremely fat and delicious, but ſurfeiting. They are the moſt voracious of all flat fiſh. There have been inſtances of their ſwallowing the lead weight at the end of a line, with which the ſeamen were ſounding the bottom from on board a ſhip. The holibut, in reſpect to its length, is the narroweſt of any of this genus except the ſole. It is perfectly ſmooth, and free from ſpines either above or below. The colour of the upper part is duſky; beneath, of a pure white. We do not count the rays of the fins in this genus; not only becauſe they are ſo numerous, but becauſe nature hath given to each ſpecies characters, independent of theſe rays, ſufficient to diſtinguiſh them by. Theſe flat fiſh ſwim ſidewiſe; for which reaſon Linnæus hath ſtyled them *pleuronectes*.

2. The *plateſſa*, or plaiſe, are very common on moſt of our coaſts, and ſometimes taken of the weight of 15 pounds; but they ſeldom reach that ſize, one of eight or nine pounds being reckoned a large fiſh. The beſt and largeſt are taken off Rye on the coaſt of Suſſex, and alſo off the Dutch coaſts. They ſpawn in the beginning of February. They are very flat, and much more ſquare than the preceding. Behind the left eye is a row of ſix tubercles, that reaches to the commencement of the lateral line. The upper part of the body and fins are of a clear brown, marked with large bright orange-coloured ſpots: the belly is white.

3. The *fleſus*, or flounder, inhabits every part of the Britiſh ſea, and even frequents our rivers at a great diſtance from the ſalt waters; and for this reaſon ſome writers call it the *paſſer fluviatilis*. It never grows large in our rivers, but is reckoned ſweeter than thoſe that live in the ſea. It is inferior in ſize to the plaiſe, ſeldom or never weighing more than ſix pounds. It may very eaſily be diſtinguiſhed from the plaiſe, or any other fiſh of this genus, by a row of ſharp ſmall ſpines that ſurround its upper ſides, and are placed juſt at the junction of the fins with the body. Another row marks the ſide-line, and runs half-way down the back. The colour of the upper part of the body is a pale brown, ſometimes marked with a few obſcure ſpots of dirty yellow; the belly is white.

4. The *limanda*, or dab, is found with the other ſpecies, but is leſs common. It is in beſt ſeaſon during February, March, and April: they ſpawn in May and June, and become flabby and watery the reſt of ſummer. They are ſuperior in quality to the plaiſe and flounder, but far inferior in ſize. It is gene-

rally of an uniform brown colour on the upper ſide, though ſometimes clouded with a darker. The ſcales are ſmall and rough, which is a character of this ſpecies. The lateral line is extremely incurvated at the beginning, then goes quite ſtraight to the tail. The lower part of the body is white.

5. The *ſolea*, or ſole, is found on all our coaſts; but thoſe on the weſtern ſhores are much ſuperior in ſize to thoſe on the north. On the former they are ſometimes taken of the weight of ſix or ſeven pounds, but towards Scarborough they rarely exceed one pound; if they reach two, it is extremely uncommon. They are uſually taken in the trawl-net: they keep much at the bottom, and feed on ſhell-fiſh. It is of a form much more narrow and oblong than any other of the genus. The irides are yellow; the pupils of a bright ſapphirine colour: the ſcales are ſmall, and very rough: the upper part of the body is of a deep brown; the tip of one of the pectoral fins black; the under part of the body white: the lateral line is ſtraight; the tail rounded at the end. It is a fiſh of a very delicate flavour; but the ſmall ſoles are in this reſpect much ſuperior to large ones. By the ancient laws of the Cinque Ports, no one was to take ſoles from the 1ſt of November to the 15th of March; neither was any body to fiſh from ſun-ſetting to ſun-riſing, that the fiſh might enjoy their night-food. The chief fiſhery for them is at Brixham in Torbay.

6. The *maximus*, or turbot, grows to a very large ſize: Mr. Pennant has ſeen them of 23 pounds weight, but has heard of ſome that weighed 30. The turbot is of a remarkable ſquare form: the colour of the upper part of the body is cinereous, marked with numbers of black ſpots of different ſizes: the belly is white; the ſkin is without ſcales, but greatly wrinkled, and mixed with ſmall ſhort ſpines, diſperſed without any order. Theſe fiſh are taken chiefly off the north coaſt of England, and others off the Dutch coaſt. See *Turbot* FISHERY.

PLEURS, a town in France, which was buried under a mountain in the year 1618. Of this fatal circumſtance biſhop Burnet, in his Travels, p. 96. gives the following account: "Having mentioned (ſays the biſhop) ſome falls of mountains in theſe parts (viz. near the Alps), I cannot paſs by the extraordinary fate of the town of Pleurs, about a league from Chavennes to the north. The town was half the bigneſs of Chavennes, but much more nobly built; for, beſides the great palace of the Francken, that coſt ſome millions, there were many other palaces built by rich factors both of Milan and the other parts of Italy, who, liking the ſituation and air, as well as the freedom of the government, gave themſelves all the indulgences that a vaſt wealth could furniſh. By one of the palaces that was a little diſtant from the town, and was not overwhelmed with it, one may judge of the reſt. It was an out houſe of the family of the Francken, and yet it may compare with many palaces in Italy. The voluptuouſneſs of this place became very crying; and Madame de Salis told me that ſhe heard her mother often relate ſome paſſages of a Proteſtant miniſter's ſermons that were preached in a little church there, who warned them often of the terrible judgments of God which were hanging over their heads, and which he believed would ſuddenly break out upon them.

"On the 25th of Auguſt 1628, an inhabitant came and told them to be gone, for he ſaw the mountains cleaving; but he was laughed at for his pains. He had a daughter whom he perſuaded to leave all and go with him; but when ſhe was ſafe out of town, ſhe called to mind that ſhe had not locked the door of a room in which ſhe had ſome things of value, and ſo ſhe went back to do that, and was buried with the reſt; for at the hour of ſupper the hill fell down, and buried the town and all the inhabitants, to the number of 2200, ſo that not one perſon eſcaped. The fall of the mountains did ſo fill the channel of the river, that the firſt news thoſe of Chavennes had of it was by the failing of their river; for three or four hours there came not a drop of water, but the river wrought for itſelf a new courſe, and returned to them.

"I could hear no particular character of the man who eſcaped (continues the biſhop); ſo I muſt leave the ſecret reaſon of ſo ſingular a preſervation to the great diſcovery, at the laſt day, of thoſe ſteps of Divine Providence that are now ſo unaccountable. Some of the family of the Francken got ſome miners to work under ground, to find out the wealth that was buried in their houſe; for, beſides their plate and furniture, there was a great deal of caſh and many jewels in the houſe. The miners pretended they could find nothing; but they went to their country of Tyrol and built fine houſes, and a great wealth appeared, of which no other viſible account could be given but this, that they had found ſome of that treaſure."

PLEXUS, among anatomiſts, a bundle of ſmall veſſels interwoven in the form of net-work: thus a congeries of veſſels within the brain is called *plexus choroides, reticularis*, or *retiformis*. See ANATOMY. A plexus of *nerves* is an union of two or more nerves, forming a ſort of ganglion or knot.

PLICA POLONICA, or *plaited hair*, in which the roots become fleſhy, and yield a great diſcharge, is a diſeaſe peculiar to Poland; whence the name. Mr. Coxe, who gives a ſhort account of it, attempts likewiſe to give the phyſical cauſes of it. Many cauſes of this kind, he tells us, have been ſuppoſed to concur in rendering the plica more frequent in thoſe regions than in other parts. It would be an endleſs work to enumerate the various conjectures with which each perſon has ſupported his favourite hypotheſis. The moſt probable are thoſe aſſigned by Dr. Vicat: The firſt cauſe is the nature of the Poliſh air, which is rendered inſalubrious by numerous woods and moraſſes, and occaſionally derives an uncommon keenneſs even in the midſt of ſummer from the poſition of the Carpathian mountains; for the ſouthern and ſouth-eaſterly winds, which uſually convey warmth in other regions, are in this chilled in their paſſage over their ſnowy ſummits. The ſecond is, unwholeſome water; for, although Poland is not deficient in good ſprings, yet the common people uſually drink that which is neareſt at hand, taken indiſcriminately from rivers, lakes, and even ſtagnant pools. The third cauſe is the groſs inattention of the natives to cleanlineſs; for experience ſhows, that thoſe who are not negligent in their perſons and habitations, are leſs liable to be afflicted with the plica than others who are deficient in that particular. Thus, perſons of higher rank are leſs ſubject to this diſorder than thoſe of inferior ſtations; the inhabitants of large towns than thoſe of ſmall villages; the free peaſants than thoſe in an abſolute ſtate of vaſſalage; the natives of Poland Proper than thoſe of Lithuania. Whatever we may determine as to the poſſibility that all or any of theſe cauſes, by themſelves, or in conjunction with others, originally produced the diſorder; we may venture to aſſert, that they all, and particularly the laſt, aſſiſt its propagation, inflame its ſymptoms, and protract its cure. In a word, the plica polonica appears to be a contagious diſtemper; which, like the leproſy, ſtill prevails among a people ignorant in medicine, and inattentive to check its progreſs, but is rarely known in thoſe countries where proper precautions are taken to prevent its ſpreading.

PLIMPTON, a town of Devonſhire, with a very good market on Saturdays. It is ſeated on a branch of the river Plime, and had once a caſtle, now in ruins. It ſends two members to parliament; is ſeven miles eaſt of Plymouth, and 218 weſt by ſouth of London. W. lon. 4. 0. N. lat. 50. 22.

PLINIA, in botany; a genus of plants of the polyandria monogynia claſs, deſcribed by Plumier and Linnæus. The empalement is divided into five ſegments ; the flower conſiſts of five petals; the ſtamina are numerous filaments, ſlender, and as long as the flower ; the antheræ are ſmall, and ſo is the germen of the piſtil ; the ſtyle is ſubulated, and of the length of the ſtamina ; the ſtigma is ſimple ; the fruit is a large globoſe berry, of a ſtriated or ſulcated ſurface, containing only one cell, in which is a very large, ſmooth, and globoſe ſeed. There is only one ſpecies

PLINTH, ORLE, or *Orlo*, in architecture, a flat ſquare member, in the form of a brick. It is uſed as the foundation of columns, being that flat ſquare table under the moulding of the baſe and pedeſtal at the bottom of the whole order. It ſeems to have been originally intended to keep the bottom of the original wooden pillars from rotting. Vitruvius alſo calls the Tuſcan abacus *plinth*. See ARCHITECTURE.

PLINTH *of a Statue*, &c. is a baſe, either flat, round, or ſquare, that ſerves to ſupport it.

PLINTH *of a Wall*, denotes two or three rows of bricks advancing out from a wall; or, in general, any flat high moulding, that ſerves in a front wall to mark the floors, to ſuſtain the eaves of a wall, or the larmier of a chimney.

PLINY the ELDER, or *Cæcilius Plinius Secundus*, one of the moſt learned men of ancient Rome, was deſcended from an illuſtrious family, and born at Verona. He bore arms in a diſtinguiſhed poſt; was one of the college of augurs; became intendant of Spain ; and was employed in ſeveral important affairs by Veſpaſian and Titus, who honoured him with their eſteem. The eruption of Mount Veſuvius, which happened in the year 79, proved fatal to him. His nephew, Pliny the Younger, relates the circumſtances of that dreadful eruption, and the death of his uncle, in a letter to Tacitus. Pliny the Elder wrote a Natural Hiſtory in 37 books, which is ſtill extant, and has had many editions ; the moſt eſteemed of which is that of Father Hardouin, printed at Paris in 1723, in two volumes folio.

PLINY *the Younger*, nephew of the former, was born in the 9th year of Nero, and 62d of Chriſt, at Novocomum, a town upon the lake Larius, near which he had ſeveral beautiful villas. Cæcilius was the name of his father, and Plinius Secundus that of his mother's brother, who adopted him. He brought into the world with him fine parts and an elegant taſte, which he did not fail to cultivate early ; for, as he tells us himſelf, he wrote a Greek tragedy at 14 years of age. He loſt his father when he was young ; and had the famous Virginius for his tutor or guardian, whom he has ſet in a glorious light. He frequented the ſchools of the rhetoricians, and heard Quintilian ; for whom he ever after entertained ſo high an eſteem, that he beſtowed a conſiderable portion upon his daughter at her marriage. He was in his 18th year when his uncle died ; and it was then that he began to plead in the forum, which was the uſual road to dignities. About a year after he aſſumed the military character, and went into Syria with the commiſſion of tribune : but this did not ſuit his taſte any more than it had done Tully's ; and therefore we find him returning after a campaign or two. He tells us that in his paſſage homewards he was detained by contrary winds at the iſland Icaria, and how he employed himſelf in making verſes : he enlarges in the ſame place upon his poetical exercitations : yet poetry was not the ſhining part of his character, any more than it had been of Tully's.

Upon his return from Syria he married a wife, and ſettled at Rome : it was in the reign of Domitian. During this moſt perilous time he continued to plead in the forum, where he was diſtinguiſhed not more by his uncommon abilities and eloquence, than by his great reſolution and courage, which enabled him to ſpeak boldly when ſcarcely one elſe durſt ſpeak at all. On theſe accounts he was often ſingled out by the ſenate to defend the plundered provinces againſt their oppreſſive governors, and to manage other cauſes of a like important and dangerous nature. One of theſe was for the province of Bœtica, in their proſecution of Bæbius Maſſa ; in which he acquired ſo general an applauſe, that the emperor Nerva, then a private man, and in baniſhment at Tarentum, wrote to him a letter, in which he congratulated not only Pliny, but the age which had produced an example ſo much in the ſpirit of the ancients. Pliny relates this affair in a letter to Cornelius Tacitus ; and he was ſo pleaſed with it himſelf, that he could not help entreating this friend to record it in his hiſtory. He entreats him, however, with infinitely more modeſty than Tully had entreated Lucceius upon the ſame occaſion : and though he might imitate Cicero in the requeſt, as he profeſſes to have conſtantly ſet that great man before him for a model, yet he took care not to tranſgreſs the bounds of decency in his manner of making it. He obtained the offices of queſtor and tribune, and luckily went unhurt through the reign of Domitian : there is, however, reaſon to ſuppoſe, if that emperor had not died juſt as he did, that Pliny would have ſhared the fate of many other great men ; for he tells us himſelf, that his name was afterwards found in Domitian's tablets, among the number of thoſe who were deſtined to deſtruction.

He loſt his wife in the beginning of Nerva's reign, and ſoon after married his beloved Calphurnia, of whom we read ſo much in his Epiſtles. He had not, however, any children by any of his wives : and hence we find him thanking Trajan for the *jus trium liberorum*, which he aſtewards obtained of that emperor for his friend Suetonius Tranquillus. He hints alſo, in his letter of thanks to Trajan, that he had been twice married in the reign of Domitian. He was promoted to the conſulate by Trajan in the year 100, when he was 38 years of age ; and in this office pronounced that famous panegyric, which has ever ſince been admired as well for the copiouſneſs of the topics as the elegance of addreſs. Then he was elected augur, and afterwards made proconſul of Bithynia ; whence he wrote to Trajan that curious letter concerning the primitive Chriſtians ; which, with Trajan's reſcript, is happily extant among his Epiſtles. Pliny's letter, as Mr. Melmoth obſerves in a note upon the paſſage, is eſteemed as almoſt the only genuine monument of eccleſiaſtical antiquity relating to the times immediately ſucceeding the apoſtles, it being written at moſt not above 40 years after the death of St. Paul. It was preſerved by the Chriſtians themſelves, as a clear and unſuſpicious evidence of the purity of their doctrines, and is frequently appealed to by the early writers of the church againſt the calumnies of their adverſaries. It is not known what became of Pliny after his return from Bithynia ; whether he lived at Rome, or what time he ſpent at his country-houſes. Antiquity is alſo ſilent as to the time of his death : but it is conjectured that he died either a little before or ſoon after that excellent prince, his admired Trajan ; that is, about the year of Chriſt 116.

Pliny was one of the greateſt wits, and one of the worthieſt men among the ancients. He had fine parts, which he cultivated to the utmoſt ; and he accompliſhed himſelf with all the various kinds of knowledge which could ſerve to make him either uſeful or agreeable. He wrote and publiſhed a great number of things ; but nothing has eſcaped the wreck of time except the books of Letters, and the panegyric upon Trajan. This has ever been conſidered as a maſter-piece : and if he has, as ſome think, almoſt exhauſted all the ideas of perfection in a prince, and gone perhaps a little beyond the truth, yet it is allowed that no panegyriſt was ever poſſeſſed of a finer ſubject, and on which he might better indulge in all the flow of eloquence without incurring the ſuſpicion of flattery and lies. His letters ſeem to have been intended for the public ; and in them he may be conſidered as writing his own memoirs. Every epiſtle is a kind of hiſtorical ſketch, wherein we have a view of him in ſome ſtriking attitude, either of active or contemplative life. In them are preſerved anecdotes of many eminent perſons, whoſe works are come down to us, as Suetonius, Silius Italicus, Martial, Tacitus, and Quintilian; and of curious things, which throw great light upon the hiſtory of thoſe times. They are written with great politeneſs and ſpirit; and if they abound too much in turn and metaphor, we muſt impute it to that degeneracy of taſte which was then accompanying the degenerate manners of Rome. Pliny, however, ſeems to have preſerved himſelf in this latter reſpect from the general contagion: whatever the manners of the Romans were, his were pure and incorrupt. His writings breathe a ſpirit of tranſcendent goodneſs and humanity; his only imperfection is, he was too deſirous that the public and poſterity ſhould know how humane and good he was. We have two elegant Engliſh tranſlations of his Epiſtles; the one by Mr. Melmoth, and the other by lord Orrery.

PLOCAMA, in botany; a genus of the monogynia order, belonging to the pentandria claſs of plants. The calyx is quinquedentate; the fruit a berry and trilocular, with ſolitary ſeeds. Of this there is only one ſpecies, viz. the *pendula*, a native of the Canaries.

PLOCE. See ORATORY.

PLOCKSKO, a town of Poland, and capital of a palatinate of the ſame name, with a caſtle and a biſhop's ſee. The churches are very magnificent; and it is built upon a hill, whence there is a fine proſpect every way, near the river Viſtula. It is 25 miles ſouth-eaſt of Uladiſlaw, and 65 weſt of Warſaw. E. lon. 19 29. N. lat. 52. 46.

PLOCKSKO, a palatinate of Poland, bounded on the north by Regal Pruſſia, on the eaſt by the palatinate of Mazovia, on the ſouth by the Viſtula, and on the weſt by the palatinate of Inovladiſlaw. The capital town is of the ſame name.

PLOEN is a town of Germany, in the circle of Lower Saxony, and capital of Holſtein. It ſtands on the banks of a lake of the ſame name, and gave title to a duke, till by the death of the laſt duke Charles without male iſſue it eſcheated to the king of Denmark in 176 . The ducal palace, riſing in the midſt of the town, on an elevated ſpot of ground, and overlooking the lake, is a very picturesque object. The town ſtands 22 miles north-weſt of Lubeck, and 10 ſouth-eaſt of Kiell. E. lon. 10. 30. N. lat. 54. 11.

PLOMO, in metallurgy, is a name given by the Spaniards, who have the care of the ſilver-mines, to the ſilver ore, when found adhering to the ſurface of ſtones, and when it incruſts their cracks and cavities like ſmall and looſe grains of gun-powder. Though theſe grains be few in number, and the reſt of the ſtone have no ſilver in it, yet they are always very happy when they find it, as it is a certain token that there is a rich vein ſomewhere in the neighbourhood. And if in digging forwards they ſtill meet with theſe grains, or the plomo in greater quantity, it is a certain ſign that they are getting more and more near the good vein.

PLOT, (Dr. ROBERT), a learned antiquarian and philoſopher, was born at Sutton-barn in the pariſh of Borden in Kent, in the year 1641, and ſtudied in Magdalen-hall, and afterwards in Univerſity-college, Oxford. In 1682 he was elected ſecretary of the Royal Society, and publiſhed the Philoſophical Tranſactions from No. 143 to No. 166 incluſive. The next year Elias Aſhmole, Eſq. appointed him firſt keeper of his muſeum, and about the ſame time the vice-chancellor nominated him firſt profeſſor of chemiſtry in the univerſity of Oxford. In 1687 he was made ſecretary to the earl marſhal, and the following year received the title of *hiſtoriographer* to king James II. In 1690 he reſigned his profeſſorſhip of chemiſtry, and likewiſe his place of keeper of the muſeum, to which he preſented a very large collection of natural curioſities; which were thoſe he had deſcribed in his Hiſtories of Oxfordſhire and Staffordſhire; the former publiſhed at Oxford in 1677, folio, and reprinted with additions and corrections in 1705; and the latter was printed in the ſame ſize in 1686. In January 1694-5, Henry Howard, earl marſhal, nominated him Mowbray-herald extraordinary; two days after which he was conſtituted regiſter of the court of honour; and on the 30th of April, 1696, he died of the ſtone at his houſe in Borden.

As Dr. Plot delighted in natural hiſtory, the above works were deſigned as eſſays towards a Natural Hiſtory of England; and he had actually formed a deſign of travelling through England and Wales for that purpoſe. He accordingly drew up a plan of his ſcheme in a letter to the learned biſhop Fell; which is inſerted at the end of the ſecond volume of Leland's Itinerary, of the edition of 1744. Amongſt ſeveral MSS. which he left behind him were large materials for the "Natural hiſtory of Kent, Middleſex, and the city of London." Beſides the above works, he publiſhed *De origine fontium tentamen philoſophicum*, 8vo, and nine papers in the Philoſophical Tranſactions.

PLOT, in dramatic poetry, is ſometimes uſed for the fable of a tragedy or comedy; but more properly for the knot or intrigue which makes the *embarras* of any piece. See POETRY.

PLOT, in ſurveying, the plan or draught of any field, farm, or manor, ſurveyed with an inſtrument, and laid down in the proper figure and dimenſions.

PLOTINUS, a Platonic philoſopher in the third century. He was born at Lycopolis, a city of Egypt, in 204; and began very early to ſhow a great ſingularity both in his taſte and manners: for, at eight years of age, when he went to ſchool, he uſed to run to his nurſe, and uncover her breaſt to ſuck; and would have continued that practice longer, if he had not been diſcouraged by her. At 28 years of age he had a ſtrong deſire to ſtudy philoſophy, on which occaſion he was recommended to the moſt famous profeſſors of Alexandria. He was not ſatisfied with their lectures; but upon hearing thoſe of Ammonius, he confeſſed that this was the man he wanted. He ſtudied for 11 years under that excellent maſter, and then went to hear the Perſian and Indian philoſophers: for in 243, when the emperor Gordianus intended to wage war againſt the Perſians, he followed the Roman army, but probably repented of it; for it was with difficulty he could ſave his life by flight, after the emperor had been ſlain. He was then 39; and the year following he went to Rome, and read philoſophical lectures in that city; but avoided following the example of Erennius and Origen, his fellow pupils, who having promiſed with him not to reveal ſome hidden and excellent doctrines they had received from Ammonius, had nevertheleſs forfeited their word. Plotinus continued ten years in Rome, without writing any thing; but in his 50th year, Porphyry became his ſcholar; who, being of an exquiſitely fine genius, was not ſatisfied with ſuperficial anſwers, but required to have all difficulties thoroughly explained; and therefore Plotinus, to treat things with greater accuracy, was obliged to write more books. He had before written 21 books, and during the ſix years of Porphyry's ſtay with him he wrote 24, and 9 after Porphyry's leaving Rome: in all 54. The Romans had a high veneration for him; and he paſſed for a man of ſuch judgment and virtue, that many perſons of both ſexes, when they found themſelves dying, intruſted him, as a kind of guardian angel, with the care of their eſtates and children. He was the arbiter of numberleſs law-ſuits; and conſtantly behaved with ſuch humanity and rectitude of mind, that he did not create himſelf one enemy during the 26 years he reſided in Rome. He, however, did not meet with the ſame juſtice from all of his own profeſſion; for Olympias, a philoſopher of Alexandria, being envious of his glory, uſed his utmoſt endeavours, though in vain, to ruin him. The emperor Gallienus, and the empreſs Salonina, had a very high regard for him; and, had it not been for the oppoſition of ſome jealous courtiers, they would have had the city of Campania rebuilt, and given to him with the territory belonging to it, to eſtabliſh a colony of philoſophers, and to have it governed by the ideal laws of Plato's commonwealth. He laboured under various diſorders during the laſt year of his life, which obliged him to leave Rome; when he was carried to Campania to the heirs of one of his friends, who furniſhed him with every thing neceſſary; and he died there in the year 270, at the age of 66, and in the nobleſt manner that a heathen philoſopher could do, theſe being his words as he breathed his laſt: "I am labouring with all my might to return the divine part of me to that Divine Whole which fills the univerſe."

We have already remarked that the ideas of Plotinus were ſingular and extraordinary; and we ſhall now ſhow that they were ſo. He was aſhamed of being lodged in a body, for which reaſon he did not care to tell the place of his birth or family. The contempt he had for all earthly things, was the reaſon why he would not permit his picture to be drawn: and when his diſciple Amelius was urgent with him upon this head, "Is it not enough (ſaid he) to drag after us, whitherſoever we go, that image in which nature has ſhut us up? Do you think that we ſhould likewiſe tranſmit to future ages an image of that image, as a ſight worthy of their attention?" From the ſame principle, he refuſed to attend to his health; for he never made uſe of preſervatives or baths; and did not even eat the fleſh of tame animals. He ate but little, and abſtained very often from bread; which, joined to his intenſe meditation, kept him very much from ſleeping. In ſhort, he thought the body altogether below his notice; and had ſo little reſpect for it, that he conſidered it as a priſon, from which it would be his ſupreme happineſs to be freed. When Amelius, after his death, inquired of the oracle of Apollo about the ſtate of his ſoul, he was told, "that it was gone to the aſſembly of the bleſſed, where charity, joy, and a love of the union with God prevail:" and the reaſon given for it, as related by Porphyry, is, "that Plotinus had been peaceable, gracious, and vigilant; that he had perpetually elevated his ſpotleſs ſoul to God; that he had loved God with his whole heart; that he had diſengaged himſelf, to the utmoſt of his abilities, from this wretched life; that, elevating himſelf with all the powers of his ſoul, and by the ſeveral gradations taught by Plato, towards that Supreme Being which fills the univerſe, he had been enlightened by him; had enjoyed the viſion of him without the help or interpoſition of ideas; had, in ſhort, been often united to him." This is the account of Porphyry, who tells us alſo, that he himſelf had once been favoured with the viſion. To this account, however, we need ſcarcely add, that little credit is due: it agrees pretty much with modern enthuſiaſm and the reveries of Behmeniſts. Plotinus had alſo his familiar ſpirit, as well as Socrates; but according to Porphyry, it was not one of thoſe called *demons*, but of the order of thoſe who are called *gods*; ſo that he was under the protection of a genius ſuperior to that of other men. The ſuperiority of his genius puffed him up not a little: for, when Amelius deſired him to ſhare in the ſacrifices, which he uſed to offer up on ſolemn feſtivals, 'It is their buſineſs (replied Plotinus) to come to me, not mine to go to them:' "which lofty anſwer (ſays Porphyry) no one could gueſs the reaſon of, or dared to aſk.'

Porphyry put the 54 books of Plotinus in order, and divided them into ſix enneases. The greater part of them turn on the moſt high flown ideas in metaphyſics; and this philoſopher ſeems in certain points not to differ much from Spinoza. He wrote two books to prove, that "all being is one and the ſame;" which is the very doctrine of Spinoza. He inquires, in another book, "Whether there are many ſouls, or only one?" His manner of compoſing partook of the ſingularity of his nature: he never read over his compoſitions after he had written them; he wrote a bad hand, and was not exact in his orthography: he ſtood in need, therefore, of a faithful friend to reviſe and correct his writings; and he choſe Porphyry for this purpoſe before Amelius, who had, however, been his diſciple 24 years, and was very much eſteemed by him. Some have accuſed Plotinus of plagiariſm, with regard to Numenius; a ſlander which Amelius refuted. Longinus was once much prejudiced againſt our great philoſopher, and wrote againſt his Treatiſe of Ideas, and againſt Porphyry's anſwer in defence of that treatiſe. He afterwards conceived a high eſteem for him; ſought induſtriouſly for all his books; and, in order to have them very correct, deſired Porphyry to lend him his copy; but at the ſame time wrote to him in the following manner: "I always obſerved to you, when we were together, when we were at a diſtance from one another, as well as when you lived at Tyre, that I did not comprehend many of the ſubjects treated of by Plotinus; but that I was extremely fond of his manner of writing, the variety of his knowledge, and the order and diſpoſition of his queſtions, which are altogether philoſophical." "This ſingle paſſage (ſays Bale) ſhows the exalted genius, the exquiſite diſcernment, and judicious penetration of Longinus. It cannot be denied, that moſt ſubjects which this philoſopher examines are incomprehenſible; nevertheleſs, we diſcover in his works, a very elevated, fruitful, and capacious genius, and a cloſe way of reaſoning. Had Longinus been an injudicious critic, had he not poſſeſſed an exalted and beautiful genius, he would not have been ſo ſenſible of Plotinus's obſcurity: for no perſons complain leſs of the obſcurity of a book, than thoſe whoſe thoughts are confuſed and underſtanding is ſhallow." Marſilius Ficinus, at the requeſt of Coſmo de Medicis, made a Latin verſion of the works of Plotinus, with a ſummary and analyſis of each book; which was printed at Baſil, firſt by itſelf, in 1559, and afterwards with the Greek in 1580, folio. His Life was written by Porphyry, the moſt illuſtrious of his diſciples.

PLOTUS, or DARTER, in ornithology, a genus of birds belonging to the order palmipedes. The bill is long and ſharp-pointed; the noſtrils are merely a long ſlit placed near the baſe; the face and chin are bare of feathers; the neck is very long; and the legs are ſhort. They have four toes webbed together. There are three ſpecies of this genus, and three varieties of the ſecond of theſe.

1. The *plotus anhinga*, or white-bellied darter, is not quite ſo big as a mallard; but its length from the point of the bill to the end of the tail is 10 inches. The bill, which is three inches long, is ſtraight and pointed: the colour is greyiſh, with a yellowiſh baſe: the irides are of a gold colour: the head is ſmall; the neck long and ſlender: the upper part of the back and ſcapulars are of a duſky black colour; the middle of the feathers are daſhed with white: the lower part of the back, &c. are of a fine black colour: the under parts from the breaſts are ſilvery white: the ſmaller wing coverts, and thoſe in the middle, are duſky black; the larger ones are ſpotted with white, and the outer ones are plain black: the tail feathers are 12 in number, broad, long, and gloſſy black: the legs and toes are of a yellowiſh grey. This ſpecies is an inhabitant of Braſil, and is exceedingly expert and cunning in catching fiſh. Like the corvorant, it builds neſts on trees, and rooſts in them at night. It is ſcarcely ever ſeen on the ground, being always on the higheſt branches of trees on the water, or ſuch as grow in the moiſt ſavannas or river ſides. When at reſt, it generally ſits with the neck drawn in between the ſhoulders like the heron. The fleſh is in general very fat; but has an oily, rank and diſagreeable taſte like that of a gull.

2. The *anhinga of Cayenne*, or black-bellied anhinga, is as

large as a common duck, with a very long neck, and a long ſharp-pointed ſtraight bill. The upper part of the bill is of a pale blue, and the lower is reddiſh: the eyes are very piercing: the head, neck, and upper part of the breaſt are light brown: both ſides of the head, and the upper part of the neck, are marked with a broad white line: the back, ſcapulars, and wing coverts, are marked with black and white ſtripes lengthwiſe in equal portions: the quill feathers, the belly, thighs, and tail, are of a deep black colour: the tail is very long and ſlender: the legs and feet are of a pale green colour; and the four toes, like thoſe of the corvorant, are united by webs. This ſpecies is found in the iſlands of Ceylon and Java. They generally ſit on the ſhrubs that hang over the water; and, when they ſhoot out their long ſlender necks, are often taken for ſerpents at firſt ſight.

Mr. Latham deſcribes three varieties of this ſpecies, which are all equal in ſize to the common birds of the ſpecies. The firſt and the ſecond variety, which laſt Mr. Latham calls the black darter, inhabit Cayenne; the third, or rufous darter, inhabits Africa, particularly Senegal, where it is called *kandar*.

3. The *Surinam darter* is about 13 inches long, being about the ſize of a teal. The bill is of a pale colour, and about $1\frac{1}{8}$ inch in length: the irides are red: the crown of the head is black, and the feathers behind form a ſort of creſt: the neck, as in the other ſpecies, is long and ſlender: the cheeks are of a bright bay colour: from the corner of each eye there comes a line of white: the ſides and back part of the neck are marked with longitudinal lines of black and white: the wings are black, and the tail is duſky brown: it is alſo tipped with white, and ſhaped like a wedge: the breaſt and belly are white: the legs ſhort, but very ſtrong, and of a pale duſky colour: the four toes are joined by a membrane, and barred with black. This ſpecies inhabits Surinam, frequenting the ſides of rivers and creeks, where it feeds on ſmall fiſh and inſects, eſpecially on flies, which it catches with great dexterity. When domeſticated, which often happens, the inhabitants call it the *ſun bird*. Authors have differed exceedingly concerning the genus to which this ſpecies belongs, ſince it is found to differ from the others in ſome pretty eſſential characters; it agrees, however, in ſo many, and thoſe the moſt eſſential, as ſufficiently to excuſe thoſe naturaliſts who claſs it with the plotus genus. See *Latham's Synopſis of Birds*, vol. iii. part 2. p. 627.

PLOUGH, in agriculture: A machine for turning up the ſoil by the action of cattle, contrived to ſave the time, labour, and expenſe, which, without this inſtrument, muſt have been employed in digging the ground, and fitting it for receiving all ſorts of ſeed. See HUSBANDRY. Amidſt all the varieties which can occur in the manner of ploughing the ground, ariſing from difference of ſoil, local habits, and other cauſes, there is ſtill a ſameneſs in the taſk which gives a certain uniformity to the chief parts of the inſtrument, and ſhould therefore furniſh principles for its conſtruction. There is not, perhaps, any invention of man that more highly merits our utmoſt endeavours to bring it to perfection; but it has been too much neglected by thoſe perſons who ſtudy machines, and has been conſidered as a rude tool, unworthy of their attention. Any thing appears to them ſufficient for the clumſy taſk of turning up the ground; and they cannot imagine that there can be any nicety in a buſineſs which is ſucceſsfully performed by the ignorant peaſant. Others acknowledge the value of the machine, and the difficulty of the ſubject; but they think that difficulty inſuperable, becauſe the operation is ſo complicated, and the reſiſtances to be overcome ſo uncertain, or ſo little underſtood, that we cannot diſcover any unequivocal principle, and muſt look for improvement only from experience or chance.

But theſe opinions are ill-founded. The difficulty is indeed great, and it is neither from the ignorant farmer nor the rude artiſt that we can expect improvement. It requires the ſerious conſideration of the moſt accompliſhed mechanician; but from him we *may* expect improvement. We have many data: we know pretty diſtinctly what preparation will fit the ground for being the proper receptacle for the ſeed, and for ſupporting and nouriſhing the plants; and though it is, perhaps, impoſſible to bring it into this ſtate by the operation of any inſtrument of the plough kind, we know that ſome ploughs prodigiouſly excel others in reducing the ſtiff ground to that uniform crumbling ſtate in which it can be left by the ſpade. The imperfections of their performance, or what yet remains to be done to bring the ground into this ſtate, is diſtinctly underſtood. It ſeems, then, a determinate problem (to uſe the language of mathematicians), becauſe the operation depends on the invariable laws of mechanical nature.

It will therefore be very proper, under this article, to aſcertain, if poſſible, what a plough in general ought to be, by deſcribing diſtinctly its taſk. This will ſurely point out a general form, the chief features of which muſt be found under every variety that can ariſe from particular circumſtances.

The plough performs its taſk, not by digging, but by being pulled along. We do not aim at immediately reducing the ground to that friable and uniform ſtate into which we can bring it by the ſpade; but we wiſh to bring it into ſuch a ſtate that the ordinary operations of the ſeaſon will complete the taſk.

For this purpoſe, a ſlice or ſod muſt be cut off from the firm land. This muſt be ſhoved to one ſide, that the plough and the ploughman may proceed in their labour; and the ſod muſt be turned over, ſo that the graſs and ſtubble may be buried and rot, and that freſh ſoil may be brought to the ſurface; and all muſt be left in ſuch a looſe and open condition, that it may quickly crumble down by the influence of the weather, without baking into lumps, or retaining water. The firſt office is performed by the coulter, which makes a perpendicular cut in the ground. The point of the ſock follows this, and its edge gets under the ſod, and lifts it up. While lifting it up, it alſo heels it over, away from the firm land. The mould-board comes laſt, and puſhes it aſide, and gradually turns it over as far as is required.

The general form of the body of a plough is that of a wedge, or very blunt chiſel, AFEDBC, (Pl. 6. fig. 1.) having the lower corner D of its edge conſiderably more advanced than the upper corner B; the edge BD and the whole back AFDB is in the ſame perpendicular plane; the bottom FDB approaches to a triangular form, acute at D, and ſquare at F; the ſurface BCED is of a complicated ſhape, generally hollow, becauſe the angle ABC is always greater than FDE: this conſequence will be eaſily ſeen by the mathematician. The back is uſually called the LAND SIDE by the ploughmen, and the baſe FDE is called the SOLE, and FE the HEEL, and BCED the mould-board. Laſtly, the angle AFE is generally ſquare, or a right angle, ſo that the ſole has level both as to length and breadth.

By comparing this form with attention, the reader will perceive, that if this wedge is pulled or puſhed along in the direction FD, keeping the edge BD always in the perpendicular cut which has been previouſly made by the coulter, the point D will both raiſe the earth and ſhove it to one ſide and twiſt it over; and when the point has advanced from F to D, the ſod, which formerly reſted on the triangle DFE, will be forced up along the ſurface BCED, the line DF riſing into the poſition D *f*, and the line EF into the poſition E *f*.—Had the bottom of this furrow been covered with a bit of cloth, this cloth would be lying on the mould-board, in the poſition D *f* E: the ſlice, thus deranged from its former ſituation, will have a ſhape ſomething like that repreſented in fig. 2.

In as much as the wedge raiſes the earth, the earth preſſes down the wedge; and as the wedge puſhes the earth to the right hand, the earth preſſes the wedge to the left; and in this manner the plough is ſtrongly preſſed, both to the bottom of the furrow by its ſole, and alſo to the firm land by its back or land-ſide. In ſhort, it is ſtrongly ſqueezed into the angle formed along the line FD (fig. 1.) by the perpendicular plane *a b* DF and the horizontal plane FDE; and in this manner the furrow becomes a firm groove, directing the motion of the plough, and giving it a reſiſting ſupport, by which it can perform all parts of its taſk. We beg our readers to keep this circumſtance conſtantly in mind. It evidently ſuggeſts a fundamental maxim in the conſtruction, namely, to make the land-ſide of the plough an exact plane, and to make the ſole, if not plane, at leaſt ſtraight from point to heel. Any projection would tear up the ſupporting planes, deſtroy the directing groove, and expend force in doing miſchief.

This wedge is ſeldom made of one piece. To give it the neceſſary width for removing the earth would require a huge block of timber. It is therefore uſually framed of ſeveral pieces, which we ſhall only mention in order to have the language of the art. Fig. 3. repreſents the land-ſide of a plough, ſuch as are made by James Small at Roſebank, near Foord, Mid Lothian. The baſe of it, CM, is a piece of hard wood, pointed before at C to receive a hollow ſhoeing of iron CO, called the SOCK, and tapering a little towards the hither end, M, called the HEEL. This piece is called the HEAD of the plough. Into its fore part, juſt behind the ſock, is mortiſed a ſloping poſt, AL, called the SHEATH, the front of which is worked ſharp, forming the edge of the wedge. Nearer the heel there is mortiſed another piece, PQ, ſloping far back, called the STILT, ſerving for a handle to the ploughman. The upper end of the ſheath is mortiſed into the long BEAM RH, which projects forward, almoſt horizontally, and is mortiſed behind into the ſtilt. To the fore end of the beam are the cattle attached. The whole of this ſide of the wedge is faſhioned into one plain ſurface, and the intervals between the pieces are filled up with boards, and commonly covered with iron plates. The COULTER, WFE, is firmly fixed by its ſhank, W, into the beam, rakes forward at an angle of 45° with the horizon, and has its point E about ſix inches before the point of the ſock. It is brought into the ſame vertical plane with the land ſide of the plough, by giving it a knee outward immediately below the beam, and then kneeing it again downward. It is further ſupported on this ſide by an iron ſtay FH, which turns on a pin at F, paſſes through an eye-bolt I on the ſide of the beam, and has a nut ſcrewed on it immediately above. When ſcrewed to its proper ſlope, it is firmly wedged behind and before the ſhank.—Fig. 3. No. 2. repreſents the ſame plough viewed from above. ST is the right hand or ſmall ſtilt fixed to the inſide of the mould board LV.

Fig. 4. repreſents the bottom of the wedge. CM is the head, covered at the point by the ſock. Juſt behind the ſock there is mortiſed into the ſide of the head a ſmaller piece DE, called the wreſt, making an angle of 16° with the land-ſide of the head, and its outſide edge is in the ſame ſtraight line with the ſide of the ſock. From the point of the heel to the head is about 33 inches, and the extreme breadth of the heel is about nine. The ſide of the wedge, called the furrow ſide, is formed by the mould-board, which is either made of a block or plank of wood, or of a thick iron plate.

The *ſock* drawn in this figure is called a SPEAR SOCK, and is chiefly uſed in coarſe or ſtony ground, which requires great force to break it up. Another form of the ſock is repreſented in the next figure, 4. No. 2. This is called a FEATHER SOCK, and has a cutting edge CF on its furrow ſide, extending back about ten inches, and to the right hand or furrow ſide about ſix. The uſe of this is to cut the ſod below, and detach it from the ground, as the coulter detaches it from the unploughed land. This is of great uſe when the ground is bound together by knotted roots, but it is evident that it cannot be uſed to advantage in very ſtony ground. In general, the feather ſock is only fit for ground which has been under tolerable culture; but it greatly facilitates the labour of ſeparating the ſod. It may reaſonably be aſked, why the feather is not much broader, ſo as to cut the whole breadth of the furrow? This is ſometimes done. But we muſt recollect that the ſod is not only to be puſhed aſide, but alſo to be turned over. If it were completely detached by the feather, and chanced at any time to break on the back of the ſock, it would only be puſhed aſide; but by leaving a little of the ſod uncut, it is held faſt below while it is ſhoved aſide above, which cannot fail to twiſt it round. As the wreſt advances, it eaſily deſtroys the remaining connexion, which in general is very ſlight and crumbling.

The *breadth of the ſole* at the heel determines the width of the furrow. Nine inches will give enough of room for a horſe or man to walk in. A greater breadth is of no uſe, and it expends force in puſhing the earth aſide. It is a miſtake to ſuppoſe that a broad ſole gives more room for the turned ſlice to ſtand on; for, whatever is the breadth of the furrow, the ſucceſſive ſlices will be left at their former diſtances, becauſe each is ſhoved aſide to the ſame diſtance. When the breadth of a ſlice exceeds its depth, and it is turned on its ſide, it will now ſtand on a narrow baſe, but higher than before, and therefore will ſtand looſer; which the farmers deſire. But in this caſe it generally falls on its back before it has been far enough removed, and is then puſhed aſide, and left with the graſſy ſide down; which is not approved of. On the other hand, when the depth conſiderably exceeds the breadth, the ſods, now turned on their ſides, muſt be ſqueezed home to the ploughed land; which breaks them and toſſes them up, making rough work. In wet clay ſoil, this is alſo apt to knead them together. On the whole, it is beſt to have the breadth and depth nearly equal. But all this is workmanſhip, and has no dependence on the width of the ſole behind.

We have already ſaid that the ſole is generally *level* from right to left at the heel. This was not the caſe formerly, but the wreſt was conſiderably raiſed behind: It reſulted from this form, that the furrow was always ſhallower on the right ſide, or there was left a low ridge of unſtirred earth between the furrows. This circumſtance alone was a bad practice; for one great aim of ploughing is the renewal of the ſuperficial ſoil. In this way of ribbing the furrows, the ſod tumbles over as ſoon as it is puſhed to the top of the rib on the right of the *rut* made by the plough; the firmeſt parts of it fall undermoſt, and the reſt crumbles above it, making the work appear neat; whereas it is extremely unequal, and what moſt needs the influence of the weather to crumble it down is ſheltered from it. Add to theſe circumſtances, that the hollow is a receptacle for water, with a ſurface which can retain it, having been conſolidated by the preſſure of the plough. For all theſe reaſons, therefore, it ſeems adviſable to form the furrow with a flat or level bottom, and therefore to keep the heel of the wreſt as low as the heel of the head. For the ſame reaſon it is proper to hold the plough with the land ſide perpendicular, and not to heel it over to that ſide, as is frequently done, producing the ſame ribbed furrow as an ill-formed ſole.

There is great variety of opinions about the *length* of the plough. If conſidered merely as a pointed inſtrument, or even as a cutting inſtrument acting obliquely on a given length of ſod, there can be no doubt but that it will be more powerful as it is longer: that is, it will require leſs force to pull it through the ground. But it muſt alſo ſhove the earth aſide; and if we double its length we cauſe it to act on twice as much earth at once; for, when the plough has entered as far as the heel, the whole furrow ſide is acting together in puſhing the earth to the ſide. Now it is found, that the force neceſſary for puſhing a maſs of earth horizontally along the rough ground is nearly equal to its weight. It would ſeem, therefore, that nothing is to be gained by making the baſe of the plough of a great length, except a greater facility in making the firſt penetration, and this is chiefly performed by the coulter and ſock; and a great length renders the plough heavy and cumberſome; and, by cauſing it to act long on the ſod, tends to knead and cake it.

Nothing very preciſe can be offered on this ſubject. Some ſenſible advantage is derived by making the plough taper, eſpecially forward, where it acts as a boring and cutting inſtrument; and for this purpoſe it is convenient to give the coulter a ſlope of 45 degrees. (This has alſo the advantage of throwing up the ſtones and roots, which it would otherwiſe drive before it through the firm ground.) And for the ſame reaſon the edge of the feather has a great ſlope, it being ten inches long and only ſix inches broad. But if we purſue this advantage too far we expoſe ourſelves to another riſk. It is ſometimes neceſſary to heel over the plough to the right, in order to get over ſome obſtruction. In doing this, the coulter is neceſſarily raiſed for a moment, and the ſlanting cut now made by the feather becomes the directing groove for the plough. When the feather has a very long ſlope, this groove has force enough to guide the whole plough; and it is almoſt impoſſible for the ploughman to prevent it from running out of the ground to the land-ſide*. The feather, therefore, ſhould not exceed 10 or 12 inches in length.

But to return to the length of the plough, from which this obſervation has diverted us a little, we muſt add, that a long plough has a great advantage in the ſteadineſs of its motion, having a much more extenſive ſupport both on the land-ſide and below, and being therefore leſs affected by its inequalities. Accordingly they are now made conſiderably longer than formerly; and 33 inches has been aſſumed as a proportion to 9 inches of breadth, in conformity to the moſt approved ploughs now in uſe.

We come now to treat of the *mould-board.* This is the moſt delicate part of the plough, and is to be ſeen in the greateſt variety in the works of different artiſts, each of whom has a noſtrum of great value in his own opinion. It is here indeed that the chief reſiſtances are exerted and muſt be overcome; and a judicious form of this part of the plough may diminiſh them conſiderably, while it performs the work in the beſt manner. Without pretending to ſay that the different reſiſtances are ſuſceptible of an accurate determination, we can ſtill draw ſufficient information from palpable rules of mechanics to direct us to what would be nearly the beſt poſſible form for a mould-board. The taſk to be performed is to raiſe, puſh aſide, and turn over to a certain degree, a ſlice already cut off from the firm ground. As we cannot provide for every inequality of the coheſion or tenacity of the earth, our ſafeſt way is to conſider it as uniform: the weight of it is always ſo. As we cannot provide for every *proportion* between the tenacity and the weight, we muſt take an average or medium proportion which is not far from that of equality. Conceiving the ſlice at firſt as only tenacious, and without weight, it is an eaſy problem to determine the form which ſhall give it the intended twiſt and removal with the ſmalleſt force. In like manner we can proceed with a ſlice that has weight without tenacity. It is equally eaſy to combine both in any proportion; and it is eaſieſt of all to make this combination on the ſuppoſition of equality of weight and coheſion. Suppoſing the ſlice like a brick, we know that it requires the greateſt force to *begin* to raiſe it on one edge, and that the ſtrain becomes leſs as it riſes, till its centre of gravity is perpendicularly above the ſupporting angle. It requires no force to raiſe it further; for, on puſhing it beyond this poſition, it would fall over of itſelf, unleſs withheld by the tenacity of what is not yet raiſed. But on conſidering the form or plan of the ſock, we find that while the weight of the ſod reſiſts moſt ſtrongly, there is leſs of it in this ſituation actually riſing, and this nearly in the ſame proportion with the labour of raiſing it; and we ſee, that after the ſod has attained that poſition in which it is ready to fall over it has reached the wider part of the wreſt, and is now puſhed aſide, which requires nearly the ſame force as to raiſe it: and this continues to the end of the operation.

When we take all theſe circumſtances into conſideration, it appears probable, that the compound reſiſtance does not change much from firſt to laſt. If this be really the caſe, it is an undoubted maxim that the whole operation ſhould proceed equably: if it does not, there muſt be ſome part of the ſod that makes a reſiſtance greater than the medium; and as the reſiſtances in all this claſs of motions increaſe nearly as the ſquares of the velocities with which they are overcome, it is demonſtrable that we ſhall loſe power if we render them unequal.

Hence we deduce this maxim, *That as the plough advances through equal ſpaces, the twiſt and the lateral ſliding of the ſod ſhould increaſe by equal degrees.* And this determines *à priori* the form of the mould-board. This principle occurred to Mr. James Small, a ploughmaker in Berwickſhire, and he publiſhed a treatiſe on the ſubject in 1784. He has given ſeveral methods for conſtructing mould-boards, which he ſuppoſes are in conformity to his principle; but being merely a country artiſt, and unacquainted with ſcience, his rules do not produce mould-boards having this property of equable operation, although they do not deviate far from it. His book is a very uſeful and inſtructive performance, and level to the capacity of thoſe for whom it is intended; and we have here availed ourſelves of the author's information on many points.

The high character which Small's ploughs have maintained for 30 years is a ſtrong argument for the truth of the maxim. We ſhall therefore give ſuch inſtructions as will enable any intelligent workman to conſtruct ſuch a mould-board without any riſk of failure; and if future theory or experience ſhould diſcover any error in the principles from which this maxim is deduced, by ſhowing that either the weight, the tenacity, or the lateral reſiſtance, is exerted according to a different law from what has been aſſumed, the directions to be given are of ſuch a nature that they adapt themſelves with preciſion to theſe changes of principle, and will ſtill produce a perfect and efficacious plough. Our readers will readily acknowledge that this is gaining a great point; becauſe at preſent the inſtrument is conſtructed very much at random, and by a gueſs of the eye.

Let us now return to the wedge formerly made uſe of for illuſtrating the action of the plough. Suppoſe it placed in a furrow already ploughed, and that the ſpace before the line FE (fig. 1.), which is ſquare from the line of motion FD, is covered with a piece of cloth or carpet, and that the point of the wedge enters upon it at F, and advances to D. It will evidently raiſe the cloth, which will now cover the ſide of the wedge, forming the triangle *f* DE. The line *f* D is what formerly lay in the angle along the line FD, and *f* E formerly lay on FE. It is this line FE therefore that we are to raiſe, ſhove aſide, and twiſt round, by equal degrees, while the plough advances through equal ſpaces.

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* This is often felt with the excellent plough deſcribed by Mr. Arbuthnot of Surry, in the Tranſactions of the Society for the Encouragement of Arts, &c. London.

Now, if the length DF of the plough-wedge, reckoned from the point of the ſock to the heel, be 33 inches, and the breadth FE behind be 9 inches, the angle DEF or DE*f* will be nearly 74°. The conſtruction of the furrow ſide of the plough is therefore reduced to this very ſimple problem, "To make the angle DE*f* turn equably round the axis DE, while the angular point E advances equably from D to E."

This will be done by means of the following very ſimple tool or inſtrument. Let IHFK (fig. 5.) be a piece of hard wood, ſuch as oak, a foot long, three inches broad, and an inch thick. Plant on this another piece BHFC of the ſame breadth, four inches long, and half an inch thick. This will leave beyond it a flat 8 inches long. We ſhall call this the *ſtock* of the inſtrument. Let ABC be a piece of clean oak, half an inch thick, 20 inches long, and three inches broad at the end BC. Let this be faſhioned like the ſtile of a ſun-dial, having its angle ABC 74°. Let it have a part BCE ſquare, to the extent of four inches from C, and the reſt EA worked into the form of a ſtraight ſlender rod. Let EFG be a ſemicircle of clean plane tree or of metal four inches radius: faſten this by ſmall ſcrews to the ſquare part of the ſtile CE, ſo that its centre may be at C. Let this ſemicircle be divided into 180 degrees, and numbered from G along the arch GFE, ſo that 0° may be at G, and 180° at E. Let this ſtile and ſemicircle turn round the line BC by means of ſmall hinges. This inſtrument may be called the mould-board, gage, or protractor. When the ſtile is folded down on the ſtock BIK, the point G will be at F; and when it is raiſed up to any angle, the degrees will be pointed out on the ſemicircle by the ſtraight edge CF.

Nothing can be more obvious than the manner of employing this inſtrument, once we have determined the moſt proper poſition for the ſod when the work is completed. Now it ſeems to be the opinion of the moſt intelligent farmers, that the beſt poſition of the ſod is that repreſented in fig. 6.

Fig. 6. repreſents a ſection of the ground and the working parts of the plough, as viewed by a perſon ſtanding ſtraight before it. ABDC is the unploughed ground, and WB the coulter, knee'd in Small's manner. FGKB is the ſection of the plough (or rather of the whole ſpace through which the plough has paſſed, for no part of the plough has this ſection). HOFE is the ſection of a ſlice, puſhed aſide and turned over, ſo as to lean on the next. HE is that ſide of the ſlice which formerly lay on KB. EF is the ſide cut off by the coulter; and FO is the upper or graſſy ſide. The lower corners are ſuppoſed to be a little bruiſed inwards, as muſt generally happen.

The ſod is puſhed 9 inches to the right hand, and it leans with its graſſy ſide on the preceding furrow, in an angle of about 50 degrees. In this poſition the graſs is turned down ſo as to rot; and there is a hollow left below to allow the rain water to run freely off, and to receive the earth as it crumbles down by the weather: and if the harrow is dragged acroſs theſe ridges, it diſtributes along the ſurface the mould which was formerly at the bottom. The ſod has got a twiſt of 130 degrees: but it is evident, that after it has been turned 90 degrees, or even a little before this, it is ready to fall over of itſelf. It is ſufficient, therefore, that it be turned 90 degrees when the heel of the wreſt has reached it, and the remainder of the twiſt is given to it by the wing or flap of the mould-board. This, then, dictates to us the manner of applying the inſtrument.

Divide the edge DE (fig. 7.) of the wreſt, or of a lath nailed on it, into 90 equal parts, and continue the diviſions backwards to G in the ſame line to 130. Number the diviſions backwards from the point of the ſock; then place the protractor on the edge of the wreſt, with the point B of fig. 5. at the 90th diviſion (fig. 7.); that is, juſt at the heel, with the ſtock under the wreſt, and the ſtile raiſed to 90°, and preſs it home to the joint, ſo that the ſtock may be ſquare to the edge, and then the ſtile will be in the poſition ſuiting that part of the mould-board. In like manner ſlide the ſtock forward to the 80th diviſion, and lower the ſtile to 80°, and it will have the poſition which ſuits that part of the mould-board. In the ſame way, ſlide it forward to 70, 60, 50, &c. and lower the ſtile to 70°, 60°, 50°, &c. and we ſhall have the poſition for theſe ſeveral parts of the mould-board; and thus it may be formed to the very point of the ſock, becauſe the ſtraight edge of the wreſt may be continued ſo far. A block of wood may be hewed to fit theſe ſeveral poſitions of the protractor ſtile: and this, when placed with its ſtraight edge on the outer line of the wreſt, and cut away behind in the land-ſide plane, will be the exact ſhape of the plough-wedge. It would riſe up indeed into a tall piece, of ſingular ſhape, gradually tapering down to the point of the ſock; but when cut off parallel to the ground, at the height of about 12 inches, it will form the mould-board, the front or edge of the ſheath, and the whole back of the ſock except the feather, which is an extraneous piece. The wing or flap of the mould-board is formed in the ſame manner, by ſliding the ſtock of the protractor to 100, 110, 120, 130, and opening the ſtile to 100°, 110°, 120°, 130°. This will extend the top of the mould-board to about 22 or 23 inches; but the lower part of the wing muſt be cut away, becauſe it would puſh the ſod too far aſide after it has got the proper twiſt. The form of this part ſhould be ſuch as would exactly apply itſelf to a plank ſet at the head of the wreſt, parallel to the land ſide of the head, and leaning outward 40 degrees. This will be very nearly the caſe if it be made a ſweep ſimilar to the edge of the ſheath. Fig. 8. is a reſemblance of the ſurface of the mould-board; AD being the edge of the ſheath, E the heel of the wreſt, and EBC the wing or flap. When cut through in a perpendicular direction, the ſection is hollow; if cut horizontally, it is convex; and if in the direction CE, making an angle of 74° with ED, it is ſtraight. If the protractor be ſet on it at D, and gradually ſlidden backwards, the mould-board will gradually open the ſtile, and the ſtile will ſkim its whole ſurface without any vacuity between them.

This form is given to the mould-board on the authority of the ſuppoſition that the ſum of the reſiſtances ariſing from weight and tenacity remains pretty conſtant in its whole length. This cannot be affirmed with confidence in any caſe, and is by no means true in all. In ſtiff clay ſoils the effects of tenacity prevail, and in light or crumbling ſoils the weight is the chief reſiſtance. The advantage of this mode of conſtruction is, that it can be adapted to any ſoil. If the difficulty of cutting and raiſing the ſod is much greater than that of ſhoving it aſide and turning it over, we have only to make the riſe and twiſt more gentle towards the point of the ſock, and more rapid as we advance; and it is eaſy to do this according to any law of acceleration that we pleaſe. Thus, inſtead of dividing the edge of the wreſt DE (fig. 9.) continued to G into 130 parts, draw a line G*g* perpendicular to it, and draw ſome curve line D*g* convex towards DG, and divide this into equal parts in the points 10, 20, 30, 40, &c.; and then draw perpendiculars to the wreſt edge, cutting it in 10, 20, 30, 40, &c.; and apply the protractor to theſe points. It is evident that the diviſions of the wreſt line are bigger at D, and grow gradually leſs towards G; and therefore, becauſe each has 10° more twiſt than the preceding, the twiſt will be more rapid as it approaches the end of the mould-board. This curve may be choſen ſo as to produce any law of acceleration. On the contrary, we produce a retarded or diminiſhed twiſt by making the curve concave towards DG, as repreſented by the dotted curve.

The mathematical reader will obſerve, that this conſtruction aims at regulating the twiſt round the line of the wreſt ED. This does not produce preciſely the ſame regulation round the line FD, which is the line of the plough's motion, and of the ſod's poſition before it is ploughed over. The difference, however, is not worth attending to in a matter ſo little ſuſceptible of preciſion. But the twiſt round the line FD may be regulated according to any law by this inſtrument with equal facility. Inſtead of placing the ſtock of the protractor ſquare with the edge of the wreſt, it may be placed ſquare with the land-ſide of the plough. To do this draw a line BL (fig. 5. No. 2.) acroſs the ſtock from the point B, making the angle LBC 16°, and put a braſs pin at L, making a hole in the ſtile that it may not be prevented from folding down. Then, in uſing the inſtrument, let the points B and L reſt againſt the edge of the wreſt, and proceed as directed.

A ſtill greater variety of forms, and accommodation to particular views, with the ſame general dependence on principle, will be procured by giving the rod BA a motion round B in the plane of the ſtile, ſo as to form a ſtile of a variable angle.

A tool may even be conſtructed in which the rod BA might be a cutting-knife: and the whole may be led along by a ſcrew, while this knife turns round according to any law, and would gradually pare away the mould-board to the proper form.

Thus have we reduced the faſhioning the operative part of the plough to a rule which is certain. We do not mean by this, that a mould-board made according to the maxim now given will make the beſt poſſible plough; but we have given a rule by which this part of the plough can be made unequivocally of a certain quality by every workman, whatever this quality may be, and this without being obliged to copy. No deſcription of any curve mould-board to be met with in books has this advantage; and we ſay that this rule is capable of any ſyſtematic variation, either with reſpect to the width of furrow, or the quantity or variation of its twiſt. We have therefore put it in the power of any intelligent perſon to make ſuch gradual and progreſſive changes as may ſerve to bring this moſt uſeful of all inſtruments to perfection. The angle of the head and wreſt, and the curve for dividing the wreſt line, can always be expreſſed in writing, and the improvements communicated to the public at large.

After this deſcription of the working parts of a plough, and directions for giving it the moſt effective form, it will not be improper to conſider a little its mode of action, with the view of attaining a more diſtinct conception of what is done by the ploughman and the cattle, and to direct him in his procedure.

Returning again to the wedge (fig. 1.), we ſee that it is preſſed down at the point D, and as far back along the mould-board as its ſurface continues to look upward, that is, all the way to the heel of the wreſt. Behind this, the perpendicular ſections of the mould-board over-hang, and look downward; and here, while preſſing down the ſod, the plough is preſſed upwards. Theſe two preſſures tend to twiſt the plough round a tranſverſe line ſomewhere between the heel and the point. The plough therefore tends to riſe at the heel, and to run its point deeper into the ground. Upon the whole, the preſſure downwards is much greater than the upward preſſure. It is exerted over a much greater ſpace, and is greater in moſt parts of that ſpace. Behind very little downward preſſure is neceſſary, the ſod being ready to fall down of itſelf, and only requiring a gentle touch to lay it in a proper poſition.

In like manner the plough is preſſed backward by the reſiſtance made to the coulter and ſock, and part of the reſiſtance made to the ſloping ſide of the mould-board: and it is preſſed to the left by the other part of the preſſure on the ſock and mould-board.

All theſe preſſures muſt be balanced by the joint action of the cattle, the reſiſtance of the bottom, and the reſiſtance of the firm ground on the left-hand or land-ſide.

It is the action of the cattle, exerted on that point to which they are attached, which produces all theſe preſſures. It is demonſtrated by the principles of mechanics, that this force muſt not only be equal to the mean or compound force of theſe reſiſting preſſures, but muſt alſo be in the oppoſite direction.

It is further demonſtrated, that if a body be dragged through any reſiſting ſubſtance by a force acting on any point G, and in any direction whatever GH, and really moves uniformly in that direction, the force exerted exactly balances the reſiſtances which it excites, both as to quantity and direction: And if the body advances without turning round the point by which it is dragged, the reſiſtances on one ſide of this point are in equilibrio with thoſe on the oppoſite ſide.

And, laſtly, it is demonſtrated, that when this equilibrium is obtained, it is indifferent to what point in the line GH the force is applied. Therefore, in fig. 3. No. 1. the force acting in the direction HO may either be applied to the point of the beam H, or to the point N of the coulter, or to the point O of the ſock.

When therefore a plough advances ſteadily, requiring no effort of the ploughman to direct it, if the line of draught OM (fig. 10.) be produced backwards to the point G of the mould-board, that point is the place round which all the reſiſtances balance each other. This point may be called the *centre of reſiſtance* and the *centre of action*.

It would be of importance to determine this point by principle; but this can hardly be done with preciſion, even in a plough of a known form: and it is impoſſible to do it in general for all ploughs, becauſe it is different in each. It even varies in any plough by every variation of the proportion between the weight and the coheſion of the ſod. We ſee how it can be found experimentally in any given uniform ſod, viz. by producing backwards the line of draught. Then, if the draught-rope, inſtead of being fixed to the muzzle of the beam, were fixed to this point, and if it were pulled in the ſame direction, the plough would continue to perform its work without any aſſiſtance from the ploughman, while the ſod continued uniform. But the ſmalleſt inequality of ſod would derange the plough ſo as to make it go entirely out of its path. Should the reſiſtances between G and D prevail, the plough would go deeper; which would increaſe the reſiſtances on that ſide where they already exceed, and the plough would run ſtill deeper. Should the reſiſtances behind G prevail, the heel would be preſſed down, and the point would riſe; which would ſtill further deſtroy the equilibrium, and, producing a greater deviation from the right path, would quickly throw the plough out of the ground.

For theſe reaſons we muſt not think of attaching the draught to the centre of reſiſtance; but muſt contrive a point of draught ſuch as ſhall reſtore the plough to its proper poſition when it has been driven out of it by any obſtruction.

The *muzzle*, or end of the beam, is a point which will completely ſuit our purpoſe. For, ſuppoſe that the reſiſtance on the back of the ſock has prevailed, and the plough MNFD (fig. 10.) has taken the poſition *mnfd* repreſented by the dotted lines, the draught-line GMO is brought down into the poſition *gmo*, diverging a little from GMO, and meeting the mould-board in a point *g* conſiderably before G. By this means the reſiſtances on the hinder ſide of *g* are increaſed, and thoſe before it are diminiſhed, and the plough quickly regains its former poſition.

From theſe obſervations it is plain, that whatever is the ſituation of the centre of reſiſtance, the point of draught may be ſo choſen that the action of the cattle ſhall be directly op-

Fig. 4. No. 1.

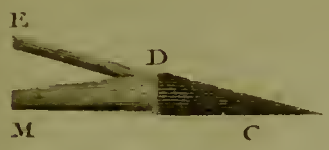


Fig. 2.

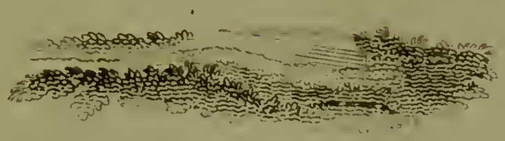


Fig. 1.

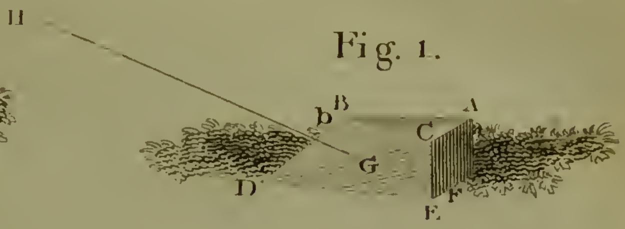


Fig. 4. No. 2.

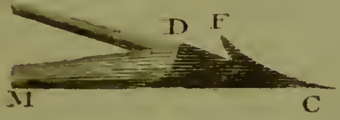


Fig. 3. No. 1.

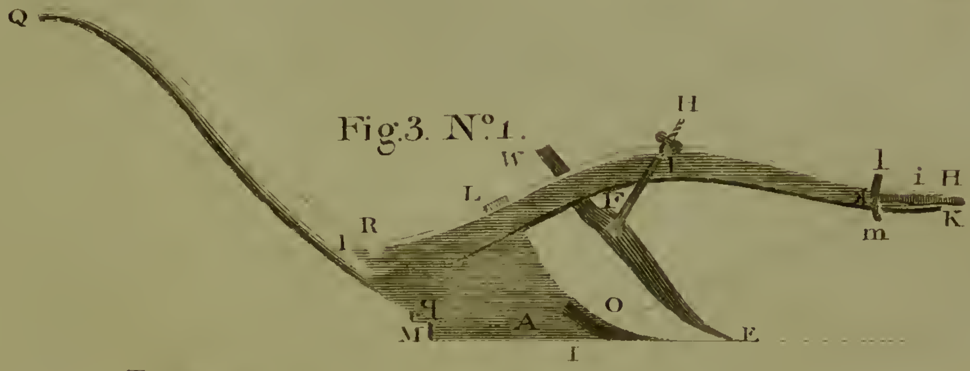


Fig. 5. No. 2.

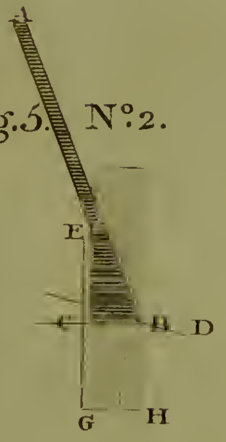


Fig. 5. No. 1.

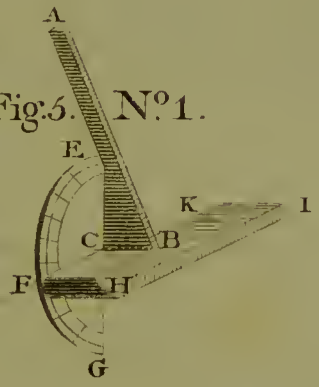


Fig. 3. No. 2.

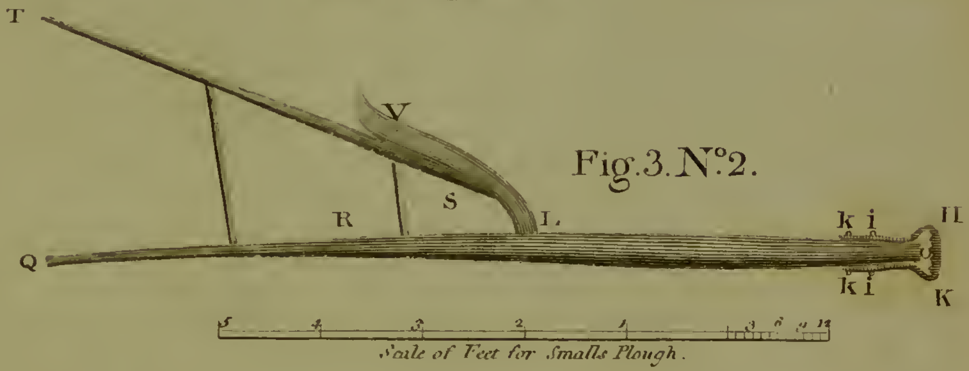


Fig. 8.

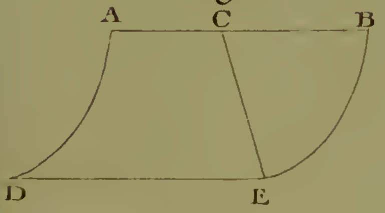


Fig. 7.

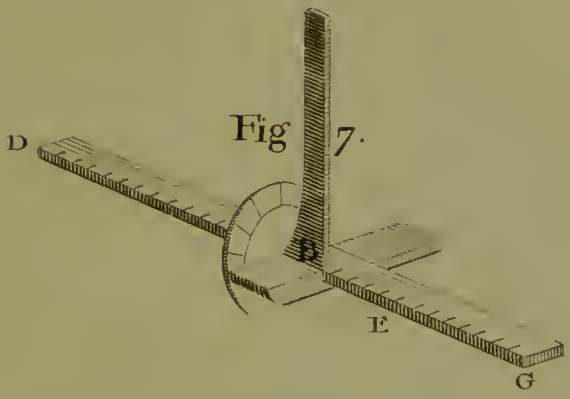


Fig. 6.

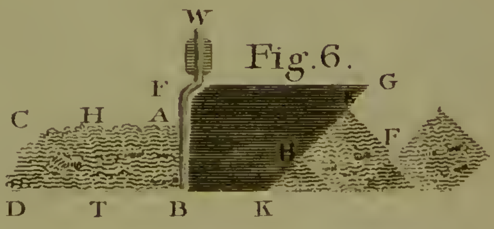


Fig. 11. *The Argyleshire Plough.*

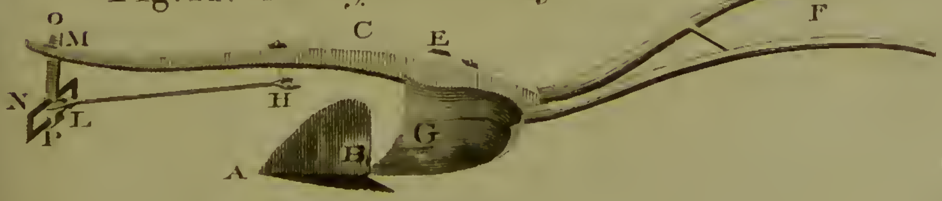


Fig. 9.

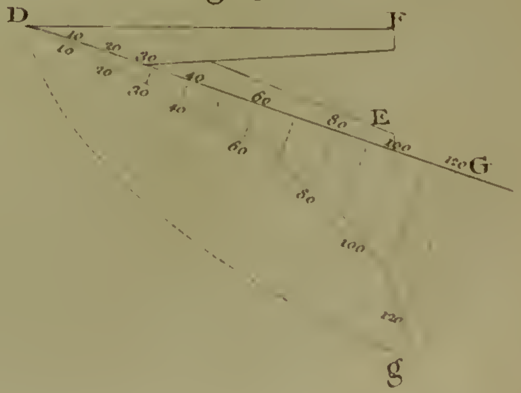
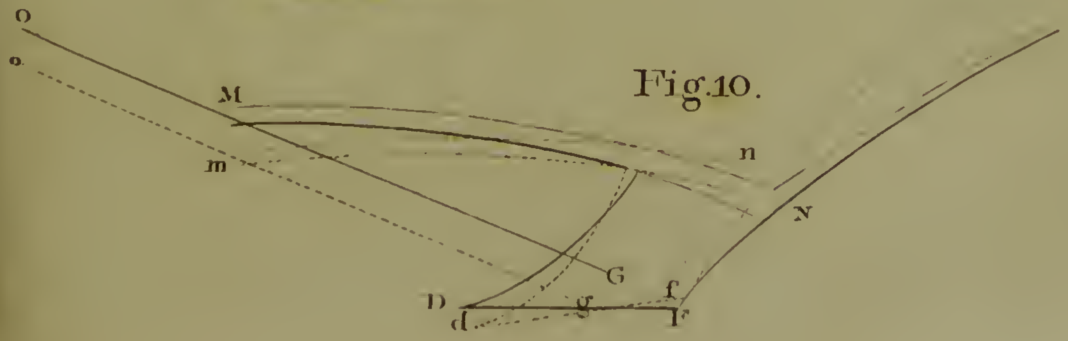


Fig. 10.



poſed to the reſiſtance of the ground, and that moreover the plough ſhall have no tendency either to go deeper or to run out. This is the uſe of the apparatus at the point of the beam called the muzzle, repreſented at H (fig. 3.). It turns round a bolt *i* through the beam, and can be ſtopped at any height by another pin *k* put through the holes in the arch *l m*. A figure is given of the muzzle immediately below, as it appears when looking down on it. The eye to which the draught-rope is hooked is ſpread out horizontally, as ſhown by H K, and has ſeveral notches O in it, to either of which the hook can be applied. This ſerves to counteract any occaſional tendency which the plough may have to the right or left.

When the plough goes on ſteadily, without any effort of the ploughman, it is ſaid to be in trim, and to ſwim fair; the preſſure before and behind the centre of action being in equilibrio with each other. In order to learn whether a plough will be in this manner under management, hook the draught-rope as high as poſſible. In this ſtate the plough ſhould have a continual tendency to riſe at the heel, and even to run a little into the ground. Then hook the rope as low as poſſible. The plough ſhould now preſs hard on the furrow with the heel, and have ſome tendency to run out of the ground. If both theſe are obſerved, the plough is properly conſtructed in this reſpect; if not, it muſt be altered, either by changing the poſition of the ſock or that of the beam. Lowering the end of the beam will correct the tendency of the plough to go deeper; the raiſing the point of the ſock will alſo have the ſame effect. But it is of conſiderable importance not to take the point of the ſock out of the plane of the ſod, and it is much better to make the alteration by the beam. The ſlope of the coulter has a conſiderable effect; but it cannot be placed very far from the inclination of 45° without the riſk of choaking the plough by driving the roots and ſtones before it. It is of great conſequence to have the coulter fit exactly in the direction of the plough's motion: if it is in any other direction, it will powerfully twiſt the plough into its own track. As it muſt be fixed in the middle of the beam's thickneſs to have ſtrength, it is removed a little from the plane of the land-ſide, and it was the uſual practice to point it to the left below to compenſate for this; but this by no means removes the diſpoſition to twiſt, and it expoſes to the riſk of catching a ſtone between its point and that of the ſock, which muſt now be driven forward through the firm ground at a great expenſe of labour to the cattle. Mr. Small has very ingeniouſly remedied this by giving the coulter a ſhort knee to the left immediately below the beam, and thus pointing it downwards in the plumb of the land-ſide. See fig. 6.

It is not without its uſe to know the abſolute force neceſſary for tilling the ground. This has been frequently meaſured with a ſpring ſteel-yard. One of Small's ploughs, worked by two horſes, and employed in breaking up ſtiff land which had been ploughed before winter, and much conſolidated by the rains, required a force of 360 lbs. averdupois; and we may ſtate this as the ordinary rate of ſuch work; but moderately firm ſod, under good culture, requires at a medium 320 lbs.

As we wiſh to embrace every opportunity of rendering this work uſeful to the public, we ſhall conclude this article with an account of a plough recommended to public notice by the Scots Highland Society as extremely proper for a hilly country. The inventor, the Rev. Alexander Campbell miniſter at Kilcalmonell in Argylſhire, was honoured with the Society's gold medal, value 25 l.

A, the ſock (fig. 11.); the land-ſide of which ſupplies the place of the coulter, and the ſole of it ſerves for a feather; it is 18 inches long, and is made of a plate of iron 12 inches broad when finiſhed, and ſomewhat under half an inch thick. —B, the head; to be made of iron in a triangular form, four inches broad by 2 inches at the thickeſt part. There are 5 inches of the head fixed in the ſock.—C, the beam, 4 inches thick by 5 inches deep, gradually tapered thinner; the length 6 feet.—E, the ſheath, muſt be of the ſame thickneſs with the beam above and the head below, and is 5 inches broad. An iron ſcrew-bolt connects the beam and head behind the ſheath.—F the handles are ſo made that the ſlope of the mould-board, which is fixed to one of them, may be the longer and more gradual. They are 5 feet 8 inches long, and 2 feet 4 inches aſunder at the ends.—G, the mould-board, conſiſts of 7 rounded ſticks 2 inches in diameter; the covert of them is in the plane of the ſole, the reſt in ſucceſſion cloſe to each other above it. This makes the mould-board 14 inches broad. To prevent any earth from getting over the mould-board, a thin deal 4 or 5 inches broad is fixed above it. The mould-board, land-ſide, and ſole of the plough, are clad with iron.—The length is 20 inches; this added to 18 inches, the length of the ſock, makes the length from point to heel 3 feet 2 inches.—The muzzle or bridle OPH is alſo of a more convenient and better conſtruction than thoſe commonly in uſe. By means of the ſcrew-pins at L and M different degrees of land may be given to the plough; the iron rod LH being thereby moved ſidewiſe in the ſocket LN, and up and down by OP. The rod is 30 inches long, one broad, and half an inch thick. It is hooked into a ſcrew-bolt at H. Two inches of the rod project at N, in the form of an eye, before the muzzle, to receive the hook of the croſs-tree.

The advantages of this plough are ſaid to be: It is not ſo liable to be interrupted or turned out of its courſe by ſtones, roots, &c. as other ploughs are; nor does it dip ſo deep as to be liable to be broken by large ſtones or flags. The motion of the muzzle is alſo thought an improvement. Another advantage it has over other ploughs is, its not being ſo liable to be choaked up by ſtubble, &c. This we underſtand to be its chief excellency, and an object much deſired in the conſtruction of the plough. Upon the whole, we are informed that this plough is lighter, leſs expenſive, and leſs liable to go out of trim, than the ordinary plough, and that with it two horſes can plough land which requires four with any other plough.

Such are ſaid to be the advantages of this conſtruction; but we cannot help expreſſing our apprehenſion that the uniting the coulter and feather at the point of the ſock will expoſe the plough to great riſks of being put out of order. When the upright edge ſtrikes a ſtone obliquely, eſpecially on the land-ſide, it muſt be violently twiſted round the point of the head; and, having but a moderate thickneſs at this part, may be broken or permanently twiſted. The plough will then be continually running out of its direction: and we apprehend that this defect cannot be amended without taking off the ſock and putting it in the fire. When a coulter is bent by the ſame cauſe, the ploughman can either rectify it by altering the wedging, or he can ſtraighten it in the field; and it muſt be obſerved, that the plough oppoſes much leſs reſiſtance to the derangement of this ſort of coulter than of the common one. In the common coulter the ſtrain does not ſo much tend to twiſt the plough round the line of its motion, as to preſs it wholly to landward. The reſiſtance to this is great, but a very moderate force will twiſt it round its line of motion. In either caſe, if the blow be given in that point of the coulter where the draught-line croſſes it, there will be no twiſt of the whole plough, but the point of the plough will be forced horizontally to or from the land. When the blow is out of this line, the ſtrain tends to twiſt the beam or the plough. Experience will determine which of the two is the moſt hazardous. Theſe ploughs are made by Thomas Lindſay, Abbeyhill, Edinburgh, and models are to be ſeen in the hall of the Highland Society.

Plough-*drill*. See **Drill**-*ſowing*, and **Husbandry**. In the Gentleman's Magazine for July 1793, p. 602, Mr. Wickins of Pondhead Lodge, New Foreſt, gives an account of a ſimplified drill-plough invented by himſelf. Its importance is increaſed, he thinks, by the cheapneſs and eaſy conſtruction of it, becauſe it can be uſed upon a ſmall ſcale by a ſingle man, and upon a larger ſcale by two men, or a man and boy; ſo that the inconvenience ſuffered by horſes trampling the ground, &c. is hereby avoided. To the drill for ſowing is occaſionally annexed a blade for hoeing between the rows: "the good effects of which (ſays Mr. Wickins) are no leſs obvious from its nurturing the growth of the corn, and producing collateral ſhoots from the application of freſh ſoil, but alſo from its affording the means of extirpating the weeds, which are ſo noxious to it." He informs us likewiſe, that his ſingle hand-drill hath been ſeen and approved by the Bath Society; and they have in conſequence been pleaſed to vote him an honorary and correſponding member. Since that time, however, he ſays, he has very materially improved and ſimplified it. Mr. Wickins's deſcription of his invention is far from accurate; and the drawing, of which there is an engraving in the ſame magazine, was taken when his machine was in its infant and leſs improved ſtate. He promiſes, however, farther information in the Gentleman's Magazine, and he offers more particulars to ſuch agricultural people as ſhall deſire it. We are far from decidedly thinking that this plough-drill is a real improvement, or that it ever will come to be really and generally uſeful. We have ſeen ſo many of theſe and ſuch-like improvements make a great noiſe for a while, and then fall into neglect, without having ever come into uſe, as makes us ſhy in forming opinions reſpecting the utility of thoſe inſtruments which are ſo often and ſo boldly obtruded on the world as the *ne plus ultra* of improvements in their ſeveral ſpheres. We think it our duty, however, to give every attempt at improvement, eſpecially in the uſeful arts, all the juſtice in our power; and, on this account, it has always been our cuſtom to lay before our readers ſuch claims to it as have occurred in the courſe of our work, whether thoſe claims appeared to ourſelves to be juſt or not.

PLOUGHMAN, the perſon who guides the plough in the operation of tilling.

PLOUGHING, in agriculture, the turning up the earth with a plough. See **Husbandry**, *paſſim*.

PLOVER, in ornithology, a ſpecies of **Charadrius**.—Theſe birds uſually fly in exceedingly large flocks in the places they frequent; people talk of 20,000 or 30,000 being ſeen in a flock. They generally come to us in September, and leave us about the end of March. In cold weather they are found very commonly in queſt of food on lands lying near the ſea; but in thaws and open ſeaſons they go higher up in the country.

They love to feed on ploughed lands, but never remain long at a time on them, for they are very cleanly in their nature; and the dirt which lodges on their beaks and feet gives them ſo much uneaſineſs, that they fly to the neareſt water to waſh themſelves. When they rooſt, they do not go to trees or hedges; but ſit ſquatting on the ground like ducks or geeſe, far from trees or hedges, when the weather is calm; but when it is ſtormy, they often get under ſhelter. In wet weather they do not ſleep in the night at all, but run about picking up the worms as they crawl out of the ground: during this feeding they are continually making a ſmall cry, that ſerves to keep them together; and in the morning they take flight. If in their flight they ſpy any others on the ground, they call them up; and if they refuſe to come, the whole body deſcends to ſee what food there is in the place that detains them.

Plovers are very eaſily taken at the time of their firſt coming over, when they have not got any other birds mixed among them; but when they afterwards pick up the teal and other ſhy birds among them, it becomes more difficult. The beſt ſeaſon for taking them is in October, eſpecially in the beginning of that month: after this they grow timorous, and are not eaſily taken again till March, which is the time of their coupling. The ſevereſt froſts are not the beſt ſeaſon for taking them in neſt, but variable weather does better. The north-weſt wind is found diſadvantageous to the taking of them; and in general, great regard is to be paid to the courſe of the wind in the ſetting of the nets. All ſea-fowl fly againſt the wind when the land lies that way; and the nets for taking them are therefore to be placed in a proper direction accordingly.

PLOWDEN (**Edmund**), ſerjeant at law, was the ſon of Humphrey Plowden of Plowden in Shropſhire, of an ancient and genteel family. He was firſt a ſtudent in the univerſity of Cambridge, where he ſpent three years in the ſtudy of philoſophy and medicine. He then removed to Oxford, where, having continued his former ſtudies about four years more, in 1552 he was admitted to the practice of phyſic and ſurgery: but probably finding the practice of the art of healing leſs agreeable than the ſtudy, he entered himſelf of the Middle Temple, and began to read law. Wood ſays, that in 1557 he was ſummer reader to that ſociety, and Lent-reader three years after, being then ſerjeant and oracle of the law. He died in the year 1584, aged 67; and was buried in the Temple-church near the north wall, at the eaſt end of the choir. He married the daughter of William Sheldon of Boley in Worceſterſhire; by whom he had a ſon, who died ſoon after his father. He wrote, 1. Commentaries or Reports of divers Caſes, &c. in the Reigns of King Edward VI. Queen Mary, and Queen Elizabeth; London, 1571, 78, 99, 1613, &c. Written in the old Norman language. 2. Queries, or a Moot-book of Caſes, &c. tranſlated, methodized, and enlarged, by H. B. of Lincoln's-Inn; Lond. 1662, 8vo.

PLUCHE (**Antony**), born at Rheims in 1688, merited by his engaging manners and proficiency in the belles-lettres the appointment of humaniſt in the univerſity of that city. Two years after he obtained the profeſſor of rhetoric's chair, and was admitted into holy orders. The biſhop of Laon, (Clermont) informed of his talents, offered him the direction of the college of his epiſcopal city. By his induſtry and ſuperior knowledge, a proper order and ſubordination ſoon took place in it; but ſome particular opinions reſpecting the affairs of the time diſturbed his tranquillity, and obliged him to quit his office. The intendant of Rouen, at the requeſt of the celebrated Rollin, entruſted him with the education of his ſon. Abbé Pluche, having filled that place with ſucceſs and great honour to himſelf, left Rouen and went to Paris, where, by the patronage of ſome literary friends and his own excellent writings, he acquired a very diſtinguiſhed reputation for learning. He publiſhed, 1. *Le Spectacle de la Nature* (Nature Diſplayed), in 9 vols. in 12mo. This work, which is equally inſtructive and entertaining, is written with perſpicuity and elegance; but the form of dialogue which he adopted has drawn him into the fault of being rather too prolix. The ſpeakers, who are the Prior, the Count, and Counteſs, are not diſtinguiſhed by any ſtriking feature; but they have all the common character, which is tolerably pleaſing, not excepting even that of the little chevalier De Breuil, who is, however, a mere ſcholar. This is the opinion which Abbé Desfontaines has formed of this work. Though the author has given the converſations a pretty ingenious turn, and even ſome vivacity, yet they now and then fall into the tone of the college. 2. *Hiſtoire du Ciel*, or Hiſtory of the Heavens, in 2 vols. in 12mo. In this performance we find two parts almoſt independent of one another. The firſt contains ſome learned inquiries into the origin of the poetic heavens. It is nearly a complete mythology, founded upon ideas which are new and ingenious. The ſecond is the hiſtory of the opinions given by philoſophers reſpecting the formation of the world. The author ſhows the inutility, the inconſtancy, and uncertainty, of the moſt eſteemed ſyſtems; and concludes with pointing out the excellence and ſublime ſimplicity of the Moſaic account. Beſides a noble and well-turned expreſſion, we find in it an erudition which does not fatigue the mind. As to the foundation of the ſyſtem explained in the firſt part, though it appears plauſible, we will not take upon us to ſay how far it is true: Voltaire called it *Fable du Ciel*, or a Fable of the Heavens. 3. *De Linguarum artificio*; a work which he tranſlated with this title, *La Mecanique des Langues*, in 12mo. In this treatiſe he propoſes a ſhort and eaſy method of learning languages, which is by the uſe of tranſlations inſtead of themes or exerciſes; and we muſt admit his reflections on that ſubject are both judicious and well expreſſed. 4. Harmony of the Pſalms and the Goſpel, or a Tranſlation of the Pſalms and Hymns of the Church, with Notes relative to the Vulgate, the Septuagint, and Hebrew Text, printed at Paris in 1764, in 12mo. In 1749, Abbé Pluche retired to Varenne St. Maure, where he gave himſelf up entirely to devotion and ſtudy. Having become ſo deaf that he could not hear without the help of a trumpet, the capital afforded him very little entertainment. It was in this retreat that he died of an apoplexy on the 20th of November 1761, at the age of 73 years. He poſſeſſed thoſe qualities which form the ſcholar, the honeſt man, and the chriſtian: temperate in his meals, true to his word, an affectionate parent, a ſenſible friend, and a humane philoſopher; he gave leſſons of virtue in his life as well as in his writings. His ſubmiſſion to all the dogmas of religion was very great. Some Deiſts having been ſurpriſed that, in matters of faith, he ſhould think and ſpeak like the vulgar, his anſwer was, "I glory in doing ſo: It is infinitely more rational to believe the word of God, than to follow the glimmering lights of a reaſon which is limited and ſubject to error."

PLUG, certain pieces of timber, formed like the fruſtum of a cone, and uſed to ſtop the hauſe-holes and the breaches made in the body of a ſhip by cannon balls; the former of which are called *hauſe-plugs*, and the latter *ſhot-plugs*, which are formed of various ſizes in proportion to the holes made by the different ſizes of ſhot, which may penetrate the ſhip's ſides or bottom in battle; accordingly they are always ready for this purpoſe.

PLUKENET (LEONARD), a phyſician who flouriſhed in the reign of king Charles II. was one of the moſt excellent and laborious botaniſts of that or any other age. He was author of the *Phytographia Plucenetiana*, the *Almageſticum Britannicum*, and other works of the like kind, on which he ſpent the greateſt part of his life and fortune. His Phytography is mentioned with the higheſt encomiums in the Philoſophical Tranſactions for February 1696-7. His *Opera Botanica*, with cuts, were printed at London in 6 vols. folio, in 1720.

PLUM-TREE, in botany. See PRUNUS.

PLUMAGE, the feathers which ſerve birds for a covering. See ORNITHOLOGY.

PLUMB-LINE, among artificers, denotes a perpendicular to the horizon; ſo called, as being commonly erected by means of a plummet.

PLUMBAGO, LEAD-WORT, in botany; a genus of the monogynia order, belonging to the pentandria claſs of plants. There are four ſpecies; the moſt remarkable of which are the Europæa and Zeylonica. The firſt grows naturally in the ſouthern parts of Europe, and has a perennial root ſtriking deep in the ground. There are many ſlender channelled ſtalks, about three feet high, terminated by tufts of ſmall funnel-ſhaped flowers, of a blue or white colour. The ſecond grows naturally in both the Indies. The upper part of the ſtalk and empalement are covered with a glutinous juice, which catches the ſmall flies that light upon it. The former ſpecies is propagated by parting the roots, and by ſeeds; but the latter is too tender to thrive in the open air in this country.

PLUMBAGO. See *Black*-LEAD.

PLUMBERY, the art of caſting and working lead, and uſing it in building. As this metal melts ſoon and with little heat, it is eaſy to caſt it into figures of any kind, by running it into moulds of braſs, clay, plaſter, &c. But the chief article in plumbery is ſheets and pipes of lead; and as theſe make the baſis of the plumber's work, we ſhall here give the proceſs of making them.

In caſting *ſheet-lead*, a table or mould is made uſe of, which conſiſts of large pieces of wood well jointed, and bound with bars of iron at the ends; on the ſides of which runs a frame conſiſting of a ledge or border of wood, three inches thick and four inches high from the mould, called the *ſharps*. The ordinary width of the mould, within theſe ſharps, is from four to five feet; and its length is 16, 17, or 18 feet. This ſhould be ſomething longer than the ſheets are intended to be, in order that the end where the metal runs off from the mould may be cut off, becauſe it is commonly thin or uneven, or ragged at the end. It muſt ſtand very even or level in breadth, and ſomething falling from the end in which the metal is poured in, viz. about an inch or an inch and a half in the length of 16 or 17 feet or more, according to the thinneſs of the ſheets wanted; for the thinner the ſheet, the more declivity the mould ſhould have. At the upper end of the mould ſtands the pan, which is a concave triangular priſm, compoſed of two planks nailed together at right angles, and two triangular pieces fitted in between them at the ends. The length of this pan is the whole breadth of the mould in which the ſheets are caſt; it ſtands with its bottom, which is a ſharp edge, on a form at the end of the mould, leaning with one ſide againſt it; and on the oppoſite ſide is a handle to lift it up by, to pour out the melted lead; and on that ſide of the pan next the mould are two iron hooks to take hold of the mould, and prevent the pan from ſlipping while the melted lead is pouring out of it into the mould. This pan is lined on the inſide with moiſtened ſand, to prevent it from being fired by the hot metal. The mould is alſo ſpread over, about two inches thick, with ſand ſifted and moiſtened, which is rendered perfectly level by moving over it a piece of wood called a *ſtrike*, and ſmoothing it over with a ſmoothing plane, which is a plate of poliſhed braſs, about one-fourth of an inch thick and nine inches ſquare, turned up on all the four edges, and with a handle fitted on to the upper or concave ſide. The ſand being thus ſmoothed, it is fit for caſting ſheets of lead: but if they would caſt a ciſtern, they meaſure out the bigneſs of the four ſides; and having taken the dimenſions of the front or fore-part, make mouldings by preſſing long ſlips of wood, which contain the ſame mouldings, into the level ſand; and form the figures of birds, beaſts, &c. by preſſing in the ſame manner leaden figures upon it, and then taking them off, and at the ſame time ſmoothing the ſurface where any of the ſand is raiſed up by making theſe impreſſions upon it. The reſt of the operation is the ſame in caſting either ciſterns or plain ſheets of lead. But before we proceed to mention the manner in which that is performed, it will be neceſſary to give a more particular deſcription of the *ſtrike*. The ſtrike, then, is a piece of board about five inches broad, and ſomething longer than the breadth of the mould on the inſide; and at each end is cut a notch about two inches deep, ſo that when it is uſed it rides upon the ſharps with thoſe notches. Before they begin to caſt, the ſtrike is made ready by tacking two pieces of an old hat on the notches, or by ſlipping a caſe of leather over each end, in order to raiſe the under ſide about one-eighth of an inch or ſomething more above the ſand, according as they would have the ſheet to be in thickneſs; then they tallow the under edge of the ſtrike, and lay it acroſs the mould. The lead being melted, it is put into the pan with ladles, in which, when there is a ſufficient quantity for the preſent purpoſe, the ſcum of the metal is ſwept off with a piece of board to the edge of the pan, letting it ſettle on the ſand, which is by this means prevented from falling into the mould at the pouring out of the metal. When the lead is cool enough, which muſt be regulated according to the thickneſs of the ſheets wanted, and is known by its beginning to ſtand with a ſhell or wall on the ſand round the pan, two men take the pan by the handle, (or elſe one of them lifts it by the bar and chain fixed to a beam in the cieling,) and pour it into the mould, while another man ſtands ready with the ſtrike, and, as ſoon as they have done pouring in the metal, puts on the mould, ſweeps the lead forward, and draws the overplus into a trough prepared to receive it. The ſheets being thus caſt, nothing remains but to roll them up or cut them into any meaſure wanted; but if it be a ciſtern, it is bent into four ſides, ſo that the two ends may join the back, where they are ſoldered together; after which the bottom is ſoldered up.

The method of caſting pipes without ſoldering. To make theſe pipes they have a kind of little mill, with arms or levers to turn it withal. The moulds are of braſs, and conſiſt of two pieces, which open and ſhut by means of hooks and hinges, their inward caliber or diameter being according to the ſize of the pipe, uſually two feet and a half. In the middle is placed a core or round piece of braſs or iron, ſomewhat longer than the mould, and of the thickneſs of the inward diameter of the pipe. This core is paſſed through two copper rundles, one at each end of the mould, which they ſerve to cloſe; and to theſe is joined a little copper tube about two inches long, and of the thickneſs the leaden pipe is intended to be of. By means of theſe tubes, the core is retained in the middle of the cavity of the mould. The core being in the mould, with the rundles at its two ends, and the lead melted in the furnace, they take it up in a ladle, and pour it into the mould by a little aperture at one end, made in the form of a funnel. When the mould is full, they paſs a hook into the end of the core, and, turning the mill, draw it out; and then opening the mould, take out the pipe. If they deſire to have the pipe lengthened, they put one end of it in the lower end of the mould, and paſs the end of the core into it; then ſhut the mould again, and apply its rundle and tube as before, the pipe juſt caſt ſerving for a rundle, &c. at the other end. Things being thus replaced, they pour in freſh metal, and repeat the operation till they have got a pipe of the length required.

For making pipes of ſheet-lead, the plumbers have wooden cylinders, of the length and thickneſs required; and on theſe they form their pipes by wrapping the ſheet around them, and ſoldering up the edges all along them.

The lead which lines the Chineſe tea-boxes is reduced to a thinneſs which we are informed European plumbers cannot imitate. The following account of the proceſs, by which the plates are formed, was communicated to a writer in the Gentleman's Magazine by an intelligent mate of an Eaſt Indiaman. The caſter ſits by a pot containing the melted metal; and has two large ſtones, the under one fixed, the upper moveable, directly before him. He raiſes the upper ſtone by preſſing his foot upon the ſide of it, and with an iron ladle pours into the opening a proper quantity of the fluid metal. He then immediately lets fall the upper ſtone, and by that means forms the lead into a thin irregular plate, which is afterwards cut into a proper ſhape. The ſurfaces of the ſtones, where they touch each other, are exactly ground together.

PLUMBUM, LEAD. See LEAD.

PLUMBUM *Corneum*, a combination of lead with the marine acid. See CHEMISTRY.

PLUME, in botany, the bud or germ. See GEMMA.

PLUMIER (CHARLES), a learned Minim, born at Marſeilles, and one of the moſt able botaniſts of the 17th century. He was inſtructed by the famous Maignan, who taught him mathematics, turnery, the art of making ſpectacles, burning-glaſſes, microſcopes, and other works. He at length went to Rome to perfect himſelf in his ſtudies, and there applied himſelf entirely to botany under a ſkilful Italian. At his return to Provence, he ſettled in the convent at Bornes, a maritime place near Hieres, where he had the conveniency of making diſcoveries in the fields with reſpect to ſimples. He was ſome time after ſent by the French king to America, to bring from thence ſuch plants as might be of ſervice in medicine. He made three different voyages to the Antilles, and ſtopped at the iſland of St. Domingo. The king honoured him with a penſion; and he at laſt ſettled at Paris. However, at the deſire of M. Fagon, he prepared to go a fourth time to America, to examine the tree which produces the Jeſuits bark; but died at the port of Santa Maria, near Cadiz, in 1706. He wrote ſeveral excellent works; the principal of which are, 1. A volume of the Plants in the American Iſlands. 2. A Treatiſe on the American Fern. 3. The Art of Turnery; a curious work embelliſhed with plates.

PLUMMET, PLUMB-*Rule*, or *Plumb-line*, an inſtrument uſed by carpenters, maſons, &c. in order to judge whether walls, &c. be upright planes, horizontal, or the like. It is thus called from a piece of lead, faſtened to the end of a cord, which uſually conſtitutes this inſtrument. Sometimes the ſtring deſcends along a wooden ruler, &c. raiſed perpendicularly on another; in which caſe it becomes a level.

PLUMMING, among miners, is the method of uſing a mine-dial, in order to know the exact place of the work where to ſink down an air-ſhaft, or to bring an adit to the work, or to know which way the load inclines when any flexure happens in it.

It is performed in this manner: A ſkilful perſon with an aſſiſtant, and with pen, ink, and paper, a long line, and a ſun-dial, after his gueſs of the place above ground, deſcends into the adit or work, and there faſtens one end of the line to ſome fixed thing in it; then the incited needle is let to reſt, and the exact point where it reſts is marked with a pen: he then goes on further in the line ſtill faſtened, and at the next flexure of the adit he makes a mark on the line by a knot or otherwiſe: and then letting down the dial again, he there likewiſe notes down that point at which the needle ſtands in this ſecond poſition. In this manner he proceeds, from turning to turning, marking down the points, and marking the line, till he comes to the intended place: this done, he aſcends, and begins to work on the ſurface of the earth what he did in the adit, bringing the firſt knot in the line to ſuch a place where the mark of the place of the needle will again anſwer its pointing, and continues this till he come to the deſired place above ground, which is certain to be perpendicular over the part of the mine into which the air-ſhaft is to be ſunk.

PLUMOSE, ſomething formed in the manner of a feather, with a ſtem and fibres iſſuing from it on each ſide: ſuch are the antennæ of certain moths, butterflies, &c.

PLURAL, in grammar, an epithet applied to that number of nouns and verbs which is uſed when we ſpeak of more than one thing. See GRAMMAR.

PLURALITY, a diſcrete quantity, conſiſting of two or a greater number of the ſame kind; thus we ſay, a plurality of gods, of worlds, &c.

PLURALITY *of Benefices*, or *Livings*, is where the ſame clerk is poſſeſſed of two or more ſpiritual preferments, with cure of ſouls. See BENEFICE. The ſmallneſs of ſome benefices firſt gave riſe to pluralities; for an eccleſiaſtic, unable to ſubſiſt on a ſingle one, was allowed to hold two, and at length the number increaſed without bounds. A remedy was attempted for this abuſe at the council of Lateran under Alexander III. and Innocent III. in the year 1215, when the holding more than one benefice was forbid by a canon under the penalty of deprivation; but the ſame canon granting the pope a power to diſpenſe with it in favour of perſons of diſtinguiſhed merit, the prohibition became almoſt uſeleſs. They were alſo reſtrained by ſtatute 21 Hen. VIII. cap. 13. which enacts, that if any perſon, having one benefice with cure of ſouls, of the yearly value of 8l. or above (in the king's books), accept any other with cure of ſouls, the firſt ſhall be adjudged in law to be void, &c. though the ſame ſtatute provides for diſpenſation in certain caſes.

In England, in order to procure a diſpenſation, the preſentee muſt obtain of the biſhop, in whoſe dioceſe the livings are, two certificates of the values in the king's books, and the reputed values and diſtance; one for the archbiſhop, and the other for the lord-chancellor. And if the livings lie in two dioceſes, then two certificates of the ſame kind are to be obtained from each biſhop. He muſt alſo ſhow the archbiſhop his preſentation to the ſecond living, and bring with him two teſtimonials from the neighbouring clergy concerning his behaviour and converſation, one for the archbiſhop and the other for the lord chancellor; and he muſt alſo ſhow the archbiſhop his letters of orders, and a certificate of his having taken the degree of maſter of arts, at the leaſt, in one of the univerſities of this realm, under the hand of the regiſter. And if he be not doctor or bachelor of divinity, nor doctor nor bachelor of law, he is to procure a qualification of a chaplain, which is to be duly regiſtered in the faculty office, in order to be tendered to the archbiſhop, according to the ſtatute. And if he hath taken any of the aforeſaid degrees, which the ſtatute allows as qualifications, he is to procure a certificate thereof as already mentioned, and to ſhow the ſame to the archbiſhop; after which his diſpenſation is made out at the faculty office, where he gives ſecurity according to the direction of the canon. He muſt then repair to the lord-chancellor for confirmation under the broad ſeal; and he muſt apply to the biſhop of the dioceſe where the living lies for his admiſſion and inſtitution. By the ſeveral ſtamp-acts, for every ſkin, or paper, or parchment, &c. on which any diſpenſation to hold two eccleſiaſtical dignities or benefices, or a dignity and a benefice, ſhall be engroſſed or written, there ſhall be paid a treble 40s. ſtamp duty.

We have alſo a regulation in regard to pluralities; but it is often diſpenſed with; for, by the faculty of diſpenſation, a pluraliſt is required, in that benefice from which he ſhall happen to be moſt abſent, to preach 13 ſermons every year, and to exerciſe hoſpitality for two months yearly.

In Germany the pope grants diſpenſations for poſſeſſing a plurality of benefices, on pretence that the eccleſiaſtical princes there need large revenues to bear up againſt the Proteſtant princes.

PLUS, in algebra, a character marked thus +, uſed for the ſign of addition. See ALGEBRA, and NEGATIVE *Sine*.

PLUSH, in commerce, &c. a kind of ſtuff, having a ſort of velvet knap or ſhag on one ſide, compoſed regularly of a woof of a ſingle woollen thread and a double warp; the one wool, of two threads twiſted; the other goats' or camels' hair; though there are ſome pluſhes entirely of worſted, and others compoſed wholly of hair.

PLUTARCH, a great philoſopher and hiſtorian of antiquity, who lived from the reign of Claudius to that of Hadrian, was born at Chæronea, a ſmall city of Bœotia in Greece. Plutarch's family was ancient in Chæronea: his grandfather Lamprias was eminent for his learning, and a philoſopher; and is often mentioned by Plutarch in his writings, as is alſo his father. Plutarch was initiated early in ſtudy, to which he was naturally inclined, and was placed under the care of Ammonius, an Egyptian, who, having taught philoſophy with great reputation at Alexandria, travelled thence into Greece, and ſettled at Athens. Under this maſter he made great advances in knowledge; and like a thorough philoſopher, more apt to regard things than words, he purſued this knowledge to the neglect of languages. The Roman language at that time was not only the language of Rome, but of Greece alſo, and much more uſed there than the French is now in England. Yet he was ſo far from regarding it then, that, as we learn from himſelf, he became not converſant in it till the declenſion of his life; and though he is ſuppoſed to have reſided in Rome near 40 years at different times, yet he never ſeems to have acquired a competent ſkill in it. But this was not the worſt: he did not cultivate his mother tongue with any great exactneſs; and hence that harſhneſs, inequality, and obſcurity, in his ſtyle, which has ſo frequently and ſo juſtly been complained of.

After he was principled and grounded by Ammonius, having an inſatiable thirſt for knowledge, he reſolved to travel. Egypt was at that time, as formerly it had been, famous for learning; and probably the myſteriouſneſs of their doctrine might tempt him, as it had tempted Pythagoras and others, to go and converſe with the prieſthood of that country. This appears to have been particularly his buſineſs, by his treatiſe *Of Iſis and Oſiris*, in which he ſhows himſelf verſed in the ancient theology and philoſophy of the wiſe men. From Egypt he returned into Greece; and viſiting in his way all the academies and ſchools of the philoſophers, gathered from them many of thoſe obſervations with which he has abundantly enriched poſterity. He does not ſeem to have been attached to any particular ſect, but culled from each of them whatever he thought excellent and worthy to be regarded. He could not bear the paradoxes of the Stoics, but yet was more averſe from the impiety of the Epicureans: in many things he followed Ariſtotle; but his favourites were Socrates and Plato, whoſe memory he revered ſo highly, that he annually celebrated their birth-days with much ſolemnity. Beſides this, he applied himſelf with extreme diligence to collect not only all books that were excellent in their kind, but alſo all the ſayings and obſervations of wiſe men which he had heard in converſation or had received from others by tradition; and likewiſe to conſult the records and public inſtruments preſerved in cities which he had viſited in his travels. He took a particular journey to Sparta, to ſearch the archives of that famous commonwealth, to underſtand thoroughly the model of their ancient government, the hiſtory of their legiſlators, their kings, and their ephori, and digeſted all their memorable deeds and ſayings with much care. He took the ſame methods with regard to many other commonwealths, and thus was enabled to leave us in his works ſuch a rich cabinet of obſervation upon men and manners, as, in the opinion of Montaigne and Bayle, have rendered him the moſt valuable author of antiquity.

The circumſtances of Plutarch's life are not known, and therefore cannot be related with any exactneſs. According to the learned Fabricius, he was born under Claudius, 50 years after the Chriſtian era. He was married to a moſt amiable woman of his own native town, whoſe name, according to the probable conjecture of Rualdus, was Timoxena, and to whoſe ſenſe and virtue he has borne the moſt affectionate teſtimony in his moral works. He had ſeveral children, and among them two ſons, one called *Plutarch* after himſelf, the other *Lamprias* in memory of his grandfather. Lamprias was he, of all his children, who ſeems to have inherited his father's philoſophy; and to him we owe the table or catalogue of Plutarch's writings, and perhaps alſo his Apophthegms. He had a nephew, Sextus Chæroneus, who taught the learned emperor Marcus Aurelius the Greek tongue, and was much honoured by him. Some think that the critic Longinus was of his family; and Apuleius, in the firſt book of his Metamorphoſes, affirms himſelf to be deſcended from him.

On what occaſion, and at what time of his life, he went to Rome, how long he lived there, and when he finally returned to his own country, are all uncertain. It is probable that the fame of him went thither before him, not only becauſe he had publiſhed ſeveral of his works, but becauſe immediately upon his arrival, as there is reaſon to believe, he had a great reſort of the Roman nobility to hear him; for he tells us himſelf that he was ſo taken up in giving lectures of philoſophy to the great men of Rome, that he had not time to make himſelf maſter of the Latin tongue, which is one of the firſt things that would naturally have engaged his attention. It appears that he was ſeveral times at Rome; and perhaps one motive to his inhabiting there was the intimacy he had contracted in ſome of theſe journeys with Soſſius Senecio, a great and worthy man, who had been four times conſul, and to whom Plutarch has dedicated many of his Lives. But the great inducement which carried him firſt to Rome was undoubtedly that which had carried him into ſo many other parts of the world, namely, to make obſervations upon men and manners, and to collect materials for writing the Lives of the Roman Worthies, in the ſame manner as he had already written thoſe of the Grecian; and accordingly he not only converſed with all the living, but ſearched the records of the capitol, and of all the libraries. Not but, as we learn from Suidas, he was intruſted alſo with the management of public affairs in the empire, during his reſidence in the metropolis. "Plutarch (ſays he) lived in the time of Trajan, who beſtowed on him the conſular ornaments, and alſo cauſed an edict to be paſſed, that the magiſtrates or officers of Illyria ſhould do nothing in that province without his knowledge and approbation."

When and how he was made known to Trajan is likewiſe uncertain; but it is generally ſuppoſed that Trajan, a private man when Plutarch firſt came to Rome, was, among other nobility, one of his auditors. It is alſo ſuppoſed that this wiſe emperor made uſe of him in his councils; at leaſt, much of the happineſs of his reign has been imputed to Plutarch. Fabricius aſſerts that he was Trajan's preceptor, and that he was raiſed to the conſular dignity by him, and made procurator of Greece in his old age by the emperor Adrian. We are equally at a loſs concerning the time of his abode in the imperial city; which, however, at different times, is not imagined to fall much ſhort of 40 years. The deſire of viſiting his native country, ſo natural to all men, and eſpecially when growing old, prevailed with him at length to leave Italy, and at his return he was unanimouſly choſen archon or chief magiſtrate of Chæronea, and not long after admitted into the number of the Delphic Apollo's prieſts. We have no particular account of his death, either as to the manner of it or the year; only it is evident that he lived, and continued his ſtudies, to a good old age. The moſt probable conjecture is that of Fabricius, who ſays he died in the fifth year of Adrian at the age of 70.

His works have been divided, and they admit of a pretty equal diviſion, into Lives and Morals; the former of which, in his own eſtimation, were to be preferred as more noble than the latter. His ſtyle, as we have already obſerved, has been excepted to with ſome reaſon: he has alſo been criticiſed for ſome miſtakes in Roman antiquities, and for a little partiality to the Greeks. On the other hand, he has been juſtly praiſed for the copiouſneſs of his fine ſenſe and learning, for his integrity, and for a certain air of goodneſs which appears in all he wrote. His buſineſs was not to pleaſe the ear, but to inſtruct and charm the mind; and in this none ever went beyond him. Of his moral writings it is to be regretted that we have no elegant Engliſh tranſlation. Even his Lives were chiefly known to the Engliſh reader by a motley and miſerable verſion, till a new one, executed with fidelity and ſpirit, was preſented to the public by the Langhornes in 1770. On the whole, it is to be wiſhed that this moſt amiable moraliſt and biographer had added a Life of himſelf to thoſe which he has given to the world of others, as the particulars which other writers have preſerved of his perſonal hiſtory are very doubtful and imperfect.

PLUTO, in Pagan worſhip, the king of the infernal regions, was the ſon of Saturn and Ops, and the brother of Jupiter and Neptune. This deity, finding himſelf childleſs and unmarried, mounted his chariot to viſit the world, and, arriving in Sicily, fell in love with Proſerpine, whom he ſaw gathering flowers with her companions in the valley of Enna, near Mount Ætna; when, forcing her into his chariot, he drove her to the river Chemarus, through which he opened himſelf a paſſage back to the realms of night. See CERES and PROSERPINE. Pluto is uſually repreſented in an ebony chariot drawn by four black horſes; ſometimes holding a ſceptre, to denote his power; at others a wand, with which he drives away the ghoſts; and at others ſome keys, to ſignify that he had the keys of death. Homer obſerves, that his helmet had the quality of rendering the wearer inviſible, and that Minerva borrowed it in order to be concealed from Mars when ſhe fought againſt the Trojans. Pluto was greatly revered both by the Greeks and Romans, who erected temples and altars to him. To this god ſacrifices were offered in the night, and it was not lawful to offer them by day.

PLUTUS, in Pagan worſhip, the god of riches, is frequently confounded with Pluto. He was repreſented as appearing lame when he approached, and with wings at his departure, to ſhow the difficulty of amaſſing wealth and the uncertainty of its enjoyment. He was alſo frequently repreſented blind, to ſhow that he often beſtowed his favours on the moſt unworthy, and left in neceſſity thoſe who had the greateſt merit.

PLUVIALIS. See CHARADRIUS.

PLUVIUS, a ſurname of Jupiter. He was invoked by that name among the Romans whenever the earth was parched up by continual heat, and was in want of refreſhing rains. He had an altar in the temple on the capitol.

PLYERS, in fortification, denote a kind of balance uſed in raiſing or letting down a draw-bridge. They conſiſt of two timber levers, twice as long as the bridge they lift, joined together by other timbers framed in the form of a St. Andrew's croſs to counterpoiſe them. They are ſupported by two upright jambs, on which they ſwing; and the bridge is raiſed or let down by means of chains joining the ends of the plyers and bridge.

PLYING, in the ſea language, the act of making, or endeavouring to make, a progreſs againſt the direction of the wind. Hence a ſhip that advances well in her courſe in this manner of ſailing is ſaid to be a good plyer. See the articles BEATING, PITCHING, and TACKING.

PLYMOUTH, a ſea-port town of Devonſhire, about 215 miles from London, ſtands between the rivers Plym and

Tamar, juſt before they fall into the Britiſh Channel. From a mere fiſhing-village it has become one of the largeſt towns in the county, and is one of the chief magazines in the kingdom, on account of its port, which is one of the ſafeſt in England, and which is ſo large as to be able to contain 1000 ſail. It is defended by ſeveral different forts, mounting altogether nearly 300 guns, of which the chief is the Royal Citadel, erected in the reign of Charles II. oppoſite to St. Nicholas Iſland, which is within the circuit of its walls, and contains a large ſtorehouſe and five regular baſtions. In time of war the outward-bound convoys generally rendezvous at Plymouth, and homeward-bound ſhips generally put in to provide pilots up the Channel. It is alſo a great place of reſort for men of war that are wind-bound.

The mouth of the Tamar is called Ham-Ooze, and that of Plym Catwater, which are both commanded by the caſtle on St. Nicholas Iſland. About two miles up the mouth of the Tamar there are four docks, two of which were built in the reign of William III. one wet and the other dry, and two which have been built ſince. They have every conveniency for building or repairing ſhips, and one of them is hewn out of a mine of ſlate and lined with Portland ſtone. This town enjoys a pilchard fiſhery of conſiderable importance, and carries on an extenſive trade with Newfoundland and the Straits. There is a cuſtom-houſe in it; and though there are two churches (and beſides ſeveral meeting-houſes), yet each church has ſo large a cure of ſouls, that the pariſh-clerks were till very lately in deacon's orders, to enable them to perform all the occaſional and other offices. The ſeat-rents are given to the poor. The lecturers are choſen every three years by the corporation, which was conſtituted by Henry VI. and conſiſts of a mayor, 12 aldermen, and 24 common-council men. The mayor is elected by a jury of 36 perſons, choſen by four others, two of whom are appointed by the mayor and aldermen, and the other two by the common-council. There is alſo a recorder, and a town-clerk, whoſe place is very profitable. The town conſiſts of four diviſions, which were anciently governed by four captains, each of whom had three conſtables under him. It is well ſupplied with freſh water, which was brought from the diſtance of ſeven miles by Sir Francis Drake, a native of the town. The toll of the markets, and of the cotton, yarn, &c. with the profit of the mill, which is very conſiderable, belongs to the corporation, as do the revenues of the ſhambles, which are farmed out for the mayor's kitchen. There is a charity-ſchool in Plymouth, four hoſpitals, and a workhouſe, in all which 100 poor children are clothed, fed, and taught; and there are two printing-houſes. To one of the hoſpitals Colonel Jory gave a charity for 12 poor widows, as he did a mace worth 120 l. to be carried before the mayor, and ſix good bells, valued at 500 l. to Charles-Church, ſo called from our kings in whoſe reigns it was begun and finiſhed. In the entrance of the bay lies the famous Edyſtone-rock, which is covered at high water, and on which the ingenious Mr. Winſtanley built a light-houſe, that was blown down in the terrible hurricane of Nov. 27th 1703, and himſelf, with others that were with him in it, never more heard of. However, another was erected in the room of it, by the corporation of the Trinity-houſe, in purſuance of an act of the 5th of queen Anne, which was deſtroyed by an accidental fire Dec. 4th 1755, but rebuilt in 1759, which alſo was burnt down, and rebuilt in the year 1770. In the reign of Edward III. the French landed, and burnt part of the town, but were ſoon repulſed by Hugh Courtenay earl of Devon. In the reign of Henry IV. the French landed here again, and burnt 600 houſes. Between this town and the ſea is a hill called the Haw, which has a delightful plain on the top, having a pleaſant proſpect all round it, and a good landmark for the uſe of mariners. The liſt of parliament-men for this borough, formerly divided into two parts, by the names of Sutton-Valtort and Sutton-Prior, commences the 26th of Edward I. and continues to the 14th of Edward III. after which we find no return made for it till the 20th of Henry VI. when the privilege was renewed. On the Haw is a fort, which at once awes the town and defends the harbour. Here is a ferry over the Tamar, called Crumwell or Crimble Paſſage, the weſt ſide of which is called Weſtone-Houſe, and is in Devonſhire, though moſt of the pariſh wherein it ſtands is in Cornwall. In April 1759 the parliament granted 25,159 l. for the better fortifying the town and dock of Plymouth, which was viſited by Geo. III. with the queen, &c. in Auguſt 1789. N. lat. 50. 26. W. lon. 4. 15.

Plymouth, in New England, a ſea-port town, and capital of the county of the ſame name, in the province of Maſſachuſets Bay in North America. It is remarkable for having been the firſt ſettlement in New England, and for having had the firſt place of worſhip. It is ſeated at the ſouth end of Plymouth Bay. W. lon. 70. 10. N. lat. 41. 58.

PLYNTERIA, a Grecian feſtival in honour of Aglauros, or rather of Minerva, who received from the daughter of Cecrops the name of Aglauros. The word is derived from πλυνειν, *lavare*, becauſe during the ſolemnity they undreſſed the ſtatue of the goddeſs and waſhed it. The day on which it was obſerved was looked upon as unfortunate and inauſpicious, and therefore no perſon was permitted to appear in the temples, as they were purpoſely ſurrounded with ropes. The arrival of Alcibiades in Athens that day was thought very unfortunate, but the ſucceſs that ever after attended him proved it to be otherwiſe. It was cuſtomary at this feſtival to bear in proceſſion a cluſter of figs, which intimated the progreſs of civilization among the firſt inhabitants of the earth, as figs ſerved them for food after they had found a diſlike for acorns.

PNEUMATICS.

THIS term is reſtricted, in the preſent habits of our language, to that part of natural philoſophy which treats of the mechanical properties of elaſtic fluids. The word, in its original meaning, expreſſes a quality of air, or more properly of breath. Under the article Physics we obſerved, that in a great number of languages the term uſed to expreſs breath was alſo one of the terms uſed to expreſs the animating principle, nay, the intellectual ſubſtance, the ſoul. It has been perhaps owing to ſome attention to this chance of confuſion that our philoſophers have appropriated the term Pneumatics to the ſcience of the mechanical properties of air, and Pneumatology to the ſcience of the intellectual phenomena conſequent on the operations or affections of our thinking principle.

We have extended (on the authority of preſent cuſtom) the term Pneumatics to the ſtudy of the mechanical properties of all elaſtic or ſenſibly compreſſible fluids, that is, of fluids whoſe elaſticity and compreſſibility become an intereſting object of our attention; as the term Hydrostatics is applied to the ſtudy of the mechanical properties of ſuch bodies as intereſt us by their fluidity or liquidity only, or whoſe elaſticity and compreſſibility are not familiar or intereſting, though not leſs real or general than in the caſe of air and all vapours.

We may be indulged in the obſervation, by the by, that there is no preciſe limit to the different claſſes of natural bodies with reſpect to their mechanical properties. There is no ſuch thing as a body perfectly hard, perfectly ſoft, perfectly elaſtic, or perfectly incompreſſible. All bodies have ſome degree of elaſticity intermixed with ſome degree of ductility. Water, mercury, oil, are compreſſible; but their compreſſibility need not be attended to in order perfectly to underſtand the phenomena conſequent on their materiality, fluidity, and gravity. But if we neglect the compreſſibility of air, we remain ignorant of the cauſe and nature of its moſt intereſting phenomena, and but imperfectly informed with reſpect to thoſe in which its elaſticity has no ſhare; and it is convenient to attend to this diſtinction in our reſearches, in order to underſtand thoſe phenomena which depend ſolely or chiefly on compreſſibility and elaſticity. This obſervation is important; for here elaſticity appears in its moſt ſimple form, unaccompanied with any other mechanical affection of matter (if we except gravity), and lies moſt open to our obſervation, whether employed for inveſtigating the nature of this very property of bodies, or for explaining its mode of action. We ſhall even find that the conſtitution of an avowedly elaſtic fluid, whoſe compreſſibility is ſo very ſenſible, will give us the diſtincteſt notions of fluidity in general, and enable us to underſtand its *characteriſtic appearances*, by which it is diſtinguiſhed from ſolidity, namely, the *equable* diſtribution of preſſure through all its parts in every direction, and the horizontality which its ſurface aſſumes by the action of gravity; phenomena which have been aſſumed as equivalent to the definition of a perfect fluid, and from which all the laws of hydroſtatics and hydraulics have been derived. And theſe laws have been applied to the explanation of the phenomena around us; and water, mercury, oil, &c. have been denominated fluid only becauſe their appearances have been found to tally exactly with theſe conſequences of this definition, while the definition itſelf remains in the form of an aſſumption, unſupported by any other proof of its obtaining in nature. A real mechanical philoſopher will therefore attach himſelf with great eagerneſs to this property, and conſider it as an introduction to much natural ſcience.

Of all the ſenſibly compreſſible fluids air is the moſt familiar, was the firſt ſtudied, and the moſt minutely examined. It has therefore been generally taken as the example of their mechanical properties, while thoſe mechanical properties which are peculiar to any of them, and therefore characteriſtic, have uſually been treated as an appendix to the general ſcience of pneumatics. No objection occurs to us againſt this method, which will therefore be adopted in treating this article.

But although the mechanical properties are the proper ſubjects of our conſideration, it will be impoſſible to avoid conſidering occaſionally properties which are more of a chemical nature; becauſe they occaſion ſuch modifications of the mechanical properties as would frequently be unintelligible without conſidering them in conjunction with the other; and, on the other hand, the mechanical properties produce ſuch modifications of the properties merely chemical, and of very intereſting phenomena conſequent on them, that theſe would often paſs unexplained unleſs we give an account of them in this place.

By *mechanical properties* we would be underſtood to mean ſuch as produce, or are connected with, ſenſible changes of motion, and which indicate the preſence and agency of moving or mechanical powers. They are therefore the ſubject of mathematical diſcuſſion; admitting of meaſure, number, and direction, notions purely mathematical. We ſhall therefore begin with the conſideration of air.

It is by no means an idle queſtion, "*What is this* air of which ſo much is ſaid and written?" We ſee nothing, we feel nothing. We find ourſelves at liberty to move about in any direction without any let or hindrance. Whence, then, the aſſertion, that we are ſurrounded with a *matter* called air? A few very ſimple obſervations and experiments will ſhow us that this aſſertion is well founded.

We are accuſtomed to ſay, that a veſſel is empty when we have poured out of it the water which it contained. Take a cylindrical glaſs jar (pl. 7. fig. 1.), having a ſmall hole in its bottom; and having ſtopped this hole, fill the jar with water, and then pour out the water, leaving the glaſs empty, in the common acceptation of the word. Now throw a bit of cork, or any light body, on the ſurface of water in a ciſtern: cover this with the glaſs jar held in the hand with its bottom upwards, and move it downwards, keeping it all the while in an upright poſition. The cork will continue to float on the ſurface of the water in the inſide of the glaſs, and will moſt diſtinctly ſhow whereabouts that ſurface is. It will thus be ſeen, that the water within the glaſs has its ſurface conſiderably lower than that of the ſurrounding water; and however deep we immerge the glaſs, we ſhall find that the water will never riſe in the inſide of it ſo as to fill it. If plunged to the depth of 32 feet, the water will only half fill it; and yet the acknowledged laws of hydroſtatics tell us, that the water would fill the glaſs if there were nothing to hinder it. There is therefore ſomething already within the glaſs which prevents the water from getting into it; manifeſting in this manner the moſt diſtinctive property of matter, viz. the hindering other matter from occupying the ſame place at the ſame time.

While things are in this condition, pull the ſtopper out of the hole in the bottom of the jar, and the water will inſtantly riſe in the inſide of the jar, and ſtand at an equal height within and without. This is juſtly aſcribed to the eſcape through the hole of the *matter* which formerly obſtructed the entry of the water; for, if the hand be held before the hole, a puff will be diſtinctly felt, or a feather held there will be blown aſide; indicating in this manner, that what prevented the entry of the water, and now eſcapes, poſſeſſes another characteriſtic property of matter, *impulſive force*. The materiality is concluded from this appearance in the ſame manner that the materiality of water is concluded from the impulſe of a jet from a pipe. We alſo ſee the mobility of the formerly pent up, and now liberated, ſubſtance, in conſequence of external preſſure, viz. the preſſure of the ſurrounding water.

Alſo, if we take a ſmooth cylindrical tube, ſhut at one end, and fit a plug or cork to its open end, ſo as to ſlide along it, but ſo tightly as to prevent all paſſage by its ſides; and if the plug be well ſoaked in greaſe, we ſhall find that no force whatever can puſh it to the bottom of the tube. There is therefore *ſomething* within the tube preventing by its impenetrability the entry of the plug, and therefore poſſeſſing this characteriſtic of matter.

In like manner, if, after having opened a pair of common bellows, we ſhut up the nozzle and valve hole, and try to bring the boards together, we find it impoſſible. There is ſomething included which prevents this, in the ſame manner as if the bellows were filled with wool; but on opening the nozzle we can eaſily ſhut them, viz. by expelling this ſomething; and if the compreſſion is forcible, the ſomething will iſſue with conſiderable force, and very ſenſibly impel any thing in its way.

It is not accurate to ſay, that we move about without *any* obſtruction; for we find, that if we endeavour to move a large fan with rapidity, a very ſenſible hindrance is perceived, and that a very ſenſible force muſt be exerted; and a ſenſible wind is produced, which will agitate the neighbouring bodies. It is therefore juſtly concluded that the motion is poſſible only in conſequence of having driven this obſtructing ſubſtance out of the way; and that this impenetrable, reſiſting, moveable, impelling ſubſtance is *matter*. We perceive the perſeverance of this matter in its ſtate of reſt when we wave a fan, in the ſame manner that we perceive the *inertia* of water when we move a paddle through it. The effects of wind in impelling our ſhips and mills, in tearing up trees, and overturning buildings, are equal indications of its perſeverance in a ſtate of motion.

To this matter, when at reſt, we give the name Air; and when it is in motion we call it Wind.

Air, therefore, is a material fluid; a fluid, becauſe its parts are eaſily moved, and yield to the ſmalleſt inequality of preſſure.

Air poſſeſſes ſome others of the very general, though not eſſential, properties of matter. It is heavy. This appears from the following facts:

1. It always accompanies this globe in its orbit round the ſun, ſurrounding it to a certain diſtance, under the name of the Atmosphere, which indicates the being connected with the earth by its general force of gravity. It is chiefly in conſequence of this that it is continually moving round the earth from eaſt to weſt, forming what is called the trade-wind, to be more particularly conſidered afterwards. All that is to be obſerved on this ſubject at preſent is, that, in conſequence of the diſturbing force of the ſun and moon, there is an accumulation of the air of the atmoſphere, in the ſame manner as of the waters of the ocean, in thoſe parts of the globe which have the moon near their zenith or nadir: and as this happens ſucceſſively, going from the eaſt to the weſt (by the rotation of the earth round its axis in the oppoſite direction), the accumulated air muſt gradually flow along to form the elevation. This is chiefly to be obſerved in the torrid zone; and the generality and regularity of this motion are greatly diſturbed by the changes which are continually taking place in different parts of the atmoſphere from cauſes which are not mechanical.

2. It is in like manner owing to the gravity of the air that it ſupports the clouds and vapours which we ſee conſtantly floating in it. We have even ſeen bodies of no inconſiderable weight float, and even riſe, in the air. Soap bubbles and balloons filled with inflammable gas riſe and float in the ſame manner as a cork riſes in water. This phenomenon proves the weight of the air in the ſame manner that the ſwimming of a piece of wood indicates the weight of the water which ſupports it.

3. But we are not left to theſe refined obſervations for the proof of the air's gravity. We may obſerve familiar phenomena, which would be immediate conſequences of the ſuppoſition that air is a heavy fluid, and, like other heavy fluids, preſſes on the outſides of all bodies immerſed in or ſurrounded by it. Thus, for inſtance, if we ſhut the nozzle and valve hole of a pair of bellows, after having ſqueezed the air out of them, we ſhall find that a very great force, even ſome hundred pounds, is neceſſary for ſeparating the boards. They are kept together by the preſſure of the heavy air which ſurrounds them, in the ſame manner as if they were immerſed in water. In like manner, if we ſtop the end of a ſyringe after its piſton has been preſſed down to the bottom, and then attempt to draw up the piſton, we ſhall find a conſiderable force neceſſary, viz. about 15 or 16 pounds for every ſquare inch of the ſection of the ſyringe. Exerting this force, we can draw up the piſton to the top, and we can hold it there: but the moment we ceaſe acting, the piſton ruſhes down and ſtrikes the bottom. It is called a ſuction, as we feel ſomething as it were drawing in the piſton; but it is really the weight of the incumbent air preſſing it in. And this obtains in every poſition of the ſyringe; becauſe the air is a fluid, and preſſes in every direction. Nay, it preſſes on the ſyringe as well as on the piſton; and if the piſton be hung by its ring on a nail, the ſyringe requires force to draw it down (juſt as much as to draw the piſton up); and if it be let go, it will ſpring up, unleſs loaded with at leaſt 15 pounds for every ſquare inch of its tranſverſe ſection. See pl. 7. fig. 2.

4. But the moſt direct proof of the weight of the air is had by weighing a veſſel empty of air, and then weighing it again when the air has been admitted: and this, as it is the moſt obvious conſequence of its weight, has been aſſerted as long ago as the days of Ariſtotle. He ſays (*ϖερί ὀυρανον*, iv. 4.), That all bodies are heavy in their place except fire: even air is heavy; for a blown bladder is heavier than when it is empty. It is ſomewhat ſurpriſing that his followers ſhould have gone into the oppoſite opinion, while profeſſing to maintain the doctrine of their leader. If we take a very large and limber bladder, and ſqueeze out the air very carefully, and weigh it, and then fill it till the wrinkles juſt begin to diſappear, and weigh it again, we ſhall find no difference in the weight. But this is not Ariſtotle's meaning; becauſe the bladder, conſidered as a veſſel, is equally full in both caſes, its dimenſions being changed. We cannot take the air out of a bladder without its immediately collapſing. But what would be true of a bladder would be equally true of any veſſel. Therefore, take a round veſſel A (fig. 3.), fitted with a ſtopcock B, and ſyringe C. Fill the whole with water, and preſs the piſton to the bottom of the ſyringe. Then keeping the cock open, and holding the veſſel upright, with the ſyringe undermoſt, draw down the piſton. The water will follow it by its weight, and leave part of the veſſel empty. Now ſhut the cock, and again puſh up the piſton to the bottom of the ſyringe; the water eſcapes through the piſton valve, as will be explained afterward: then opening the cock, and again drawing down the piſton; more water will come out of the veſſel. Repeat this operation till all the water have come out. Shut the cock, unſcrew the ſyringe, and weigh the veſſel very accurately. Now open the cock, and admit the air, and weigh the veſſel again, it will be found heavier than before, and this additional weight is the weight of the air which fills it; and it will be found to be 523 grains, about an ounce and a fifth avoirdupoiſe, for every cubic foot that the veſſel contains. Now ſince a cubic foot of water would weigh 1000 ounces, this experiment would ſhow that water is about 840 times heavier than air. The moſt accurate judgment of this kind of which we have met with an account is that recorded by Sir George Shuckburgh, which is in the 67th vol. of the Philoſophical Tranſactions, p. 560. From this it follows, that when the air is of the temperature 53, and the barometer ſtands at 29$\frac{1}{4}$ inches, the air is 836 times lighter than water. But the experiment is not ſuſceptible of ſufficient accuracy for determining the exact weight of a cubic foot of air. Its weight is very ſmall: and the veſſel muſt be ſtrong and heavy, ſo as to overload any balance that is ſufficiently nice for the experiment.

To avoid this inconvenience, the whole may be weighed in water, firſt loading the veſſel ſo as to make it preponderate an ounce or two in the water. By this means the balance will be loaded only with this ſmall preponderancy. But even in this caſe there are conſiderable ſources of error ariſing from changes in the ſpecific gravity of the water and other cauſes. The experiment has been often repeated with this view, and the air has been found at a medium to be about 840 times as light as water, but with great variations, as may be expected from its very heterogeneous nature, in conſequence of its being the menſtruum of almoſt every fluid, of all vapours, and even of moſt ſolid bodies; all which it holds in ſolution, forming a fluid perfectly tranſparent, and of very different denſity according to its compoſition. It is found, for inſtance, that perfectly pure air, of the temperature of our ordinary ſummer, is conſiderably denſer than when it has diſſolved about half as much water as it can hold in that temperature; and that with this quantity of water the difference of denſity increaſes in proportion as the maſs grows warmer, for damp air is more expanſible by heat than dry air. We ſhall have occaſion to conſider this ſubject again, when we treat of the connexion of the mechanical properties of air with the ſtate of the weather. See WEATHER.

Such is the reſult of the experiment ſuggeſted by Ariſtotle, evidently proving the weight of the air; and yet, as has been obſerved, the Peripatetics, who profeſs to follow the *dictates* of Ariſtotle, uniformly refuſed it this property. It was a matter long debated among the philoſophers of the laſt century. The reaſon was, that Ariſtotle, with that indiſtinctneſs and inconſiſtency which is obſerved in all his writings which relate to matters of fact and experience, aſſigns a different cauſe to many phenomena which any man led by common obſervation would aſcribe to the weight of the air. Of this kind is the riſe of water in pumps and ſyphons, which all the Peripatetics had for ages aſcribed to ſomething which they called *nature's abhorrence of a void*. Ariſtotle had aſſerted (for reaſons not our buſineſs to adduce at preſent), that all nature was full of being, and that nature abhorred a void. He adduces many facts, in which it appears, that, if not abſolutely impoſſible, it is very difficult, and requires great force, to produce a ſpace void of matter. When the operation of pumps and ſyphons came to be known, the philoſophers of Europe (who had all embraced the Peripatetic doctrines) found in this fancied horror of a fancied mind (what elſe is this that nature abhors?) a ready ſolution of the phenomena. We ſhall ſtate the facts, that every reader may ſee what kinds of reaſoning were received among the learned not two centuries ago.

Pumps were then conſtructed in the following manner: A long pipe GB (fig. 4.) was ſet in the water of the well A. This was fitted with a ſucker or piſton C, having a long rod CF, and was furniſhed with a valve B at the bottom, and a lateral pipe DE at the place of delivery, alſo furniſhed with a valve. The fact is, that if the piſton be thruſt down to the bottom, and then drawn up, the water will follow it; and upon the piſton being again puſhed down, the water ſhuts the valve B by its weight, and eſcapes or is expelled at the valve E; and on drawing up the piſton again the valve E is ſhut, the water again riſes after the piſton, and is again expelled at its next deſcent.

The Peripatetics explain all this by ſaying, that if the water did *not follow the piſton* there would be a void between them. But nature abhors a void; or a void is impoſſible: therefore the water follows the piſton. It is not worth while to criticiſe the wretched reaſoning in this pretence to explanation. It is all overturned by one obſervation. Suppoſe the pipe ſhut at the bottom, the piſton *can* be drawn up, and thus a void produced. No, ſay the Peripatetics; and they ſpeak of certain ſpirits, effluvia, &c. which occupy the place. But if ſo, why needs the water riſe? This therefore is not the cauſe of its aſcent. It is a curious and important phenomenon.

The ſagacious Galileo ſeems to have been the firſt who ſeriouſly aſcribed this to the weight of the air. Many before him had ſuppoſed air heavy; and thus explained the difficulty of raiſing the board of bellows, or the piſton of a ſyringe, &c. But he diſtinctly applies to this allowed weight of the air all the conſequences of hydroſtatical laws; and he reaſons as follows:

The heavy air reſts on the water in the ciſtern, and preſſes it with its weight. It does the ſame with the water in the pipe, and therefore both are on a level: but if the piſton, after being in contact with the ſurface of the water, be drawn up, there is no longer any preſſure on the ſurface of the water within the pipe; for the air now reſts on the piſton only, and thus occaſions a difficulty in drawing it up. The water in the pipe, therefore, is in the ſame ſituation as if more water were poured into the ciſtern, that is, as much as would exert the ſame preſſure on its ſurface as the air does. In this caſe we are certain that the water will be preſſed into the pipe, and will raiſe up the water already in it, and follow it till it is equally high within and without. The ſame preſſure of the air ſhuts the valve E during the deſcent of the piſton. (See *Gal. Diſcourſes.*)

He did not wait for the very obvious objection, that if the riſe of the water was the effect of the air's preſſure, it would alſo be its meaſure, and would be raiſed and ſupported only to a certain height. He directly ſaid ſo, and adduced this as a deciſive experiment. If the horror of a void be the cauſe, ſays he, the water muſt riſe to any height however great; but if it be owing to the preſſure of the air, it will only riſe till the weight of the water in the pipe is in equilibrio with the preſſure of the air, according to the common laws of hydroſtatics. And he adds, that this is well known; for it is a fact, that pumps will not *draw* water much above forty palms, although they may be made to *propel* it, or to *lift it* to any height. He then makes an aſſertion, which, if true, will be deciſive. Let a very long pipe, ſhut at one end, be filled with water, and let it be erected perpendicularly with the cloſe end uppermoſt, and a ſtopper in the other end, and then its lower orifice immerſed into a veſſel of water; the water will ſubſide in the pipe upon removing the ſtopper, till the remaining column is in equilibrio with the preſſure of the external air. This experiment he propoſes to the curious; ſaying, however, that he thought it unneceſſary, there being already ſuch abundant proofs of the air's preſſure.

It is probable that the cumberſomeneſs of the neceſſary apparatus protracted the making of this experiment. Another equally concluſive, and much eaſier, was made in 1642 after Galileo's death, by his zealous and learned diſciple Torricelli. He filled a glaſs tube, cloſe at one end, with mercury; judging, that if the ſupport of the water was owing to the preſſure of the air, and was the meaſure of this preſſure, mercury would in like manner be ſupported by it, and this at a height which was alſo the meaſure of the air's preſſure, and therefore 13 times leſs than water. He had the pleaſure of ſeeing his expectation verified in the completeſt manner; the mercury deſcending in the tube AB (pl. 7. fig. 5.), and finally ſettling at the height *f* B of 29¾ Roman inches: and he found, that when the tube was inclined, the point *f* was in the ſame horizontal plane with *f* in the upright tube, according to the received laws of hydroſtatical preſſure. The experiment was often repeated, and ſoon became famous, exciting great controverſies among the philoſophers about the poſſibility of a vacuum. About three years afterwards the ſame experiment was publiſhed, at Warſaw in Poland, by Valerianus Magnus, as his own ſuggeſtion and diſcovery; but it appears plain, from the letters of Roberval, not only that Torricelli was prior, and that his experiment was the general topic of diſcuſſion among the curious, but alſo highly probable that Valerianus Magnus was informed of it when at Rome, and daily converſant with thoſe who had ſeen it. He denies, however, even having heard of the name of Torricelli.

This was the era of philoſophical ardour; and we think that it was Galileo's invention and immediate application of the teleſcope which gave it vigour. Diſcoveries of the moſt wonderful kind in the heavens, and which required no extent of previous knowledge to underſtand them, were thus put into the hands of every perſon who could purchaſe a ſpy-glaſs; while the high degree of credibility which ſome of the diſcoveries, ſuch as the phaſes of Venus and the rotation and ſatellites of Jupiter, gave to the Copernican ſyſtem, immediately ſet the whole body of the learned in motion. Galileo joined to his ardour a great extent of learning, particularly of mathematical knowledge and ſound logic, and was even the firſt who formally united mathematics with phyſics; and his treatiſe on accelerated motion was the firſt, and a precious fruit of this union. About the years 1642 and 1644, we find clubs of gentlemen aſſociated in Oxford and London for the cultivation of knowledge by experiment; and before 1655 all the doctrines of hydroſtatics and pneumatics were familiar there, eſtabliſhed upon experiment. Mr. Boyle procured a coalition and correſpondence of theſe clubs under the name of the Inviſible and Philoſophical Society. In May 1658 Mr. Hooke finiſhed for Mr. Boyle an air-pump, which had employed him a long time, and occaſioned him ſeveral journeys to London for things which the workmen of Oxford could not execute. He ſpeaks of this as a great improvement on Mr. Boyle's own pump, which he had been uſing ſome time before. Boyle therefore muſt have invented his air-pump, and was not indebted for it to Schottus's account of Otto Guerick's, publiſhed in his (Schottus) *Mechanica Hydraulo-pneumatica* in 1657, as he aſſerts *(Techna Curioſa)*. The Royal Society of London aroſe in 1656 from the coalition of theſe clubs, after 15 years co-operation and correſpondence. The Montmorine Society at Paris had ſubſiſted nearly about the ſame time; for we find Paſcal in 1648 ſpeaking of the meetings in the Sorbonne College, from which we know that ſociety originated.—Nuremberg, in Germany, was alſo a diſtinguiſhed ſeminary of experimental philoſophy. The magiſtrates, ſenſible of its valuable influence in manufactures, the ſource of the opulence and proſperity of their city, and many of them philoſophers, gave philoſophy a profeſſed and munificent patronage, furniſhing the philoſophers with a copious apparatus, a place of aſſembly, and a fund for the expence of their experiments; ſo that this was the firſt academy of ſciences out of Italy under the patronage of government. In Italy, indeed, there had long exiſted inſtitutions of this kind. Rome was the centre of church-government, and the reſort of all expectants for preferment. The clergy were the majority of the learned in all Chriſtian nations, and particularly of the ſyſtematic philoſophers. Each, eager to recommend himſelf to notice, brought forward every thing that was curious; and they were the willing vehicles of philoſophical communication. Thus the experiments of Galileo and Torricelli were rapidly diffuſed by perſons of rank, the dignitaries of the church, or by the monks their obſequious ſervants. Perhaps the recent defection of England, and the want of a reſiding embaſſy at Rome, made her ſometimes late in receiving or ſpreading philoſophical reſearches, and was the cauſe that ſo much more was done there *proprio Marte*.

We hope to be excuſed for this digreſſion. We were naturally led into it by the pretenſions of Valerianus Magnus to originality in the experiment of the mercury ſupported by the preſſure of the air. Such is the ſtrength of national attachment, that there were not wanting ſome who found that Torricelli had borrowed his experiment from Honoratus Fabri, who had propoſed and explained it in 1641; but whoever knows the writings of Torricelli, and Galileo's high opinion of him, will never think that he could need ſuch helps. (See this ſurmiſe of Mounier in *Schott. Tech. Cur.* III. at the end.)

Galileo muſt be conſidered as the author of the experiment when he propoſes it to be made. Valerianus Magnus owns himſelf indebted to him for the principle and the contrivance of the experiment. It is neither wonderful that many ingenious men, of one opinion, and inſtructed by Galileo, ſhould ſeparately hit on ſo obvious a thing; nor that Torricelli, his immediate diſciple, his enthuſiaſtic admirer, and who was in the habits of correſponding with him till his death in 1642, ſhould be the firſt to put it in practice. It became the ſubject of diſpute from the national arrogance and ſelf-conceit of ſome Frenchmen, who have always ſhown themſelves diſpoſed to conſider their nation as at the head of the republic of letters, and cannot brook the concurrence of any foreigners. Roberval was in this inſtance, however, the champion of Torricelli; but thoſe who know his controverſies with the mathematicians of France at this time will with little difficulty account for this exception.

All now agree in giving Torricelli the honour of the *firſt* invention; and it univerſally paſſes by the name of the TORRICELLIAN EXPERIMENT. The tube is called the TORRICELLIAN TUBE; and the ſpace left by the mercury is called the TORRICELLIAN VACUUM, to diſtinguiſh it from the BOYLEAN VACUUM, which is only an extreme rarefaction.

The experiment was repeated in various forms, and with apparatus which enabled philoſophers to examine ſeveral effects which the vacuum produced on bodies expoſed in it. This was done by making the upper part of the tube terminate in a veſſel of ſome capacity, or communicate with ſuch a veſſel, in which were included along with the mercury bodies on which the experiments were to be made. When the mercury had run out, the phenomena of theſe bodies were carefully obſerved.

An objection was made to the concluſion drawn from Torricelli's experiment, which appears formidable. If the Torricellian tube be ſuſpended on the arm of a balance, it is found that the counterpoiſe muſt be equal to the weight both of the tube and of the mercury it contains. This could not be, ſay the objectors, if the mercury were ſupported by the air. It is evidently ſupported by the balance; and this gave riſe to another notion of the cauſe different from the peripatetic *fuga vacui*: a ſuſpenſive force, or rather attraction, was aſſigned to the upper part of the tube.

But the true explanation of the phenomenon is moſt eaſy and ſatisfactory. Suppoſe the mercury in the ciſtern and tube to freeze, but without adhering to the tube, ſo that the tube could be freely drawn up and down. In this caſe the mercury is ſupported by the baſe, without any dependence on the preſſure of the air; and the tube is in the ſame condition as before, and the ſolid mercury performs the office of a piſton to this kind of ſyringe. Suppoſe the tube thruſt down till the top of it touches the top of the mercury. It is evident that it muſt be drawn up in oppoſition to the preſſure of the external air, and it is preciſely ſimilar to the ſyringe formerly mentioned. The weight ſuſtained therefore by this arm of the balance is the weight of the tube and the downward preſſure of the atmoſphere on its top.

The curioſity of philoſophers being thus excited by this very manageable experiment, it was natural now to try the original experiment propoſed by Galileo. Accordingly Berti in Italy, Paſcal in France, and many others in different places, made the experiment with a tube filled with water, wine, oil, &c. and all with the ſucceſs which might be expected in ſo ſimple a matter: and the doctrine of the weight and preſſure of the air was eſtabliſhed beyond contradiction or doubt. All was done before the year 1648.—A very beautiful experiment was exhibited by Auzout, which completely ſatisfied all who had any remaining doubts.

A ſmall box or phial EFGH (fig. 6.) had two glaſs tubes, AB, CD, three feet long, inſerted into it in ſuch a manner as to be firmly fixed in one end, and to reach nearly to the other end. AB was open at both ends, and CD was cloſe at D. This apparatus was completely filled with mercury, by unſcrewing the tube AB, filling the box, and the hole CD; then ſcrewing in the tube AB, and filling it: then holding a finger on the orifice A, the whole was inverted and ſet upright in the poſition repreſented in figure β, immerſing the orifice A (now *a*) in a ſmall veſſel of quickſilver. The reſult was, that the mercury ran out at the orifice *a*, till its ſurface *m n* within the phial deſcended to the top of the tube *b a*. The mercury alſo began to deſcend in the tube *d c* (formerly DC) and run over into the tube *b a*, and ran out at *a*, till the mercury in *d c* was very near equal in a level with *m n*. The mercury deſcending in *b a* till it ſtood at *k*, $29\frac{1}{2}$ inches above the ſurface *o p* of the mercury in the ciſtern, juſt as in the Torricellian tube.

The rationale of this experiment is very eaſy. The whole apparatus may firſt be conſidered as a Torricellian tube of an uncommon ſhape, and the mercury would flow out at *a*. But as ſoon as a drop of mercury comes out, leaving a ſpace above *mn*, there is nothing to keep up the mercury in the tube *dc*. Its mercury therefore deſcends alſo; and running over into *b a*, continues to ſupply its expenſe till the tube *dc* is almoſt empty, or can no longer ſupply the waſte of *b a*. The inner ſurface, therefore, falls as low as it can, till it is level with *b*. No more mercury can enter *b a*, yet its column is too heavy to be ſupported by the preſſure of the air on the mercury in the ciſtern below; it therefore deſcends in *b a*, and finally ſettles at the height *k o*, equal to that of the mercury in the Torricellian tube.

The prettieſt circumſtance of the experiment remains. Make a ſmall hole *g* in the upper cap of the box. The external air immediately ruſhes in by its weight, and now preſſes on the mercury in the box. This immediately raiſes the mercury in the tube *dc* to *l*, $29\frac{1}{2}$ inches above *m n*. It preſſes on the mercury at *k* in the tube *b a*, balancing the preſſure of the air in the ciſtern. The mercury in the tube therefore is left to the influence of its own weight, and it deſcends to the bottom. Nothing can be more appoſite or deciſive.

And thus the doctrine of the gravity and preſſure of the air is eſtabliſhed by the moſt unexceptionable evidence: and we are entitled to aſſume it as a ſtatical principle, and to affirm *à priori* all its legitimate conſequences.

And in the firſt place, we obtain an exact meaſure of the preſſure of the atmoſphere. It is preciſely equal to the weight of the column of mercury, of water, of oil, &c. which it can ſupport; and the Torricellian tube, or others fitted up upon the ſame principle, are juſtly termed *baroſcopes* and *barometers* with reſpect to the air. Now it is obſerved that water is ſupported at the height of 32 feet nearly: The weight of the column is exactly 2000 avoirdupois pounds on every ſquare foot of baſe, or $13\frac{9}{10}$ on every ſquare inch. The ſame concluſion very nearly may be drawn from the column of mercury, which is nearly $29\frac{1}{2}$ inches high when in equilibrium with the preſſure of the air. We may here obſerve, that the meaſure taken from the height of a column of water, wine, ſpirits, and the other fluids of conſiderable volatility, as chemiſts term it, is not ſo exact as that taken from mercury, oil, and the like. For it is obſerved, that the volatile fluids are converted by the ordinary heat of our climates into vapour when the confining preſſure of the air is removed; and this vapour, by its elaſticity, exerts a ſmall preſſure on the ſurface of the water, &c. in the pipe, and thus counteracts a ſmall part of the external preſſure; and therefore the column ſupported by the remaining preſſure muſt be lighter, that is, ſhorter. Thus it is found, that rectified ſpirits will not ſtand much higher than is competent to a weight of 13 pounds on an inch, the elaſticity of its vapour balancing about $\frac{1}{15}$ of the preſſure of the air. We ſhall afterwards have occaſion to conſider this matter more particularly.

As the medium height of the mercury in the barometer is $29\frac{1}{2}$ inches, we ſee that the whole globe ſuſtains a preſſure equal to the whole weight of a body of mercury of this height; and that all bodies on its ſurface ſuſtain a part of this in proportion to their ſurfaces. An ordinary ſized man ſuſtains a preſſure of ſeveral thouſand pounds. How comes it then that we are not ſenſible of a preſſure which one ſhould think enough to cruſh us together? This has been conſidered as a ſtrong objection to the preſſure of the air; for, when a man is plunged a few feet under water, he is very ſenſible of the preſſure. The anſwer is by no means ſo eaſy as is commonly imagined. We feel very diſtinctly the effects of removing this preſſure from any part of the body. If any one will apply the open end of a ſyringe to his hand, and then draw up the piſton, he will find his hand ſucked into the ſyringe with great force, and it will give pain; and the ſoft part of the hand will ſwell into it, being preſſed in by the neighbouring parts, which are ſubject to the action of the external air. If one lays his hand on the top of a long perpendicular pipe, ſuch as a pump filled to the brim with water, which is at firſt prevented from running out by the valve below; and if the valve be then opened, ſo that the water deſcends, he will then find his hand ſo hard preſſed to the top of the pipe that he cannot draw it away. But why do we only feel the *inequality* of preſſure? There is a ſimilar inſtance wherein we do not feel it, although we cannot doubt of its exiſtence. When a man goes ſlowly to a great depth under water in a diving-bell, we know unqueſtionably that he is expoſed to a new and very great preſſure, yet he does not feel it. But thoſe facts are not ſufficiently familiar for general argument. The human body is a bundle of ſolids, hard or ſoft, filled or mixed with fluids, and there are few or no parts of it which are empty. All communicate either by veſſels or pores; and the whole ſurface is a ſieve through which the inſenſible perſpiration is performed. The whole extended ſurface of the lungs is open to the preſſure of the atmoſphere; every thing is therefore in equilibrio: and if free or ſpeedy acceſs be given to every part, the body will not be damaged by the preſſure, however great, any more than a wet ſponge would be deranged by plunging it any depth in water. The preſſure is inſtantaneouſly diffuſed by means of the incompreſſible fluids with which the parts are filled; and if any parts are filled with air or other compreſſible fluids, theſe are compreſſed till their elaſticity again balances the preſſure. Beſides, all our fluids are acquired ſlowly, and gradually mixed with that proportion of air which they can diſſolve or contain. The whole animal has grown up in this manner from the firſt vital atom of the embryo. For ſuch reaſons the preſſure can occaſion no change of ſhape by ſqueezing together the flexible parts; nor any obſtruction by compreſſing the veſſels or pores. We cannot ſay what would be felt by a man, were it poſſible that he could have been produced and grown up *in vacuo*, and then ſubjected to the compreſſion. We even know that any ſudden and conſiderable change of general preſſure is very ſeverely felt. Perſons in a diving-bell have been almoſt killed by letting them down or drawing them up too ſuddenly. In drawing up, the elaſtic matters within have ſuddenly ſwelled, and not finding an immediate eſcape have burſt the veſſels. Dr. Halley experienced this, the blood guſhing out from his ears by the expanſion of air contained in the internal cavities of this organ, from which there are but very ſlender paſſages.

A very important obſervation recurs here: the preſſure of the atmoſphere is variable. This was obſerved almoſt as ſoon as philoſophers began to attend to the barometer. Paſcal obſerved it in France, and Deſcartes obſerved it in Sweden in 1650. Mr. Boyle and others obſerved it in England in 1656. And before this, obſervers, who took notice of the concomitancy of theſe changes of aerial preſſure with the ſtate of the atmoſphere, remarked, that it was generally greateſt in winter and in the night; and certainly moſt variable during winter and in the northern regions. Familiar now with the weight of the air, and conſidering it as the vehicle of the clouds and vapours, they noted with care the connection between the weather and the preſſure of the air, and found that a great preſſure of the air was generally accompanied with fair weather, and a diminution of it with rain and miſts. Hence the barometer came to be conſidered as an index not only of the preſent ſtate of the air's weight, but alſo as indicating by its variations changes of weather. It became a WEATHER-GLASS, and continued to be anxiouſly obſerved with this view. This is an important ſubject, and will afterwards be treated in ſome detail.

In the next place, we may conclude that the preſſure of the air will be different in different places, according to their elevation above the ſurface of the ocean: for, if air be a heavy fluid, it muſt preſs in ſome proportion according to its perpendicular height. If it be a homogeneous fluid of equal denſity and weight in all its parts, the mercury in the ciſtern of a barometer muſt be preſſed preciſely in proportion to the depth to which that ciſtern is immerſed in it; and as this preſſure is exactly meaſured by the height of the mercury in the tube, the height of the mercury in the Torricellian tube muſt be exactly proportional to the depth of the place of obſervation under the ſurface of the atmoſphere.

The celebrated Deſcartes firſt entertained this thought (Epiſt. 67. of Pr. III.), and ſoon after him Paſcal. His occupation in Paris not permitting him to try the juſtneſs of his conjecture, he requeſted Mr. Perrier, a gentleman of Clermont in Auvergne, to make the experiment, by obſerving the height of the mercury at one and the ſame time at Clermont and on the top of a very high mountain in the neighbourhood. His letters to Mr. Perrier in 1647 are ſtill extant. Accordingly Mr. Perrier, in September 1648, filled two equal tubes with mercury, and obſerved the heights of both to be the ſame, viz. 26$\frac{7}{24}$ inches, in the garden of the convent of the Friars Minims, ſituated in the loweſt part of Clermont. Leaving one of them there, and one of the fathers to obſerve it, he took the other to the top of Puy de Domme, which was elevated nearly 500 French fathoms above the garden. He found its height to be 23$\frac{2}{24}$ inches. On his return to the town, in a place called *Font de l'Arbre*, 150 fathoms above the garden, he found it 25 inches; when he returned to the garden it was again 26$\frac{7}{24}$, and the perſon ſet to watch the tube which had been left ſaid that it had not varied the whole day. Thus a difference of elevation of 3000 French feet had occaſioned a depreſſion of 3$\frac{1}{8}$ inches; from which it may be concluded, that 3$\frac{1}{8}$ inches of mercury weighs as much as 3000 feet of air, and one-tenth of an inch of mercury as much as 96 feet of air. The next day he found, that taking the tube to the top of a ſteeple 120 feet high made a fall of one-ſixth of an inch. This gives 72 feet of air for one-tenth of an inch of mercury; but ill agreeing with the former experiment. But it is to be obſerved, that a very ſmall error of obſervation of the barometer would correſpond to a great difference of elevation, and alſo that the height of the mountain had not been meaſured with any preciſion. This has been ſince done (Mem. Acad. Par. 1703), and found to be 529 French toiſes.

Paſcal publiſhed an account of this great experiment (*Grande Exp. ſur la Peſanteur de l'Air*), and it was quickly repeated in many places of the world. In 1653 it was repeated in England by Dr. Power (Power's Exper. Phil.); and in Scotland, in 1661, by Mr. Sinclair, profeſſor of philoſophy in the univerſity of Glaſgow, who obſerved the barometer at Lanark, on the top of mount Tintock in Clydſdale, and on the top of Arthur's Seat at Edinburgh. He found a depreſſion of two inches between Glaſgow and the top of Tintock, three quarters of an inch between the bottom and top of Arthur's Seat, and $\frac{5}{32}$ of an inch at the cathedral of Glaſgow on a height of 126 feet. See Sinclair's *Ars Nova et Magna Gravitatis et Levitatis*; *Sturmii Collegium Experimentale*, and *Schotti Technica Curioſa*.

Hence we may derive a method of meaſuring the heights of mountains. Having aſcertained with great preciſion the elevation correſponding to a fall of one-tenth of an inch of mercury, which is nearly 90 feet, we have only to obſerve the length of the mercurial column at the top and bottom of the mountain, and to allow 90 feet for every tenth of an inch. Accordingly this method has been practiſed with great ſucceſs: but it requires an attention to many things not yet conſidered; ſuch as the change of denſity of the mercury by heat and cold; the changes of denſity of air, which are much more remarkable from the ſame cauſes; and above all, the changes of the denſity of air from its compreſſibility; a change immediately connected with or dependent on the very elevation we wiſh to meaſure. Of all theſe afterwards.

Theſe obſervations give us the moſt accurate meaſure of the denſity of the air and its ſpecific gravity. This is but vaguely though directly meaſured by weighing air in a bladder or veſſel. The weight of a manageable quantity is ſo ſmall, that a balance ſufficiently tickliſh to indicate even very ſenſible fractions of it is overloaded by the weight of the veſſel which contains it, and ceaſes to be exact: and when we take Bernoulli's ingenious method of ſuſpending it in water, we expoſe ourſelves to great riſk of error by the variation of the water's denſity. Alſo it muſt neceſſarily be humid air which we can examine in this way: but the proportion of an elevation in the atmoſphere to the depreſſion of the column of mercury or other fluid, by which we meaſure its preſſure, gives us at once the proportion of this weight, or their ſpecific gravity. Thus, ſince it is found that in ſuch a ſtate of preſſure that the barometer ſtands at 30 inches, and the thermometer at 32°, 87 feet of riſe produces one-tenth of an inch of fall in the barometer, the air and the mercury being both of the freezing temperature, we muſt conclude that mercury is 10,440 times heavier or denſer than air. Then, by comparing mercury and water, we get $\frac{1}{801}$ nearly for the denſity of air relative to water: but this varies ſo much by heat and moiſture, that it is uſeleſs to retain any thing more than a general notion of it; nor is it eaſy to determine whether this method or that by actual weighing is preferable. It is extremely difficult to obſerve the height of the mercury in the barometer nearer than $\frac{1}{200}$ of an inch; and this will produce a difference of even five feet, or $\frac{1}{26}$ of the whole. Perhaps this is a greater proportion than the error in weighing.

From the ſame experiments we alſo derive ſome knowledge of the height of the aerial covering which ſurrounds our globe. When we raiſe our barometer 87 feet above the ſurface of the ſea, the mercury falls about one-tenth of an inch in the barometer: therefore, if the barometer ſhows 30 inches at the ſea-ſhore, we may expect that by raiſing it 300 times 87 feet, or 5 miles, the mercury in the tube will deſcend to the level of the ciſtern, and that this is the height of our atmoſphere. But other appearances lead us to ſuppoſe a much greater height. Meteors are ſeen with us much higher than this, and which yet give undoubted indication of being ſupported by our air. There can be little doubt, too, that the viſibility of the expanſe above us is owing to the reflection of the ſun's light by our air. Were the heavenly ſpaces perfectly tranſparent, we ſhould no more ſee them than the pureſt water through which we ſee other objects; and we ſee *them* as we ſee water tinged with milk or other fæculæ. Now it is eaſy to ſhow, that the light which gives us what is called twilight muſt be reflected from the height of at leaſt 50 miles; for we have it when the ſun is depreſſed 18 degrees below our horizon.

A little attention to the conſtitution of our air will convince us, that the atmoſphere muſt extend to a much greater height than 300 times 87 feet. We ſee from the moſt familiar facts, that it is compreſſible: we can ſqueeze it in an ox-bladder. It is alſo heavy; preſſing on the air in this bladder with a very great force, not leſs than 1500 pounds. We muſt therefore conſider it as in a ſtate of compreſſion, exiſting in ſmaller room than it would aſſume if it were not compreſſed by the incumbent air. It muſt therefore be in a condition ſomething reſembling that of a quantity of fine carded wool thrown looſely into a deep pit; the lower ſtrata carrying the weight of the upper ſtrata, and being compreſſed by them; and ſo much the more compreſſed as they are further down, and only the upper ſtratum in its unconſtrained and moſt expanded ſtate. If we ſhall ſuppoſe this wool thrown in by a hundred weight at a time, it will be divided into ſtrata of equal weights, but of unequal thickneſs; the loweſt being the thinneſt, and the ſuperior ſtrata gradually increaſing in thickneſs. Now, ſuppoſe the pit filled with air, and reaching to the top of the atmoſphere, the *weight* of all the ſtrata above any horizontal plane in it is meaſured by the height of the mercury in the Torricellian tube placed in that plane; and one-tenth of an inch of mercury is juſt equal to the weight of the loweſt ſtratum 87 feet thick; for, on raiſing the tube 87 feet from the ſea, the ſurface of the mercury will deſcend one-tenth of an inch. Raiſe the tube till the mercury fall another tenth: This ſtratum muſt be more than 87 feet thick; how much more we cannot tell, being ignorant of the law of the air's expanſion. In order to make it fall a third tenth, we muſt raiſe it through a ſtratum ſtill thicker; and ſo on continually.

All this is abundantly confirmed by the very firſt experiment made by the order and directions of Paſcal: For, by carrying the tube from the garden of the convent to a place 150 fathoms higher, the mercury fell $1\frac{7}{24}$ inches, or 1,2917; which gives about 69 feet 8 inches of aerial ſtratum for $\frac{1}{10}$ of an inch of mercury; and by carrying it thence to a place 350 fathoms higher, the mercury fell $1\frac{22}{24}$, or 1,9167 inches, which gives 109 feet 7 inches for $\frac{1}{10}$ of an inch of mercury. Theſe experiments were not accurately made; for at that time the philoſophers, though zealous, were but *ſcholars* in the *ſcience* of experimenting, and *novices* in the art. But the reſults abundantly ſhow this general truth, and they are completely confirmed by thouſands of ſubſequent obſervations. It is evident from the whole tenor of them, that the ſtrata of air decreaſe in denſity as we aſcend through the atmoſphere; but it remained to be diſcovered what is the force of this decreaſe, that is, the law of the air's expanſion. Till this be done we can ſay nothing about the conſtitution of our atmoſphere: we cannot tell in what manner it is fitteſt for raiſing and ſupporting the exhalations and vapours which are continually ariſing from the inhabited regions; not as an excrementitious waſte, but to be ſupported, perhaps manufactured, in that vaſt laboratory of nature, and to be returned to us in beneficent ſhowers. We cannot uſe our knowledge for the curious, and frequently uſeful, purpoſe of meaſuring the heights of mountains and taking the levels of extenſive regions; in ſhort, without an accurate knowledge of this, we can hardly acquire any acquaintance with thoſe mechanical properties which diſtinguiſh air from thoſe liquids which circulate here below.

Having therefore conſidered at ſome length the leading conſequences of the air's fluidity and gravity, let us conſider its compreſſibility with the ſame care; and then, combining the agency of both, we ſhall anſwer all the purpoſes of philoſophy, diſcover the laws, explain the phenomena of nature, and improve art. We proceed therefore to conſider a little the phenomena which indicate and characteriſe this other property of the air. All fluids are elaſtic and compreſſible as well as air; but in them the compreſſibility makes no figure, or does not intereſt us while we are conſidering their preſſures, motions, and impulſions. But in air the compreſſibility and expanſion draw our chief attention, and make it a proper repreſentative of this claſs of fluids.

Nothing is more familiar than the compreſſibility of air. It is ſeen in a bladder filled with it, which we can forcibly ſqueeze into leſs room; it is ſeen in a ſyringe, of which we can puſh the plug further and further as we increaſe the preſſure.

But theſe appearances bring into view another, and the moſt intereſting, property of air, *viz.* its *elaſticity*. When we have ſqueezed the air in the bladder or ſyringe into leſs room, we find that the force with which we *compreſſed* it is neceſſary to *keep it in this bulk;* and that if we ceaſe to preſs it together, it will ſwell out and regain its natural dimenſions. This diſtinguiſhes it eſſentially from ſuch a body as a maſs of flour, ſalt, or ſuch like, which remain in the compreſſed ſtate to which we reduce them.

There is therefore ſomething which oppoſes the compreſſion different from the ſimple impenetrability of the air: there is ſomething that oppoſes mechanical force: there is ſomething too which produces motion, not only reſiſting compreſſion, but puſhing back the compreſſing body, and communicating motion to it. As an arrow is gradually accelerated by the bow-ſtring preſſing it forward, and at the moment of its diſcharge is brought to a ſtate of rapid motion; ſo the ball from a pop-gun or wind-gun is gradually accelerated along the barrel by the preſſure of the air during its expanſion from its compreſſed ſtate, and finally quits it with an accumulated velocity. Theſe two motions are indications perfectly ſimilar of the elaſticity of the bow and of the air.

Thus it appears that air is heavy and elaſtic. It needs little conſideration to convince us in a vague manner that it is fluid. The eaſe with which it is penetrated, and driven about in every direction, and the motion of it in pipes and channels, however crooked and intricate, entitle it to this character. But before we can proceed to deduce conſequences from its fluidity, and to offer them as a true account of what will happen in theſe circumſtances, it is neceſſary to exhibit ſome diſtinct and ſimple caſe, in which the characteriſtic mechanical property of a fluid is clearly and unequivocally obſerved in it. That property of fluids from which all the laws of hydroſtatics and hydraulics are derived with the ſtricteſt evidence is, that any preſſure applied to any part of them is propagated through the whole maſs in every direction; and that in conſequence of this diffuſion of preſſure, any two external forces can be put in equilibrio by the interpoſition of a fluid, in the ſame way as they can be put in equilibrio by the intervention of any mechanical engine.

Let a cloſe veſſel ABC (fig. 7.), of any form, have two upright pipes EDC, GFB, inſerted into any parts of its top, ſides, or bottom, and let water be poured into them, ſo as to ſtand in equilibrio with the horizontal ſurfaces at E, D, G, F, and let D *d*, F *f*, be horizontal lines, *it will be found* that the height of the column E *d* is ſenſibly equal to that of the column G *f*. This is a fact univerſally obſerved, in whatever way the pipes are inſerted.

Now the ſurface of the water at D is undoubtedly preſſed upwards with a force equal to a column of water, having its ſurface for its baſe, and E *d* for its height; it is therefore prevented from riſing by ſome oppoſite force. This can be nothing but the elaſticity of the confined air preſſing it down. The very ſame thing muſt be ſaid of the ſurface at F; and thus there are two external preſſures at D and F ſet in equilibrio by the interpoſition of air. The force exerted on the ſurface D, by the preſſure of the column E *d*, is therefore propagated to the ſurface at F; and thus air has this characteriſtic mark of fluidity.

In this experiment the *weight* of the air is inſenſible when the veſſel is of ſmall ſize, and has no ſenſible ſhare in the preſſure reaching at D and F. But if the elevation of the point F above D is very great, the column F*d will be obſerved* ſenſibly to exceed the column G*f*. Thus if F be 70 feet higher than D, E *d* will be an inch longer than the column G*f*: for in this caſe there is re acting at D, not only the preſſure propagated from F, but alſo the weight of a column of air, having the ſurface at D for its baſe and 70 feet high. This is equal to the weight of a column of water one inch high.

It is by this propagation of preſſure, this *fluidity*, that the pellet is diſcharged from a child's pop gun. It ſticks faſt in the muzzle; and he forces in another pellet at the other end, which he preſſes forward with the rammer, condenſing the air between them, and thus propagating to the other pellet the preſſure which he exerts, till the friction is overcome, and the pellet is diſcharged by the air expanding and following it.

There is a pretty philoſophical plaything which illuſtrates this property of air in a very perſpicuous manner, and which we ſhall afterwards have occaſion to conſider as converted into a moſt uſeful hydraulic machine. This is what is uſually called *Hero's fountain*, having been invented by a Syracuſan of that name. It conſiſts of two veſſels KLMN (Pl. 7. fig. 8.), OPQR, which are cloſe on all ſides. A tube AB, having a funnel a-top, paſſes through the uppermoſt veſſel without communicating with it, being ſoldered into its top and bottom. It alſo paſſes through the top of the under veſſel, where it is alſo ſoldered, and reaches almoſt to its bottom. This tube is open at both ends. There is another open tube ST, which is ſoldered into the top of the under veſſel and the bottom of the upper veſſel, and reaches almoſt to its top. Theſe two tubes ſerve alſo to ſupport the upper veſſel. A third tube GF is ſoldered into the top of the upper veſſel, and reaches almoſt to its bottom. This tube is open at both ends, but the orifice G is very ſmall. Now ſuppoſe the uppermoſt veſſel filled with water to the height EN, E *e* being its ſurface a little below T. Stop the orifice G with the finger, and pour in water at A. This will deſcend through AB, and compreſs the air in OQRP into leſs room. Suppoſe the water in the under veſſel to have acquired the ſurface C *c*, the air which formerly occupied the whole of the ſpaces OPQR and KL *e* E will now be contained in the ſpaces *o* P *c* C and KL *e* E; and its elaſticity will be in equilibrio with the weight of the column of water, whoſe baſe is the ſurface E *e*, and whoſe height is A *c*. As this preſſure is exerted in every part of the air, it will be exerted on the ſurface E *e* of the water of the upper veſſel; and if the pipe FG were continued upwards, the water would be ſupported in it to a height *e* H above E *e*, equal to A *c*. Therefore, if the finger be now taken from off the orifice G, the water will ſpout up to the ſame height as if it had been immediately forced out by a column of water A *c* without the intervention of the air, that is, nearly to H. If, inſtead of the funnel at A, the veſſel have a brim which will cauſe the water diſcharged at G to run down the pipe AB, this fountain will play till all the water in the upper veſſel is expended. The operation of this ſecond fountain will be better underſtood from fig. 9. which an intelligent reader will ſee is perfectly equivalent to fig. 8 A very powerful engine for raiſing water upon this principle has long been employed in the Hungarian mines; where the pipe AB is about 200 feet high, and the pipe FG about 120; and the condenſation is made in the upper veſſel, and communicated to the lower, at the bottom of the mine, by a long pipe. See WATER-*Works*.

We may now apply to air all the laws of hydroſtatics and hydraulics, in perfect confidence that their legitimate conſequences will be obſerved in all its ſituations. We ſhall in future ſubſtitute, in place of any force acting on a ſurface of air, a column of water, mercury, or any other fluid whoſe weight is equal to this force: and as we know diſtinctly from theory what will be the conſequences of this hydroſtatic preſſure, we ſhall determine *a priori* the phenomena in air; and in caſes where theory does not enable us to ſay with preciſion what is the effect of this preſſure, experience informs us in the caſe of water, and analogy enables us to tranſfer this to air. We ſhall find this of great ſervice in ſome caſes, which otherwiſe are almoſt deſperate in the preſent ſtate of our knowledge.

From ſuch familiar and ſimple obſervations and experiments, the fluidity, the heavineſs, and elaſticity, are diſcovered of the ſubſtance with which we are ſurrounded, and which we call *air*. But to underſtand theſe properties, and completely to explain their numerous and important conſequences, we muſt call in the aid of more refined obſervations and experiments which even this ſcanty knowledge of them enables us to make; we muſt contrive ſome methods of producing with preciſion any degree of condenſation or rarefaction, of employing or excluding the gravitating preſſure of air, and of modifying at pleaſure the action of all its mechanical properties.

Nothing can be more obvious than a method of compreſſing a quantity of air to any degree. Take a cylinder or priſmatic tube AB (fig. 10.) ſhut at one end, and fit it with a piſton or plug C, ſo nicely that no air can paſs by its ſides. This will be beſt done in a cylindric tube by a turned ſtopper, covered with oiled leather, and fitted with a long handle CD. When this is thruſt down, the air which formerly occupied the whole capacity of the tube is *condenſed* into leſs room. The force neceſſary to produce any degree of compreſſion may be concluded from the weight neceſſary for puſhing down the plug to any depth. But this inſtrument leaves us little opportunity of making intereſting experiments on or in this condenſed air; and the force required to make any degree of compreſſion cannot be meaſured with much accuracy; becauſe the piſton muſt be very cloſe, and have great friction, in order to be ſufficiently tight: And as the compreſſion is increaſed, the leather is more ſqueezed to the ſide of the tube; and the proportion of the external force, which is employed merely to overcome this variable and uncertain friction, cannot be aſcertained with any tolerable preciſion. To get rid of theſe imperfections, the following addition may be made to the inſtrument, which then becomes what is called the *condenſing ſyringe*.

The end of the ſyringe is perforated with a very ſmall hole *e f*; and being externally turned to a ſmall cylinder, a narrow ſlip of bladder, or of thin leather, ſoaked in a mixture of oil and tallow, muſt be tied over the hole. Now let us ſuppoſe the piſton puſhed down to the bottom of the barrel, to which it applies cloſe: when it is drawn up to the top, it leaves a void behind, and the weight of the external air preſſes on the ſlip of bladder, which therefore claps cloſe to the braſs, and thus performs the part of a valve, and keeps it cloſe ſo that no air can enter. But the piſton having reached the top of the barrel, a hole F in the ſide of it is juſt below the piſton, and the air ruſhes through this hole and fills the barrel. Now puſh the piſton down again, it immediately paſſes the hole F, and no air eſcapes through it; it therefore forces open the valve at *f*, and eſcapes while the piſton moves to the bottom.

Now let E be any veſſel, ſuch as a glaſs bottle, having its mouth furniſhed with a braſs cap firmly cemented to it, having a hollow ſcrew which fits a ſolid ſcrew *p o*, turned on the cylindric nozzle of the ſyringe. Screw the ſyringe into this cap, and it is evident that the air forced out of the ſyringe will be accumulated in this veſſel: for upon drawing up the piſton the valve *f* always ſhuts by the elaſticity or expanding force of the air in E; and on puſhing it down again, the valve will open as ſoon as the piſton has got ſo far down that the air in the lower part of the barrel is more powerful than the air already in the veſſel. Thus at every ſtroke an additional barrelful of air will be forced into the veſſel E; and it will be found, that after every ſtroke the piſton muſt be further puſhed down before the valve will open. It cannot open till the preſſure ariſing from the elaſticity of the air condenſed in the barrel is ſuperior to the elaſticity of the air condenſed in the veſſel: that is, till the condenſation of the firſt, or its denſity, is *ſomewhat* greater than that of the laſt, in order to overcome the ſtraining of the valve on the whole, and the ſticking occaſioned by the clammy matter employed to make it air-tight.

Sometimes the ſyringe is conſtructed with a valve in the piſton. This piſton, inſtead of being of one piece and ſolid, conſiſts of two pieces perforated. The upper part *i k n m* is connected with the rod or handle, and has its lower part turned down to a ſmall cylinder, which is ſcrewed into the lower part *k l o n*; and has a perforation *g b* going up in the axis, and terminating in a hole *b* in one ſide of the rod, a piece of oiled leather is ſtrained acroſs the hole *g*. When the piſton is drawn up and a void left below it, the weight of the external air forces it through the hole *b g*, opens the valve *g*, and fills the barrel. Then, on puſhing down the piſton, the air being ſqueezed into leſs room, preſſes on the valve *g*, ſhuts it; and none eſcaping through the piſton, it is gradually condenſed as the piſton deſcends till it opens the valve *f*, and is added to that already accumulated in the veſſel E.

Having in this manner forced a quantity of air into the veſſel E, we can make many experiments in it in this ſtate of condenſation. We are chiefly concerned at preſent with the effect which this produces on its elaſticity. We ſee this to be greatly increaſed; for we find more and more force required for introducing every ſucceſſive barrelful. When the ſyringe is unſcrewed, we ſee the air ruſh out with great violence, and every indication of great expanding force. If the ſyringe be connected with the veſſel E in the ſame manner as the ſyringe in No. 17, viz. by interpoſing a ſtopcock B between them (ſee pl. 7. fig. 3.), and if this ſtopcock have a pipe at its extremity, reaching near to the bottom of the veſſel, which is previouſly half filled with water, we can obſerve diſtinctly when the elaſticity of the air in the ſyringe exceeds that of the air in the receiver: for the piſton muſt be puſhed down a certain length before the air from the ſyringe bubbles up through the water, and the piſton muſt be further down at each ſucceſſive ſtroke before this appearance is obſerved. When the air has thus been accumulated in the receiver, it preſſes the ſides of it outward, and will burſt it if not ſtrong enough. It alſo preſſes on the ſurface of the water; and if we now ſhut the cock, unſcrew the ſyringe, and open the cock again, the air will force the water through the pipe with great velocity, cauſing it to riſe in a beautiful jet. When a metal receiver is uſed, the condenſation may be puſhed to a great length, and the jet will then riſe to a great height; which gradually diminiſhes as the water is expended and room given to the air to expand itſelf. See the figure.

We judge of the condenſation of air in the veſſel E by the number of ſtrokes and the proportion of the capacity of the ſyringe to that of the veſſel. Suppoſe the firſt to be one-tenth of the laſt; then we know, that after 10 ſtrokes the quantity of air in the veſſel is doubled, and therefore its denſity double, and ſo on after any number of ſtrokes. Let the capacity of the ſyringe (when the piſton is drawn to the top) be *a*, and that of the veſſel be *b*, and the number of ſtrokes be *n*, the denſity of air in the veſſel will be $\frac{b+na}{b}$, or $1+\frac{na}{b}$.

But this is on the ſuppoſition that the piſton accurately fills the barrel, the bottom of the one applying cloſe to that of the other, and that no force is neceſſary for opening either of the valves: but the firſt cannot be inſured, and the laſt is very far from being true. In the conſtruction now deſcribed, it will require at leaſt one-twentieth part of the ordinary preſſure of the air to open the piſton valve: therefore the air which gets in will want at leaſt this proportion of its complete elaſticity; and there is always a ſimilar part of the elaſticity employed in opening the nozzle valve. The condenſation therefore is never nearly equal to what is here determined.

It is accurately enough meaſured by a gage fitted to the inſtrument. A glaſs tube GH of a cylindric bore, and cloſe at the end, is ſcrewed into the ſide of the cap on the mouth of the veſſel E. A ſmall drop of water or mercury is taken into this tube by warming it a little in the hand, which expands the contained air, ſo that when the open end is dipped into water, and the whole allowed to cool, the water advances a little into the tube. The tube is furniſhed with a ſcale divided into ſmall equal parts, numbered from the cloſe end of the tube. Since this tube communicates with the veſſel, it is evident that the condenſation will force the water along the tube, acting like a piſton on the air beyond it, and the air in the tube and veſſel will always be of one denſity. Suppoſe the number at which the drop ſtands before the condenſation is made to be *c*, and that it ſtands at *d* when the condenſation has attained the degree required, the denſity of the air in the remote end of the gage, and conſequently in the veſſel, will be $\frac{c}{d}$.

Sometimes there is uſed any bit of tube cloſe at one end, having a drop of water in it, ſimply laid into the veſſel E, and furniſhed or not with a ſcale: but this can only be uſed with glaſs veſſels, and theſe are too weak to reſiſt the preſſure ariſing from great condenſation. In ſuch experiments metalline veſſels are uſed, fitted with a variety of apparatus for different experiments. Some of theſe will be occaſionally mentioned afterwards.

It muſt be obſerved in this place, that very great condenſations require great force, and therefore ſmall ſyringes. It is therefore convenient to have them of various ſizes, and to begin with thoſe of a larger diameter, which operate more quickly; and when the condenſation becomes fatiguing, to change the ſyringe for a ſmaller.

For this reaſon, and in general to make the condenſing apparatus more convenient, it is proper to have a ſtop-cock interpoſed between the ſyringe and the veſſel, or, as it is uſually called, the receiver. This conſiſts of a braſs pipe, which has a well-ground cock in its middle, and has a hollow ſcrew at one end, which receives the nozzle ſcrew of the ſyringe, and a ſolid ſcrew at the other end, which fits the ſcrew of the receiver. See fig. 3.

By theſe gages, or contrivances ſimilar to them, we have been able to aſcertain very great degrees of condenſation in the courſe of ſome experiments. Dr. Hales found, that when dry wood was put into a ſtrong veſſel, which it almoſt filled, and the remainder was filled with water, the ſwelling of the wood, occaſioned by its imbibition of water, condenſed the air of his gage into the thouſandth of its original bulk. He found that peaſe treated in the ſame way generated elaſtic air, which preſſing on the air in the gage condenſed it into the fifteen hundredth part of its bulk. This is the greateſt condenſation that has been aſcertained with preciſion, although in other experiments it has certainly been carried much further; but the preciſe degree could not be aſcertained.

The only uſe to be made of this obſervation at preſent is, that ſince we have been able to exhibit air in a denſity a thouſand times greater than the ordinary denſity of the air we breathe, it cannot, as ſome imagine, be only a different form of water; for in this ſtate it is as denſe or denſer than water, and yet retains its great expanſibility.

Another important obſervation is, that in every ſtate of denſity in which we find it, it retains its perfect fluidity, tranſmitting all preſſures which are applied to it with undiminiſhed force; as appears by the equality conſtantly obſerved between the oppoſing columns of water or other fluid by which it is compreſſed, and by the facility with which all motions are performed in it in the moſt compreſſed ſtates in which we can make obſervations of this kind. This fact is totally incompatible with the opinion of thoſe who aſcribe the elaſticity of air to the ſpringy ramified ſtructure of its particles, touching each other like ſo many pieces of ſponge or foot-balls. A collection of ſuch particles might indeed be pervaded by ſolid bodies with conſiderable eaſe, if they were merely touching each other, and not ſubjected to any external preſſure. But the moment ſuch preſſure is exerted, and the aſſemblage ſqueezed into a ſmaller ſpace, each preſſes on its adjoining particles: they are individually compreſſed, flattened in their touching ſurfaces, and *before the denſity is doubled* they are ſqueezed into the form of perfect cubes, and compoſe a maſs, which may indeed propagate preſſure from one place to another in an imperfect manner, and with great diminution of its intenſity, but will no more be fluid than a maſs of ſoft clay. It will be of uſe to keep this obſervation in mind.

We have ſeen that air is heavy and compreſſible, and might now proceed to deduce in order the explanation of the appearances conſequent on each of theſe properties. But, as has been already obſerved, the elaſticity of air modifies the effects of its gravity ſo remarkably, that they would be imperfectly underſtood if both qualities were not combined in our conſideration of either. At any rate, ſome further conſequences of its elaſticity muſt be conſidered, before we underſtand the means of varying at pleaſure the effects of its gravity.

Since air is heavy, the lower ſtrata of a maſs of air muſt ſupport the upper; and, being compreſſible, they muſt be condenſed by their weight. In this ſtate of compreſſion the elaſticity of the lower ſtrata of air acts in oppoſition to the weight of the incumbent air, and balances it. There is no reaſon which ſhould make us ſuppoſe that its expanding force belongs to it only when in ſuch a ſtate of compreſſion. It is more probable, that, if we could free it from this preſſure, the air would expand itſelf into ſtill greater bulk. This is moſt diſtinctly ſeen in the following experiment.

Into the cylindric jar ABCD (fig. 11.), which has a ſmall hole in its bottom, and is furniſhed with an air-tight piſton E, put a ſmall flaccid bladder, having its mouth tied with a ſtring. Having puſhed the piſton near to the bottom, and noticed the ſtate of the bladder, ſtop up the hole in the bottom of the jar with the finger, and draw up the piſton, which will require a conſiderable force. You will obſerve the bladder ſwell out, as if air had been blown into it; and it will again collapſe on allowing the piſton to deſcend. Nothing can be more unexceptionable than the concluſion from this experiment, that ordinary air is in a ſtate of compreſſion, and that its elaſticity is not limited to this ſtate. The bladder being flaccid, ſhows that the included air is in the ſame ſtate with the air which ſurrounds it; and the ſame muſt be affirmed of it while it ſwells but ſtill remains flaccid. We muſt conclude, that the whole air within the veſſel expands, and continues to fill it, when its capacity has been enlarged. And ſince this is obſerved to go on as long as we give it more room, we conclude, that by ſuch experiments we have not yet given it ſo much room as it can occupy.

It was a natural object of curioſity to diſcover the limits of this expanſion; to know what was the natural unconſtrained bulk of a quantity of air, beyond which it would not expand though all external compreſſing force were removed. Accordingly philoſophers conſtructed inſtruments for *rarefying* the air. The common water pump had been long familiar, and appeared very proper for this purpoſe. The moſt obvious is the following.

Let the barrel of the ſyringe AB (fig. 12.) communicate with the veſſel V, with a ſtopcock C between them. Let it communicate with the external air by another orifice D, in any convenient ſituation, alſo furniſhed with a ſtopcock. Let this ſyringe have a piſton very accurately fitted to it ſo as to touch the bottom all over when puſhed down, and have no vacancy about the ſides.

Now ſuppoſe the piſton at the bottom, the cock C open, and the cock D ſhut, draw the piſton to the top. The air which filled the veſſel V will expand ſo as to fill both that veſſel and the barrel AB; and as no reaſon can be given to the contrary, we muſt ſuppoſe that the air will be uniformly diffuſed through both. Calling V and B the capacity of the veſſel and barrel, it is plain that the bulk of the air will now be $V + B$; and ſince the quantity of matter remains the ſame, and the denſity of a fluid is as its quantity of matter directly and its bulk inverſely, the denſity of the expanded air will be $\frac{V}{V+B}$, the denſity of common air being 1: for $V+B : V = 1 : \frac{V}{V+B}$.

The piſton requires force to raiſe it, and it is raiſed in oppoſition to the preſſure of the incumbent atmoſphere; for this had formerly been balanced by the elaſticity of the common air: and we conclude from the fact, *that force is required to raiſe the piſton*, that the elaſticity of the expanded air is leſs than that of air in its ordinary ſtate; and an accurate obſervation of the force neceſſary to raiſe it would ſhow how much the elaſticity is diminiſhed. When therefore the piſton is let go, it will deſcend as long as the preſſure of the atmoſphere exceeds the elaſticity of the air in the barrel; that is, till the air in the barrel is in a ſtate of ordinary denſity. To put it further down will require force, becauſe the air muſt be compreſſed in the barrel; but if we now open the cock D, the air will be expelled through it, and the piſton will reach the bottom.

Now ſhut the *diſcharging cock* D, and open the cock C, and draw up the piſton. The air which occupied the ſpace V, with the denſity $\frac{V}{V+B}$, will now occupy the ſpace $V+B$, if it expands ſo far. To have its denſity D, ſay, As its preſent bulk $V+B$ is to its former bulk V, ſo is its former denſity $\frac{V}{V+B}$ to its new denſity; which will therefore be $\frac{V \times V}{\overline{V+B} \times \overline{V+B}}$, or $\left.\overline{\frac{V}{V+B}}\right|^{2}$.

It is evident, that if the air continues to expand, the denſity of the air in the veſſel after the third drawing up of the piſton will be $\left.\overline{\frac{V}{V+B}}\right|^{3}$, after the fourth it will be $\left.\overline{\frac{V}{V+B}}\right|^{4}$, and after any number of ſtrokes n will be $\left.\overline{\frac{V}{V+B}}\right|^{n}$. Thus, if the veſſel is four times as large as the barrel, the denſity after the fifth ſtroke will be $\frac{1024}{3125}$, nearly $\frac{1}{3}$ of its ordinary denſity.

On the other hand, the number n of ſtrokes neceſſary for reducing the air to the denſity D is $\frac{\text{Log. D} -}{\text{Log. V} - \text{Log. } (V+B)}$.

Thus we ſee that this inſtrument can never abſtract the whole air in conſequence of its expanſion, but only rarefy it continually as long as it continues to expand; nay, there is a limit beyond which the rarefaction cannot go. When the piſton has reached the bottom, there remains a ſmall ſpace between it and the cock C filled with common air. When the piſton is drawn up, this ſmall quantity of air expands, and alſo a ſimilar quantity in the neck of the other cock; and no air will come out of the receiver V till the expanded air in the barrel is of a ſmaller denſity than the air in the receiver. This circumſtance evidently directs us to make theſe two ſpaces as ſmall as poſſible, or by ſome contrivance to fill them up altogether. Perhaps this may be done effectually in the following manner.

Let BE (Pl. 8. fig. 13.) repreſent the bottom of the barrel, and let the circle HKI be the ſection of the key of the cock, of a large diameter, and place it as near to the barrel as can be. Let this communicate with the barrel by means of a hole FG widening upwards, as the fruſtum of a hollow obtuſe cone. Let the bottom of the piſton *b f h g e* be ſhaped ſo as to fit the bottom of the barrel and this hole exactly. Let the cock be pierced with two holes. One of them, HI, paſſes perpendicularly through its axis, and forms the communication between the receiver and barrel. The other hole, KL, has one extremity K on the ſame circumference with H, ſo that when the key is turned a fourth part round, K will come into the place of H: but this hole is pierced obliquely into the key, and thus keeps clear of the hole HI. It goes no further than the axis, where it communicates with a hole bored along the axis and terminating at its extremity. This hole forms the communication with the external air, and ſerves for diſcharging the air in the barrel. (A ſide view of the key is ſeen in Pl. 7. fig. 14.) Fig. 12. ſhows the poſition of the cock while the piſton is moving upwards, and fig. 14. ſhows its poſition while the piſton is moving downwards. When the piſton has reached the bottom, the conical piece *f h g* of the piſton, which may be of firm leather, fills the hole FHG, and therefore completely expels the air from the barrel. The canal KL*l* of the cock contains air of the common denſity; but this is turned aſide into the poſition KL (fig. 13.), while the piſton is ſtill touching the cock. It cannot expand into the barrel during the aſcent of the piſton. In place of it the perforation HLI comes under the piſton, filled with air that had been turned aſide with it when the piſton was at the top of the barrel, and therefore of the ſame denſity with the air of the receiver. It appears therefore that there is no limit to the rarefaction as long as the air will expand.

This inſtrument is called an Exhausting Syringe. It is more generally made in another form, which is much leſs expenſive, and more convenient in its uſe. Inſtead of being furniſhed with *cocks* for eſtabliſhing the communications and ſhutting them, as is neceſſary, it has *valves* like thoſe of the condenſing ſyringe, but opening in the oppoſite direction. It is thus made:

The pipe of communication or conduit MN (Pl. 8. fig. 15.) has a male ſcrew in its extremity, and over this is tied a ſlip of bladder or leather M. The lower half of the piſton has alſo a male ſcrew on it, covered at the end with a ſlip of bladder O. This is ſcrewed into the upper half of the piſton, which is pierced with a hole H coming out of the ſide of the rod.

Now ſuppoſe the ſyringe ſcrewed to the conducting pipe, and that ſcrewed into the receiver V, and the piſton at the bottom of the barrel. When the piſton is drawn up, the preſſure of the external air ſhuts the valve O, and a void is left below the piſton: there is therefore no preſſure on the upper ſide of the valve M to balance the elaſticity of the air in the receiver which formerly balanced the weight of the atmoſphere. The air therefore in the receiver lifts this valve, and diſtributes itſelf between the veſſel and the barrel; ſo that when the piſton has reached the top the denſity of the air in both receiver and barrel is as before, $\frac{V}{V+B}$.

When the piſton is let go it deſcends, becauſe the elaſticity of the expanded air is not a balance for the preſſure of the atmoſphere, which therefore preſſes down the piſton with the difference, keeping the piſton-valve ſhut all the while. At the ſame time the valve M alſo ſhuts; for it was opened by the prevailing elaſticity of the air in the receiver, and while it is open the two airs have equal denſity and elaſticity; but the moment the piſton deſcends, the capacity of the barrel is diminiſhed, the elaſticity of its air increaſes by collapſing, and now prevailing over that of the air in the receiver ſhuts the valve M.

When it has arrived at ſuch a part of the barrel that the air in it is of the denſity of the external air, there is no force to puſh it further down; the hand muſt therefore preſs it. This attempts to condenſe the air in the barrel, and therefore increaſes its elaſticity; ſo that it lifts the valve O and eſcapes, and the piſton gets to the bottom. When drawn up again, greater force is required than the laſt time, becauſe the elaſticity of the included air is leſs than in the former ſtroke. The piſton riſes further before the valve M is lifted up, and when it has reached the top of the barrel the denſity of the included air is $\overline{\frac{V}{V+B}}\Big|^{2}$.
The piſton, when let go, will deſcend further than it did before ere the piſton-valve open, and the preſſure of the hand will again puſh it to the bottom, all the air eſcaping through O. The rarefaction will go on at every ſucceſſive ſtroke in the ſame manner as with the other ſyringe.

This ſyringe is evidently more eaſy in its uſe, requiring no attendance to the cocks to open and ſhut them at the proper times. On this account this conſtruction of an exhauſting ſyringe is much more generally uſed.

But it is greatly inferior to the ſyringe with cocks with reſpect to its power of rarefaction. Its operation is greatly limited. It is evident that no air will come out of the receiver unleſs its elaſticity *exceed* that of the air in the barrel by a difference able to lift up the valve M. A piece of oiled leather tied acroſs this hole can hardly be made tight and certain of clapping to the hole without ſome ſmall ſtraining, which muſt therefore be overcome. It muſt be very gentle indeed not to require a force equal to the weight of two inches of water, and this is equal to about the 200th part of the whole elaſticity of the ordinary air; and therefore this ſyringe, for this reaſon alone, cannot rarefy air above 200 times, even though air were capable of an indefinite expanſion. In like manner the valve O cannot be raiſed without a ſimilar prevalence of the elaſticity of the air in the barrel above the weight of the atmoſphere. Theſe cauſes united, make it difficult to rarefy the air more than 100 times, and very few ſuch ſyringes will rarefy it more than 50 times; whereas the ſyringe with cocks, when new and in good order, will rarefy it 1000 times.

But, on the other hand, ſyringes with cocks are much more expenſive, eſpecially when furniſhed with apparatus for opening and ſhutting the cocks. They are more difficult to make equally tight, and (which is the greateſt objection) do not remain long in good order. The cocks, by ſo frequently opening and ſhutting, grow looſe, and allow the air to eſcape. No method has been found of preventing this. They muſt be ground tight by means of emery or other cutting powders. Some of theſe unavoidably ſtick in the metal, and continue to wear it down. For this reaſon philoſophers, and the makers of philoſophical inſtruments, have turned their chief attention to the improvement of the ſyringe with valves. We have been thus minute in the account of the operation of rarefaction, that the reader may better underſtand the value of theſe improvements, and in general the operation of the principal pneumatic engines.

Of the Air-Pump.

An Air-Pump is nothing but an exhauſting ſyringe accommodated to a variety of experiments. It was firſt invented by Otto Guericke, a gentleman of Magdeburgh in Germany, about the year 1654. We truſt that it will not be unacceptable to our readers to ſee this inſtrument, which now makes a principal article in a philoſophical apparatus, in its firſt form, and to trace it through its ſucceſſive ſteps to its preſent ſtate of improvement.

Guericke, indifferent about the ſolitary poſſeſſion of an invention which gave entertainment to numbers who came to ſee his wonderful experiments, gave a minute deſcription of all his pneumatic apparatus to Gaſpar Schottus profeſſor of mathematics at Wirtemberg, who immediately publiſhed it with the author's conſent, with an account of ſome of its performances, firſt in 1657, in his *Mechanica Hydraulico-pneumatica*; and then in his *Technica Curioſa*, in 1664; a curious collection of all the wonderful performances of art which he collected by a correſpondence over all Europe.

Otto Guericke's air pump conſiſts of a glaſs receiver A (fig. 16.), of a form nearly ſpherical, fitted up with a braſs cap and cock B. The nozzle of the cap was fixed to a ſyringe CDE, alſo of braſs, bent at D into half a right angle. This had a valve at D, opening from the receiver into the ſyringe, and ſhutting when preſſed in the oppoſite direction. In the upper ſide of the ſyringe there is another valve F, opening from the ſyringe into the external air, and ſhutting when preſſed inwards. The piſton had no valve. The ſyringe, the cock B, and the joint of the tube, were immerſed in a ciſtern filled with water. From this deſcription it is eaſy to underſtand the operation of the inſtrument. When the piſton was drawn up from the bottom of the ſyringe, the valve F was kept ſhut, by the preſſure of the external air, and the valve D opened by the elaſticity of the air in the receiver. When it was puſhed down again, the valve D immediately ſhut by the ſuperior elaſticity of the air in the ſyringe; and when this was ſufficiently compreſſed, it opened the valve F, and was diſcharged. It was immerſed in water, that no air might find its way through the joints or cocks.

It would ſeem that this machine was not very perfect, for Guericke ſays that it took ſeveral hours to produce an evacuation of a moderate-ſized veſſel; but he ſays, that when it was in good order, the rarefaction (for he acknowledges that it was not, nor could be, a complete evacuation) was ſo great, that when the cock was opened, and water admitted, it filled the receiver ſo as ſometimes to leave no more than the bulk of a pea filled with air. This is a little ſurpriſing; for, if the valve F be placed as far from the bottom of the ſyringe as in Schottus's figure, it would appear that the rarefaction could not be greater than what muſt ariſe from the air in DF expanding till it filled the whole ſyringe: becauſe, as ſoon as the piſton in its deſcent paſſes F it can diſcharge no more air, but muſt compreſs it between F and the bottom, to be expanded again when the piſton is drawn up. It is probable that the piſton was not very tight, but that on preſſing it down it allowed the air to paſs it; and the water in which the whole was immerſed prevented the return of the air when it was drawn up again: and this accounts for the great time neceſſary for producing the deſired rarefaction.

Guericke, being a gentleman of fortune, ſpared no expenſe, and added a part to the machine, which ſaved his numerous viſitants the trouble of hours attendance before they could ſee the curious experiments with the rarefied air. He made a large copper veſſel G (fig. 17.), having a pipe and cock below, which paſſed through the floor of the chamber into an under apartment, where it was joined to the ſyringe immerſed in the ciſtern of water, and worked by a lever. The upper part of the veſſel terminated in a pipe, furniſhed with a ſtopcock H, ſurrounded with a ſmall brim to hold water for preventing the ingreſs of air. On the top was another cap I, alſo filled with water, to protect the junction of the pipes with the receiver K. This great veſſel was always kept exhauſted, and workmen attended below. When experiments were to be performed in the receiver K, it was ſet on the top of the great veſſel, and the cock H was opened. The air in K immediately diffuſed itſelf equally between the two veſſels, and was ſo much more rarefied as the receiver K was ſmaller than the veſſel G. When this rarefaction was not ſufficient, the attendants below immediately worked the pump.

Theſe particulars deſerve to be recorded, as they ſhow the inventive genius of this celebrated philoſopher, and becauſe they are uſeful even in the preſent advanced ſtate of the ſtudy. Guericke's method of excluding air from all the joints of his apparatus, by immerſing theſe joints in water, is the only method that has to this day been found effectual; and there frequently occur experiments where this excluſion for a long time is abſolutely neceſſary. In ſuch caſes it is neceſſary to conſtruct little cups or ciſterns at every joint, and to fill them with water or oil. In a letter to Schottus, 1662-3, he deſcribes very ingenious contrivances for producing complete rarefaction after the elaſticity of the remaining air has been ſo far diminiſhed that it is not able to open the valves. He opens the exhauſting valves by a plug, which is puſhed in by the hand; and the diſcharging valve is opened by a ſmall pump placed on its outſide, ſo that it opens into a void inſtead of opening againſt the preſſure of the atmoſphere. (See *Schotti Technica Curioſa*, p. 68. 70.) Theſe contrivances have been lately added to air-pumps by Haas and Hurter as new inventions.

It muſt be acknowledged, that the application of the pump or ſyringe to the exhauſtion of air was a very obvious thought on the principle exhibited in No. 17. and in this way it was alſo employed by Guericke, who firſt filled the receiver with water, and then applied the ſyringe. But this was by no means either his object or his principle. His object was not ſolely to procure a veſſel void of air, but to exhauſt the air which was already in it: and his principle was the power which he ſuſpected to be in air of expanding itſelf into a greater ſpace when the force was removed which he ſuppoſed to compreſs it. He expreſsly ſays (*Tract. de Experimentis Magdeburgicis, et in Epiſt. ad Schottum*), that the contrivance occurred to him accidentally when occupied with experiments in the Torricellian tube, in which he found that the air would really expand, and completely fill a much larger ſpace than what it uſually occupied, and that he had found no limits to the expanſion, evincing this by facts which we ſhall perfectly underſtand by and by. This was a doctrine quite new, and required a philoſophical mind to view it in a general and ſyſtematic manner; and it muſt be owned that his manner of treating the ſubject is equally remarkable for ingenuity and for modeſty. (*Epiſt. ad Schottum.*)

His doctrine and his machine were ſoon ſpread over Europe. It was the age of literary ardour and philoſophical curioſity; and it is moſt pleaſant to us, who, ſtanding on the ſhoulders of our predeceſſors, can ſee far around us, to obſerve the eagerneſs with which every new, and to us frivolous, experiment was repeated and canvaſſed. The worſhippers of Ariſtotle were daily receiving ſevere mortifications from the experimenters, or empirics as they affected to call them, and they exerted themſelves ſtrenuouſly in ſupport of his now tottering cauſe. This contributed to the rapid propagation of every diſcovery; and it was a moſt profitable and reſpectable buſineſs to go through the chief cities of Germany and France exhibiting philoſophical experiments.

About this time the foundations of the Royal Society of London were laid. Mr. Boyle, Mr. Wren, Lord Brounker, Dr. Wallis, and other curious gentlemen, held meetings at Oxford, in which were received accounts of whatever was doing in the ſtudy of nature; and many experiments were exhibited. The reſearches of Galileo, Torricelli, and Paſcal, concerning the preſſure of the air, greatly engaged their attention, and many additions were made to their diſcoveries. Mr. Boyle, the moſt ardent and ſucceſsful ſtudier of nature, had the principal ſhare in theſe improvements, his inquiſitive mind being aided by an opulent fortune. In a letter to his nephew lord Dungarvon, he ſays that he had made many attempts to ſee the appearances exhibited by bodies freed from the preſſure of the air. He had made Torricellian tubes, having a ſmall veſſel a-top, into which he put ſome bodies before filling the tubes with mercury; ſo that when the tube was ſet upright, and the mercury run out, the bodies were *in vacuo*. He had alſo abſtracted the water from a veſſel, by a ſmall pump, by means of its weight, in the manner deſcribed in No. 17, having previouſly put bodies into the veſſel along with the water. But all theſe ways were very troubleſome and imperfect. He was delighted when he learned from Schottus's firſt publication, that counſellor Guericke had effected this by the expanſive power of the air; and immediately ſet about conſtructing a machine from his own ideas, no deſcription of Guericke's being then publiſhed.

It conſiſted of a receiver A (fig. 18,), furniſhed with a ſtop-cock B, and ſyringe CD placed in a vertical poſition below the receiver. Its valve C was in its bottom, cloſe adjoining to the entry of the pipe of communication; and the hole by which the air iſſued was further ſecured by a plug which could be removed. The piſton was moved by a wheel and rack-work. The receiver of Guericke's pump was but ill adapted for any conſiderable variety of experiments; and accordingly very few were made in it. Mr. Boyle's receiver had a large opening EF, with a ſtrong glaſs margin. To this was fitted a ſtrong braſs cap, pierced with a hole G in its middle, to which was fitted a plug ground into it, and ſhaped like the key of a cock. The extremity of this key was furniſhed with a ſcrew, to which could be affixed a hook, or a variety of pieces for ſupporting what was to be examined in the receiver, or for producing various motions within it, without admitting the air. This was further guarded againſt by means of oil poured round the key, where it was retained by the hollow cup-like form of the cover. With all theſe precautions, however, Mr. Boyle ingenuouſly confeſſes, that it was but ſeldom, and with great difficulty, that he could produce an extreme degree of rarefaction; and it appears by Guericke's letter to Schottus, that in this reſpect the Magdeburgh machine had the advantage. But moſt of Boyle's very intereſting experiments did not require this extreme rarefaction; and the variety of them, and their philoſophic importance, compenſated for this defect, and ſoon eclipſed the fame of the inventor to ſuch a degree, that the ſtate of air in the receiver was generally denominated the *vacuum Boyleanum*, and the air-pump was called *machina Boyleana*. It does not appear that Guericke was at all ſolicitous to maintain his claim to priority of invention. He appears to have been of a truly noble and philoſophical mind, aiming at nothing but the advancement of ſcience.

Mr. Boyle found, that to make a veſſel air-tight, it was ſufficient to place a piece of wet or oiled leather on its brim, and to lay a flat plate of metal upon this. The preſſure of the external air ſqueezed the two ſolid bodies ſo hard together, that the ſoft leather effectually excluded it. This enabled him to render the whole machine incomparably more convenient for a variety of experiments. He cauſed the conduit-pipe to terminate in a flat plate which he covered with leather, and on this he ſet the glaſs ball or receiver, which had both its upper and lower brim ground flat. He covered the upper orifice in like manner with a piece of oiled leather and a flat plate, having cocks and a variety of other perforations and contrivances ſuited to his purpoſes. This he found infinitely more expeditious, and alſo tighter, than the clammy cements which he had formerly uſed for ſecuring the joints.

He was now aſſiſted by Dr. Hooke, the moſt ingenious and inventive mechanic that the world has ever ſeen. This perſon made a great improvement on the air-pump, by applying two ſyringes whoſe piſton-rods were worked by the ſame wheel, as in fig. 20. No. 1. and putting valves in the piſtons in the ſame manner as in the piſton of a common pump. This evidently doubled the expedition of the pump's operation: but it alſo greatly diminiſhed the labour of pumping; for it muſt be obſerved, that the piſton H muſt be drawn up againſt the preſſure of the external air; and when the rarefaction is nearly perfect this requires a force of nearly 15 pounds for every inch of the area of the piſton. Now, when one piſton H is at the bottom of the barrel, the other K is at the top of the barrel, and the air below K is equally rare with that in the receiver. Therefore the preſſure of the external air on the piſton K is *nearly* equal to that on the piſton H. Both, therefore, are acting in oppoſite directions on the wheel which gave them motion; and the force neceſſary for raiſing H is only the difference between the elaſticity of the air in the barrel H and that of the air in the barrel K. This is very ſmall in the beginning of the ſtroke, but gradually increaſes as the piſton K deſcends, and becomes equal to the whole exceſs of the air's preſſure above the elaſticity of the remaining air of the receiver when the air at K of the natural denſity begins to open the piſton valves. An accurate attention to the circumſtances will ſhow us that the force requiſite for working the pump is greateſt at firſt, and gradually diminiſhes as the rarefaction advances; and when this is nearly complete, hardly any more force is required than what is neceſſary for overcoming the friction of the piſtons, except during the diſcharge of the air at the end of each ſtroke.

This is therefore the form of the air-pump which is moſt generally uſed all over Europe. Some traces of national prepoſſeſſion remain. In Germany, air-pumps are frequently made after the original model of Guericke's (Wolff Cyclomatheſis); and the French generally uſe the pump made by Papin, though extremely awkward. We ſhall give a deſcription of Boyle's air-pump as finally improved by Hawkſbee, which, with ſome ſmall accommodations to particular views, ſtill remains the moſt approved form.

Here follows the deſcription from Deſaguliers.

It conſiſts of two braſs barrels *a a*, *a a* (pl. 9. fig. 19.), 12 inches high and 2 wide. The piſtons are raiſed and depreſſed by turning the winch *b b*. This is faſtened to an axis paſſing through a ſtrong toothed wheel, which lays hold of the teeth of the racks *c c c c*. Then the one is raiſed while the other is depreſſed; by which means the valves, which are made of limber bladder, fixed in the upper part of each piſton, as well as in the openings into the bottom of the barrels, perform their office of diſcharging the air from the barrels, and admitting into them the air from the receiver to be afterwards diſcharged; and when the receiver comes to be pretty well exhauſted of its air, the preſſure of the atmoſphere in the deſcending piſton is nearly ſo great, that the power required to raiſe the other is little more than is neceſſary for overcoming the friction of the piſton; which renders this pump preferable to all others, which require more force to work them as the rarefaction of the air in the receiver advances.

The barrels are ſet in a braſs diſh about two inches deep, filled with water or oil to prevent the inſinuation of air. The barrels are ſcrewed tight down by the nuts *e e*, *e e*, which force the frontiſpiece *f f* down on them, through which the two pillars *g g*, *g g* paſs.

From between the barrels riſes a ſlender braſs pipe *h h*, communicating with each by a perforation in the tranſverſe piece of braſs on which they ſtand. The upper end of this pipe communicates with another perforated piece of braſs, which ſcrews underneath the plate *i i i i*, of ten inches diameter, and ſurrounded with a braſs rim to prevent the ſhedding of water uſed in ſome experiments. This piece of braſs has three branches: 1ſt, A horizontal one communicating with the conduit pipe *b b*. 2. An upright one ſcrewed into the middle of the pump-plate, and terminating in a ſmall pipe *k*, riſing about an inch above it. 3d, Is a perpendicular one, looking downwards in the continuation of the pipe *k*, and having a hollow ſcrew in its end receiving the braſs cap of the gage-pipe *l l l l*, which is of glaſs, 34 inches long, and immerſed in a glaſs ciſtern *m m* filled with mercury. This is covered a-top with a cork float, carrying the weight of a light wooden ſcale divided into inches, which are numbered from the ſurface of the mercury in the ciſtern. This ſcale will therefore riſe and fall with the mercury in the ciſtern, and indicate the true elevation of that in the tube.

There is a ſtopcock immediately above the inſertion of the gage pipe, by which its communication may be cut off. There is another at *n*, by which a communication is opened with the external air for allowing its re-admiſſion; and there is ſometimes another immediately within the inſertion of the conduct-pipe for cutting off the communication between the receiver and the pump. This is particularly uſeful when the rarefaction is to be continued long, as there are by theſe means fewer chances of the inſinuation of air by the many joints.

The receivers are made tight by ſimply ſetting them on the pump plate with a piece of wet or oiled leather between; and the receivers, which are open a-top, have a braſs cover ſet on them in the ſame manner. In theſe covers there are various perforations and contrivances for various purpoſes. The one in the figure has a ſlip wire paſſing through a collar of oiled leather, having a hook or a ſcrew in its lower end for hanging any thing on, or producing a variety of motions.

Sometimes the receivers are ſet on another plate, which has a pipe ſcrewed into its middle, furniſhed with a ſtop-cock and a ſcrew, which fits the middle pipe *k*. When the rarefaction has been made in it, the cock is ſhut, and then the whole may be unſcrewed from the pump, and removed to any convenient place. This is called a *tranſporter plate*.

It only remains to explain the gage *l l l l*. In the ordinary ſtate of the air its elaſticity balances the preſſure of the incumbent atmoſphere. We find this from the force that is neceſſary to ſqueeze it into leſs bulk in oppoſition to this elaſticity. Therefore the elaſticity of the air increaſes with the vicinity of its particles. It is therefore reaſonable to expect, that when we allow it to occupy more room, and its particles are further aſunder, its elaſticity will be diminiſhed though not annihilated; that is, it will no longer balance the WHOLE preſſure of the atmoſphere, though it may ſtill balance part of it. If therefore an upright pipe have its lower end immerſed in a veſſel of mercury, and communicate by its upper end with a veſſel containing rarefied, therefore leſs elaſtic, air, we ſhould expect that the preſſure of the air will prevail, and force the mercury into the tube, and cauſe it to riſe to ſuch a height that the weight of the mercury, joined to the elaſticity of the rarefied air acting on its upper ſurface, ſhall be exactly equal to the whole preſſure of the atmoſphere. The height of the mercury is the exact meaſure of that part of the whole preſſure which is not balanced by the elaſticity of the rarefied air, and its deficiency from the height of the mercury in the Torricellian tube is the exact meaſure of this remaining elaſticity.

It is evident, therefore, that the pipe will be a ſcale of the elaſticity of the remaining air, and will indicate in ſome ſort the degree of rarefaction: for there muſt be ſome analogy between the denſity of the air and its elaſticity; and we have no reaſon to imagine that they do not increaſe and diminiſh together, although we may be ignorant of the law, that is, of the change of elaſticity correſponding to a known change of denſity. This is to be diſcovered by experiment; and the air-pump itſelf furniſhes us with the beſt experiments for this purpoſe. After rarefying till the mercury in the gage has attained half the height of that in the Torricellian tube, ſhut the communication with the barrels and gage, and admit the water into the receiver. It will go in till all is again in equilibrio with the preſſure of the atmoſphere; that is, till the air in the receiver has collapſed into its natural bulk. This we can accurately meaſure, and compare with the whole capacity of the receiver; and thus obtain the preciſe degree of rarefaction correſponding to half the natural elaſticity. We can do the ſame thing with the elaſticity reduced to one third, one fourth, &c. and thus diſcover the whole law.

This gage muſt be conſidered as one of the moſt ingenious and convenient parts of Hawkeſbee's pump; and it is well diſpoſed, being in a ſituation protected againſt accidents: but it neceſſarily increaſes greatly the ſize of the machine, and cannot be applied to the table pump, repreſented in pl. 8. fig. 20. No. 1. When it is wanted here, a ſmall plate is added behind, or between the barrels and receiver; and on this is ſet a ſmall tubulated (as it is termed) receiver, covering a common weather-glaſs tube.—This receiver being rarefied along with the other, the preſſure on the mercury in the ciſtern ariſing from the elaſticity of the remaining air is diminiſhed ſo as to be no longer able to ſupport the mercury at its full height; and it therefore deſcends till the height at which it ſtands puts it in equilibrio with the elaſticity. In this form, therefore, the height of the mercury is directly a meaſure of the remaining elaſticity; while in the other it meaſures the remaining unbalanced preſſure of the atmoſphere. But this gage is extremely cumberſome and liable to accidents. We are ſeldom much intereſted in the rarefaction till it is great: a contracted form of this gage is therefore very uſeful, and was early uſed. A ſyphon ABCD (pl. 8. fig. 20. No. 2.), each branch of which is about four inches long, cloſe at A and open at D, is filled with boiling mercury till it occupies the branch AB and a very ſmall part of CD, having its ſurface at O. This is fixed to a ſmall ſtand, and fixed into the receiver, along with the things that are to be exhibited in the rarefied air. When the air has been rarefied till its remaining elaſticity is not able to ſupport the column BA, the mercury deſcends in AB, and riſes in CD, and the remaining elaſticity will always be meaſured by the elevation of the mercury in AB above that in the leg CD. Could the exhauſtion be perfected, the ſurfaces in both legs would be on a level. Another gage might be put into the ſame foot, having a ſmall bubble of air at A. This would move from the beginning of the rarefaction; but our ignorance of the analogy between the denſity and elaſticity hinders us from uſing it as a meaſure of either.

It is enough for our preſent purpoſe to obſerve, that the barometer or ſyphon gage is a perfect indication and meaſure of the performance of an air-pump, and that a pump is (*cæteris paribus*) ſo much the more perfect, as it is able to raiſe the mercury higher in the gage. It is in this way that we diſcover that none can produce a complete exhauſtion, and that their operation is only a very great rarefaction: for none can raiſe the mercury to that height at which it ſtands in the Torricellian tube well purged of air. Few pumps will bring it within $\frac{1}{10}$ of an inch. Hawkeſbee's, fitted up according to his inſtructions, will ſeldom bring it within $\frac{1}{5}$. Pumps with cocks, when conſtructed according to the principles mentioned when ſpeaking of the exhauſting ſyringe, and new and in fine order, will in favourable circumſtances bring it within $\frac{1}{40}$. None with valves fitted up with wet leather, or when water or volatile fluids are allowed acceſs into any part, will bring it nearer than $\frac{1}{2}$. Nay, a pump of the beſt kind, and in the fineſt order, will have its rarefying power reduced to the loweſt ſtandard, as meaſured by this gage, if we put into the receiver the tenth part of a ſquare inch of white ſheep-ſkin, freſh from the ſhops, or of any ſubſtance equally damp. This is a diſcovery made by means of the improved air-pump, and leads to very extenſive and important conſequences in general phyſics; ſome of which will be treated of under this article: and the obſervation is made thus early, that our readers may better underſtand the improvements which have been made on this celebrated machine.

It would require a volume to deſcribe all the changes which have been made on it. An inſtrument of ſuch multifarious uſe, and in the hands of curious men, each diving into the ſecrets of nature in his favourite line, muſt have received many alterations and real improvements in many particular reſpects. But theſe are beſide our preſent purpoſe; which is to conſider it merely as a machine for rarefying elaſtic or expanſive fluids. We muſt therefore confine ourſelves to this view of it; and ſhall carefully ſtate to our readers every improvement founded on principle, and on pneumatical laws.

All who uſed it perceived the limit ſet to the rarefaction by the reſiſtance of the valves, and tried to perfect the conſtruction of the cocks. The Abbé Nollet and Graveſande, two of the moſt eminent experimental philoſophers in Europe, were the moſt ſucceſsful.

Mr. Graveſande juſtly preferred Hooke's plan of a double pump, and contrived an apparatus for turning the cocks by the motion of the pump's handle. This is far from either being ſimple or eaſy in working; and occaſions great jerks and concuſſions in the whole machine. This, however, is not neceſſarily connected with the truly pneumatical improvement. His piſton has no valve, and the rod is connected with it by a ſtirrup D (fig. 21), as in a common pump. The rod has a cylindric part *c p*, which paſſes through the ſtirrup, and has a ſtiff motion in it up and down of about half an inch; being ſtopped by the ſhoulder *c* above and the nut below. The round plate ſupported by this ſtirrup has a ſhort ſquare tube *n d*, which fits tight into the hole of a piece of cork F. The round plate E has a ſquare ſhank *g*, which goes into the ſquare tube *n d*. A piece of thin leather *f*, ſoaked in oil, is put between the cork and the plate E, and another between the cork and the plate which forms the ſole of the ſtirrup. All theſe pieces are ſcrewed together by the nail *e*, whoſe flat head covers the hole *n*. Suppoſe, therefore, the piſton touching the bottom of the barrel, and the winch turning to raiſe it again, the friction of the piſton on the barrel keeps it in its place, and the rod is drawn up through the ſtirrup D. Thus the wheel has liberty to turn about an inch; and this is ſufficient for turning the cock, ſo as to cut off the communication with the external air, and to open the communication with the receiver. This being done, and the motion of the winch continued, the piſton is raiſed to the top of the barrel. When the winch is turned in the oppoſite direction, the piſton remains fixed till the cock is turned, ſo as to ſhut the communication with the receiver, and open that with the external air.

This is a pretty contrivance, and does not at firſt appear neceſſary; becauſe the cocks might be made to turn at the beginning and end of the ſtroke without it. But this is juſt poſſible; and the ſmalleſt error of adjuſtment, or wearing of the apparatus, will cauſe them to be open at improper times. Beſides, the cocks are not turned in an inſtant, and are improperly open during ſome very ſmall time; but this contrivance completely obviates this difficulty.

The cock is preciſely ſimilar to that formerly deſcribed, having one perforation diametrically through it, and another entering at right angles to this; and after reaching the centre, it paſſes along the axis of the cock, and comes out to the open air.

It is evident, that by this conſtruction of the cock, the ingenious improvement of Dr. Hooke, by which the preſſure of the atmoſphere on one piſton is made to balance (in great part) the preſſure on the other, is given up: for, whenever the communication with the air is opened, it ruſhes in, and immediately balances the preſſure on the upper ſide of the piſton in this barrel; ſo that the whole preſſure in the other muſt be overcome by the perſon working the pump. Graveſande, aware of this, put a valve on the orifice of the cock; that is, tied a ſlip of wet bladder or oiled leather acroſs it; and now the piſton is preſſed down, as long as the air in the barrel is rarer than the outward air, in the ſame manner as when the valve is in the piſton itſelf.

This is all that is neceſſary to be deſcribed in Mr. Graveſande's air-pump. Its performance is highly extolled by him, as far exceeding his former pumps with valves. The ſame preference was given to it by his ſucceſſor Muſchenbroek. But, while they both prepared the piſtons and valves and leathers of the pump, by ſteeping them in oil, and then in a mixture of water and ſpirits of wine, we are certain that no juſt eſtimate could be made of its performance. For with this preparation it could not bring the gage within $\frac{1}{5}$ of an inch of the barometer. We even ſee other limits to its rarefaction: from its conſtruction, it is plain that a very conſiderable ſpace is left between the piſton and cock, not leſs than an inch, from which the air is never expelled; and if this be made extremely ſmall, it is plain that the pump muſt be worked very ſlow, otherwiſe there will not be time for the air to diffuſe itſelf from the receiver into the barrel, eſpecially towards the end, when the expelling force, viz. the elaſticity of the remaining air, is very ſmall. There is alſo the ſame limit to the rarefaction, as in Hooke's or Hawkeſbee's pump, oppoſed by the valve E, which will not open till the air below the piſton is conſiderably denſer than the external air; and this pump ſoon loſt any advantages it poſſeſſed when freſh from the workman's hands, by the cock's growing looſe and admitting air. It is ſurpriſing that Graveſande omitted Hawkeſbee's ſecurity againſt this, by placing the barrels in a diſh filled with oil; which would effectually have prevented this inconvenience.

We muſt not omit a ſeemingly paradoxical obſervation of Graveſande, that in a pump conſtructed with valves, and worked with a determined uniform velocity, the required degree of rarefaction is ſooner produced by ſhort barrels than by long ones. It would require too much time to give a general demonſtration of this, but it will eaſily be ſeen by an example. Suppoſe the long barrel to have equal capacity with the receiver, then at the end of the firſt ſtroke the air in the receiver will have $\frac{1}{2}$ its natural denſity. Now, let the ſhort barrels have half this capacity; at the end of the firſt ſtroke the denſity of the air in the receiver is $\frac{2}{3}$, and at the end of the ſecond ſtroke it is $\frac{4}{9}$, which is leſs than $\frac{1}{2}$, and the two ſtrokes of the ſhort barrel are ſuppoſed to be made in the ſame time with one of the longeſt, &c.

Hawkeſbee's pump maintained its pre-eminence without rival in Britain, and generally too on the continent, except in France, where every thing took the *ton* of the academy, which abhorred being indebted to foreigners for any thing in ſcience, till about the year 1750, when it engaged the attention of Mr. John Smeaton, a perſon of uncommon knowledge, and ſecond to none but Dr. Hooke in ſagacity and mechanical reſource. He was then a maker of philoſophical inſtruments, and made many attempts to perfect the pumps with cocks, but found, that whatever perfection he could bring them to, he could not enable them to preſerve it; and he never would ſell one of this conſtruction. He therefore attached himſelf ſolely to the valve pumps.

The firſt thing was to diminiſh the reſiſtance to the entry of the air from the receiver into the barrels: this he rendered almoſt nothing, by enlarging the ſurface on which this feebly elaſtic air was to preſs. Inſtead of making theſe valves to open by its preſſure on a circle of $\frac{1}{20}$ of an inch in diameter, he made the valve-hole one inch in diameter, enlarging the ſurface 400 times; and to prevent this piece of thin leather from being burſt by the great preſſure on it, when the piſton in its deſcent was approaching the bottom of the barrel, he ſupported it by a delicate but ſtrong grating, dividing the valve-hole like the ſection of a honey-comb, as repreſented in pl. 8. fig. 22. No. 3.; and the ribs of this grating are ſeen edgewiſe in fig. 22. No. 1. at *a b c*.

The valve was a piece of thin membrane or oiled ſilk, gently ſtrained over the mouth of the valve-hole, and tied on by a fine ſilk thread wound round it in the ſame manner that the narrow ſlips had been tied on formerly. This done, he cut with a pointed knife the leather round the edge, nearly four quadrantal arcs, leaving a ſmall tongue between each, as in fig. 22. No. 3. The ſtrained valve immediately ſhrinks inwards, as repreſented by the ſhaded parts; and the ſtrain by which it is kept down is now greatly diminiſhed, taking place only at the corners. The gratings being reduced nearly to an edge (but not quite, leſt they ſhould cut), there is very little preſſure to produce adheſion by the clammy oil. Thus it appears, that a very ſmall elaſticity of the air in the receiver will be ſufficient to raiſe the valve; and Mr. Smeaton found, that when it was not able to do this at firſt, when only about $\frac{1}{700}$ of the natural elaſticity, it would do it after keeping the piſton up eight or ten ſeconds, the air having been all the while undermining the valve, and gradually detaching it from the grating.

Unfortunately he could not follow this method with the piſton valve. There was not room round the rod for ſuch an expanded valve; and it would have obliged him to have a great ſpace below the valve, from which he could not expel the air by the deſcent of the piſton. His ingenuity hit on a way of increaſing the expelling force through the common valve: he incloſed the rod of the piſton in a collar of leather *l*, through which it moved freely without allowing any air to get paſt its ſides. For greater ſecurity, the collar of leather was contained in a box terminating in a cup filled with oil. As this makes a material change in the principle of conſtruction of the air-pump (and indeed of pneumatic engines in general), and as it has been adopted in all the ſubſequent attempts to improve them, it merits a particular conſideration.

The piſton itſelf conſiſts of two pieces of braſs faſtened by ſcrews from below. The uppermoſt, which is of one ſolid piece with the rod GH (pl. 8. fig. 22. No. 1.), is of a diameter ſomewhat leſs than the barrel; ſo that when they are ſcrewed together, a piece of leather ſoaked in a mixture of boiled oil and tallow is put between them; and when the piſton is thruſt into the barrel from above, the leather comes up around the ſide of the piſton, and fills the barrel, making the piſton perfectly air-tight. The lower half of the piſton projects upwards into the upper, which has a hollow *g b c g* to receive it. There is a ſmall hole through the lower half at *a* to admit the air; and a hole *c d* in the upper half to let it through, and there is a ſlip of oiled ſilk ſtrained acroſs the hole *a* by way of valve, and there is room enough left at *b c* for this valve to riſe a little when preſſed from below. The rod GH paſſes through the piece of braſs which forms the top of the barrel ſo as to move freely, but without any ſenſible ſhake: this top is formed into a hollow box, conſiſting of two pieces ECDF and CNOD, which ſcrew together at CD. This box is filled with rings of oiled leather exactly fitted to its diameter, each having a hole in it for the rod to paſs through. When the piece ECDF is ſcrewed down, it compreſſes the leathers; ſqueezing them to the rod, ſo that no air can paſs between them; and, to ſecure us againſt all ingreſs of air, the upper part is formed into a cup EF, which is kept filled with oil.

The top of the barrel is alſo pierced with a hole LK, which riſes above the flat ſurface NO, and has a ſlip of oiled ſilk tied over it to act as a valve; opening when preſſed from below, but ſhutting when preſſed from above.

The communication between the barrel and receiver is made by means of the pipe ABPQ; and there goes from the hole K in the top of the barrel a pipe KRST, which either communicates with the open air or with the receiver, by means of the cock at its extremity T. The conduit pipe ABPQ has alſo a cock at Q, by which it is made to communicate either with the receiver or with the open air. Theſe channels of communication are variouſly conducted and terminated, according to the views of the maker: the ſketch in this figure is ſufficient for explaining the principle, and is ſuited to the general form of the pump, as it has been frequently made by Nairne and other artiſts in London.

Let us now ſuppoſe the piſton at the top of the barrel, and that it applies to it all over, and that the air in the barrel is very much rarefied: in the common pump the piſton valve is preſſed hard down by the atmoſphere, and continues ſhut till the piſton gets far down, condenſes the air below it beyond its natural ſtate, and enables it to force up the valves. But here, as ſoon as the piſton quits the top of the barrel, it leaves a void behind it; for no air gets in round the piſton rod, and the valve at K is ſhut by the preſſure of the atmoſphere. There is nothing now to oppoſe the elaſticity of the air below but the ſtiffneſs of the valve *b c*; and thus the expelling (or more accurately the liberating) force is prodigiouſly increaſed.

The ſuperiority of this conſtruction will be beſt ſeen by an example. Suppoſe the ſtiffneſs of the valve equal to the weight of $\frac{1}{10}$ of an inch of mercury, when the barometer ſtands at 30 inches, and that the pump gage ſtands at 29.9; then, in an ordinary pump, the valve in the piſton will not riſe till the piſton has got within the 300th part of the bottom of the barrel, and it will leave the valve-hole filled with air of the ordinary denſity. But in this pump the valve will riſe as ſoon as the piſton quits the top of the barrel; and when it is quite down, the valve-hole *a* will contain only the 300th part of the air which it would have contained in a pump of the ordinary form. Suppoſe further, that the barrel is of equal capacity with the receiver, and that both pumps are ſo badly conſtructed, that the ſpace left below the piſton is the 300th part of the barrel. In the common pump the piſton valve will riſe no more, and the rarefaction can be carried no further, however delicate the barrel valve may be; but in this pump the next ſtroke will raiſe the gage to 29.95, and the piſton valve will again riſe as ſoon as the piſton gets half way down the barrel.

The limit to the rarefaction by this pump depends chiefly on the ſpace contained in the hole LK; and in the ſpace *bcd* of the piſton. When the piſton is brought up to the top, and applied cloſe to it, thoſe ſpaces remain filled with air of the ordinary denſity, which will expand as the piſton deſcends, and thus will retard the opening of the piſton valve. The rarefaction will ſtop when the elaſticity of this ſmall quantity of air, expanded ſo as to fill the whole barrel (by the deſcent of the piſton to the bottom), is juſt equal to the force requiſite for opening the piſton valve.

Another advantage attending this conſtruction is, that in drawing up the piſton, we are not reſiſted by the whole preſſure of the air; becauſe the air is rarefied above this piſton as well as below it, and the piſton is in preciſely the ſame ſtate of preſſure as if connected with another piſton in a double pump. The reſiſtance to the aſcent of the piſton is the exceſs of the elaſticity of the air above it over the elaſticity of the air below: this, toward the end of the rarefaction, is very ſmall, while the piſton is near the bottom of the barrel, but gradually increaſes as the piſton riſes, and reduces the air above it into ſmaller dimenſions, and becomes equal to the preſſure of the atmoſphere, when the air above the piſton is of the common denſity. If we ſhould raiſe the piſton ſtill further, we muſt condenſe the air above it: but Mr. Smeaton has here made an iſſue for the air by a ſmall hole in the top of the barrel, covered with a delicate valve. This allows the air to eſcape, and ſhuts again as ſoon as the piſton begins to deſcend, leaving almoſt a perfect void behind it as before.

This pump has another advantage. It may be changed in a moment from a rarefying to a condenſing engine, by ſimply turning the cocks at Q and T. While T communicates with the open air and Q with the receiver, it is a rarefying engine or air-pump: but when T communicates with the receiver, and Q with the open air, it is a condenſing engine.

Fig. 23. in pl. 9. repreſents Mr. Smeaton's air-pump as it is uſually made by Nairne. Upon a ſolid baſe or table are ſet up three pillars F, H, H: the pillar F ſupports the pump plate A; and the pillars H, H, ſupport the front or head, containing a braſs cog-wheel, which is turned by the handle B, and works in the rack C faſtened to the upper end of the piſton rod. The whole is ſtill further ſteadied by two pieces of braſs *c b* and *o k*, which connect the pump-plate with the front, and have perforations communicating between the hole *a* in the middle of the plate and the barrel, as will be deſcribed immediately. DE is the barrel of the pump, firmly fixed to the table by ſcrews through its upper flanch: *e f d c* is a ſlender braſs tube ſcrewed to the bottom of the barrel, and to the under hole of the horizontal canal *c b*. In this canal there is a cock which opens a communication between the barrel and the receiver, when the key is in the poſition repreſented here: but when the key is at right angles with this poſition, this communication is cut off. If that ſide of the key which is here drawn next to the pump-plate be turned outward, the external air is admitted into the receiver; but, if turned inwards, the air is admitted into the barrel.

g b is another ſlender braſs pipe, leading from the diſcharging valve at *g* to the horizontal canal *b k*, to the under ſide of which it is ſcrewed faſt. In this horizontal canal there is a cock *n*, which opens a paſſage from the barrel to the receiver when the key is in the poſition here drawn; but opens a paſſage from the barrel to the external air when the key is turned outwards, and from the receiver to the external air when the key is turned inwards. This communication with the external air is not immediate, but through a ſort of box *i*; the uſe of this box is to receive the oil which is diſcharged through the top valve *g*. In order to keep the pump tight, and in working order, it is proper ſometimes to pour a table-ſpoonful of olive-oil into the hole *a* of the pump-plate, and then to work the pump. The oil goes along the conduit *b c d f e*, gets into the barrel and through the piſton-valve, when the piſton is preſſed to the bottom of the barrel, and is then drawn up, and forced through the diſcharging valve *g* along the pipe *g b*, the horizontal paſſage *b n*, and finally into the box *i*. This box has a ſmall hole in its ſide near the top, through which the air eſcapes.

From the upper ſide of the canal *c b* there riſes a ſlender pipe which bends outward and then turns downwards, and is joined to a ſmall box, which cannot be ſeen in this view. From the bottom of this box proceeds downwards the gage-pipe of glaſs, which enters the ciſtern of mercury G fixed below.

On the upper ſide of the other canal at *o* is ſeen a ſmall ſtud, having a ſhort pipe of glaſs projecting horizontally from it, cloſe by and parallel to the front piece of the pump, and reaching to the other canal. This pipe is cloſe at the further end, and has a ſmall drop of mercury or oil in it at the end *o*. This ſerves as a gage in condenſing, indicating the degree of condenſation by the place of the drop: For this drop is forced along the pipe, condenſing the air before it in the ſame degree in which it becomes condenſed in the barrel and in the receiver.

In conſtructing this pump, Mr. Smeaton introduced a method of joining together the different pipes and other pieces, which has great advantages over the uſual manner of ſcrewing them together with leather between, and which is now much uſed in hydraulic and pneumatic engines. We ſhall explain this to our readers by a deſcription of the manner in which the exhauſting gage is joined to the horizontal duct *c b*.

The piece *b i p*, in pl. 8. fig 22. No. 2. is the ſame with the little cylinder obſervable on the upper ſide of the horizontal canal *c d*, in pl. 9. fig. 23. The upper part *b i* is formed into an outſide ſcrew, to fit the hollow ſcrew of the piece *d e e d*. The top of this laſt piece has a hole in its middle, giving an eaſy paſſage to the bent tube *c b a*, ſo as to ſlip along it with freedom. To the end *c* of this bent tube is ſoldered a piece of braſs *c f g*, perforated in continuation of the tube, and having its end ground flat on the top of the piece *b i p*, and alſo covered with a ſlip of thin leather ſtrained acroſs it and pierced with a hole in the middle.

It is plain from this form, that if the ſurface *f g* be applied to the top of *b i*, and the cover *d e e d* be ſcrewed down on it, it will draw or preſs them together, ſo that no air can eſcape by the joint, and this without turning the whole tube *c b a* round, as is neceſſary in the uſual way. This method is now adopted for joining together the conducting pipes of the machines for extinguiſhing fires, an operation which was extremely troubleſome before this improvement.

The conduit pipe E*e f c* (fig. 23.) is faſtened to the bottom of the barrel, and the diſcharging pipe *g b* to its top, in the ſame manner. But to return to the gage; the bent pipe *c b a* enters the box *s t* near one ſide, and obliquely, and the gage-pipe *q r* is inſerted through its bottom towards the oppoſite ſide. The uſe of this box is to catch any drops of mercury which may ſometimes be daſhed up through the gage-pipe by an accidental oſcillation. This, by going through the paſſages of the pump, would corrode them, and would act particularly on the joints, which are generally ſoldered with tin. When this happens to an air-pump, it muſt be cleaned with the moſt ſcrupulous attention, otherwiſe it will be quickly deſtroyed.

This account of Smeaton's pump is ſufficient for enabling the reader to underſtand its operation and to ſee its ſuperiority. It is reckoned a very fine pump of the ordinary conſtruction which will rarefy 200 times, or raiſe the gage to 29.85, the barometer ſtanding at 30. But Mr. Smeaton found, that his pump, even after long uſing, raiſed it to 29.95, which we conſider as equivalent to rarefying 600 times. When in fine order, he found no bounds to its rarefaction, frequently raiſing the gage as high as the barometer; and he thought its performance ſo perfect, that the barometer-gage was not ſufficiently delicate for meaſuring the rarefaction. He therefore ſubſtituted the ſyphon gage already deſcribed, which he gives ſome reaſons for preferring; but even this he found not ſufficiently ſenſible.

He contrived another, which could be carried to any degree of ſenſibility. It conſiſted of a glaſs body A (fig. 24.), of a pear ſhape, and was therefore called the pear-gage. This had a ſmall projecting orifice at B, and at the other end a tube CD, whoſe capacity was the hundredth part of the capacity of the whole veſſel. This was ſuſpended at the ſlip-wire of the receiver, and there was ſet below it a ſmall cup with mercury. When the pump was worked, the air in the pear-gage was rarefied along with the reſt. When the rarefaction was brought to the degree intended, the gage was let down till B reached the bottom of the mercury. The external air being now let in, the mercury was raiſed into the pear, and ſtood at ſome height E in the tube CD. The length of this tube being divided into 100 parts, and thoſe numbered from D, it is evident that $\frac{DE}{DB}$ will expreſs the degree of rarefaction which had been produced when the gage was immerſed into the mercury: or if DC be $\frac{1}{100}$ of the whole capacity, and be divided into 100 parts by a ſcale annexed to it, each unit of the ſcale will be $\frac{1}{10000}$ of the whole.

This was a very ingenious contrivance, and has been the means of making ſome very curious and important diſcoveries which at preſent engage the attention of philoſophers. By this gage Mr. Smeaton found, that his pump frequently rarefied a thouſand, ten thouſand, nay a hundred thouſand times. But though he in every inſtance ſaw the great ſuperiority of his pump above all others, he frequently found irregularities which he could not explain, and a want of correſpondence between the pear and the barometer gages which puzzled him. The pear-gage frequently indicated a prodigious rarefaction, when the barometer-gage would not ſhow more than 600.

Theſe unaccountable phenomena excited the curioſity of philoſophers, who by this time were making continual uſe of the air-pump in their meteorological reſearches, and much intereſted in every thing connected with the ſtate or conſtitution of elaſtic fluids. Mr. Nairne, a moſt ingenious and accurate maker of philoſophical inſtruments, made many curious experiments in the examination and compariſon of Mr. Smeaton's pump with thoſe of the uſual conſtruction, attending to every circumſtance which could contribute to the inferiority of the common pumps or to their improvement, ſo as to bring them nearer to this rival machine. This rigorous compariſon brought into view ſeveral circumſtances in the conſtitution of the atmoſpheric air, and its relation to other bodies, which are of the moſt extenſive and important influence in the operations of nature. We ſhall notice at preſent ſuch only as relate to the operation of the air-pump in extracting AIR from the receiver.

Mr. Nairne found, that when a little water, or even a bit of paper damped with water, was expoſed under the receiver of Mr. Smeaton's air-pump, when in the moſt perfect condition, raiſing the mercury in the barometer-gage to 29.95, he could not make it riſe above 29.8 if Fahrenheit's thermometer indicated the temperature 47°, nor above 29.7 if the thermometer ſtood at 55°; and that to bring the gage to this height and keep it there, the operation of the pump muſt be continued for a long time after the water had diſappeared, or the paper become perfectly dry. He found that a drop of ſpirits, or paper moiſtened with ſpirits, could not in thoſe circumſtances allow the mercury in the gage to riſe to near that height; and that ſimilar effects followed from admitting any volatile body whatever into the receiver or any part of the apparatus.

This ſhowed him at once how improper the directions were which had been given by Guericke, Boyle, Graveſande, and others, for fitting up the air-pump for experiment, by ſoaking the leather in water, covering the joints with water, or, in ſhort, admitting water or any other volatile body near it.

He therefore took his pumps to pieces, cleared them of all the moiſture which he could drive from them by heat, and then leathered them anew with leather ſoaked in a mixture of olive oil and tallow, from which he had expelled all the water it uſually contains, by boiling it till the firſt frothing was over. When the pumps were fitted up in this manner, he uniformly found that Mr. Smeaton's pump rarefied the gage to 29.95, and the beſt common pump to 29.87, the firſt of which he computed to indicate a rarefaction to 600, and the other to 230. But in this ſtate he again found that a piece of damp paper, leather, wood, &c. in the receiver, reduced the performance in the ſame manner as before.

But the moſt remarkable phenomenon was, that when he made uſe of the pear-gage with the pump cleared from all moiſture, it indicated the ſame degree of rarefaction with the barometer-gage: but when he expoſed a bit of paper moiſtened with ſpirits, and thus reduced the rarefaction of the pump to what he called 50, the barometer-gage ſtanding at 29.4, the pear-gage indicated a rarefaction exceeding 100,000; in ſhort, it was not meaſurable; and this phenomenon was almoſt conſtant. Whenever he expoſed any ſubſtance ſuſceptible of evaporation, he found the rarefaction indicated by the barometer-gage greatly reduced, while that indicated by the pear-gage was prodigiouſly increaſed; and both theſe effects were more remarkable as the ſubject was of eaſier evaporation, or the temperament of the air of the chamber was warmer.

This uniform reſult ſuggeſted the true cauſe. Water boils at the temperature 212, that is, it is then converted into a vapour which is permanently elaſtic while of that temperature, and its elaſticity balances the preſſure of the atmoſphere. If this preſſure be diminiſhed by rarefying the air above it, a lower temperature will now allow it to be converted into elaſtic vapour, and keep it in that ſtate. Water will boil in the receiver of an air-pump at the temperature 96, or even under it. Philoſophers did not think of examining the ſtate of the vapour in temperatures lower than what produced ebullition. But it now appears, that in much lower heats than this the ſuperficial water is converted into elaſtic vapour, which continues to exhale from it as long as the water laſts, and, ſupplying the place of air in the receiver, exerts the ſame elaſticity, and hinders the mercury from riſing in the gage in the ſame manner as ſo much air of equal elaſticity would have done.

When Mr. Nairne was exhibiting theſe experiments to the honourable Henry Cavendiſh in 1776, this gentleman informed him, that it appeared from a ſeries of experiments of his father lord Charles Cavendiſh, that when water is of the temperature 72, it is converted into vapour, under any preſſure leſs than three-fourths of an inch of mercury, and at 41° it becomes vapour when the preſſure is leſs than one-fourth of an inch: even mercury evaporates in this manner when all preſſure is removed. A dewy appearance is frequently obſerved covering the inſide of the tube of a barometer, where we uſually ſuppoſe a vacuum. This dew, when viewed through a microſcope, appears to be a ſet of detached globules of mercury; and upon inclining the tube ſo that the mercury may aſcend along it, theſe globules will be all licked up, and the tube become clear. The dew which lined it was the vapour of the mercury condenſed by the ſide of the tube; and it is never obſerved but when one ſide is expoſed to a ſtream of cold air from a window, &c.

To return to the vapour in the air-pump receiver, it muſt be obſerved, that as long as the water continues to yield it, we may continue to work the pump; and it will be continually abſtracted by the barrels, and diſcharged in the form of water, becauſe it collapſes as ſoon as expoſed to the external preſſure. All this while the gage will not indicate any more rarefaction, becauſe the thing immediately indicated by the barometer-gage is *diminiſhed elaſticity*, which does not happen here. When all the water which the temperature of the room can keep elaſtic has evaporated under a certain preſſure, ſuppoſe $\frac{1}{2}$ an inch of mercury, the gage ſtanding at 29.5, the vapour which now fills the receiver expands, and by its diminiſhed elaſticity the gage riſes, and now ſome more water which had been attached to bodies by chemical or corpuſcular attraction is detached, and a new ſupply continues to ſupport the gage at a greater height; and this goes on continually till *almoſt* all has been abſtracted: but there will remain ſome which no art can take away; for, as it paſſes through the barrels, and gets between the piſton and the top, it ſucceſſively collapſes into water during the aſcent of the piſton, and again expands into vapour when we puſh the piſton down again. Whenever this happens there is an end of the rarefaction.

While this operation is going on, the air comes out along with the vapour; but we cannot ſay in what proportion. If it were always uniformly mixed with the vapour, it would diminiſh rapidly; but this does not appear to be the caſe. There is a certain period of rarefaction in which a tranſient cloudineſs is perceived in the receiver. This is watery vapour formed at that degree of rarefaction, mingled with, but not diſſolved in or united with, the air, otherwiſe it would be tranſparent. A ſimilar cloud will appear if damp air be admitted ſuddenly into an exhauſted receiver. The vapour which formed an uniform tranſparent maſs with the air, is either ſuddenly expanded, and thus detached from the other ingredient, or is ſuddenly let go by the air, which expands more than it does. We cannot affirm with probability which of theſe is the caſe: different compoſitions of air, that is, air loaded with vapours from different ſubſtances, exhibit remarkable differences in this reſpect. But we ſee from this and other phenomena, which ſhall be mentioned in their proper places, that the air and vapour are not always intimately united; and therefore will not always be drawn out together by the air-pump. But let them be ever ſo confuſedly blended, we ſee that the air muſt come out along with the vapour, and its quantity remaining in the receiver muſt be prodigiouſly diminiſhed by this aſſociation, probably much more than could be, had the receiver only contained pure air.

Let us now conſider what muſt happen in the pear-gage. As the air and vapour are continually drawn off from the receiver, the air in the pear expands and goes off with it. We ſhall ſuppoſe that the generated vapour hinders the gage from riſing beyond 29.5. During the continued working of the pump, the air in the pear, whoſe elaſticity is 0.5, ſlowly mixes with the vapour at the mouth of the pear, and the mixture even advances into its inſide; ſo that, if the pumping be long enough continued, what is in the pear is nearly of the ſame compoſition with what is in the receiver, conſiſting perhaps of 20 parts of vapour and one part of air, all of the elaſticity of 0.5. When the pear is plunged into the mercury, and the external air allowed to get into the receiver, the mercury riſes in the pear-gage, and leaves not $\frac{1}{60}$, but $\frac{1}{60 \times 20}$ or $\frac{1}{1200}$ of it filled with common air, the vapour having collapſed into an inviſible atom of water. Thus the pear-gage will indicate a rarefaction of 1200, while the barometer-gage only ſhowed 60, that is, ſhowed the elaſticity of the included ſubſtance diminiſhed 60 times. The concluſion to be drawn from theſe two meaſures (the one of the rarefaction of air, and the other of the diminution of elaſticity) is, that the matter with which the receiver was filled, immediately before the re-admiſſion of the air, conſiſted of one part of incondenſable air, and $\frac{1200}{60}$, or 20 parts of watery vapour.

The only obſcure part of this account is what relates to the compoſition of the matter which filled the pear-gage before the admiſſion of the mercury. It is not eaſy to ſee how the vapour of the receiver comes in by a narrow mouth while the air is coming out by the ſame paſſage. Accordingly it requires a *very long time* to produce this extreme rarefaction in the pear-gage; and there are great irregularities in any two ſucceeding experiments, as may be ſeen by looking at Mr. Nairne's account of them in the Philoſophical Tranſactions, vol. lxvii. Some vapours appear to have mixed much more readily with the air than others; and there are ſome unaccountable caſes where vitriolic acid and ſulphureous bodies were included, in which the diminution of denſity indicated by the pear-gage was uniformly leſs than the diminution of elaſticity indicated by the barometer gage. It is enough for us at preſent to have eſtabliſhed, by unqueſtionable facts, this production of elaſtic vapour, and the neceſſity of attending to it, both in the conſtruction of the air-pump, and in drawing reſults from experiments exhibited in it.

Mr. Smeaton's pump, when in good order, and perfectly free from all moiſture, will in dry weather rarefy air about 600 times, raiſing the barometer-gage to within $\frac{1}{20}$ of an inch of a fine barometer. This was a performance ſo much ſuperior to that of all others, and by means of Mr. Nairne's experiments opened ſo new a field of obſervation, that the air-pump once more became a capital inſtrument among the experimental philoſophers. The cauſes of its ſuperiority were alſo ſo diſtinct, that artiſts were immediately excited to a further improvement of the machine; ſo that this becomes a new epoch in its hiſtory.

This is one imperfection which Mr. Smeaton has not attempted to remove. The diſcharging valve is ſtill opened againſt the preſſure of the atmoſphere. An author of the Swediſh academy adds a ſubſidiary pump to this valve, which exhauſts the air from above it, and thus puts it in the ſituation of the piſton valve. We do not find that this improvement has been adopted ſo as to become general. Indeed the quantity of air which remains in the paſſage to this valve is ſo exceedingly little, that it does not ſeem to merit attention. Suppoſing the valve-hole $\frac{1}{20}$ of an inch wide and as deep (and it need not be more), it will not occupy more than $\frac{1}{5000}$ part of a barrel twelve inches long and two inches wide.

Mr. Smeaton, by his ingenious conſtruction, has greatly diminiſhed, but has not annihilated, the obſtructions to the paſſage of the air from the receiver into the barrel. His firſt ſucceſs encouraged further attempts. One of the firſt and moſt ingenious was that of profeſſor Ruſſel of the univerſity of Edinburgh, who about the year 1770 conſtructed a pump in which both cocks and valves were avoided.

The piſton is ſolid, as repreſented in pl. 9. fig. 25. and its rod paſſes through a collar of leather on the top of the barrel. This collar is divided into three portions by two braſs rings *a*, *b*, which leave a very ſmall ſpace round the piſton rod. The upper ring *a* communicates by means of a lateral perforation with the bent tube *l m n*, which enters the barrel at its middle *n*. The lower ring *b* communicates with the bent tube *c d*, which communicates with the horizontal paſſage *de*, going to the middle *e* of the pump plate. By the way, however, it communicates alſo with a barometer gage *p o*, ſtanding in a ciſtern of mercury *o*, and covered with a glaſs tube cloſe at the top. Beyond *e*, on the oppoſite circumference of the receiver-plate, there is a cock or plug *f* communicating with the atmoſphere.

The piſton rod is cloſely embraced by the three collars of leather; but, as already ſaid, has a free ſpace round it in the two braſs rings. To produce this preſſure of the leathers to the rod, the braſs rings which ſeparate them are turned thinner on the inner ſide, ſo that their croſs ſection along a diameter would be a taper wedge. In the ſide of the piſton rod are two cavities *q r*, *t s*, about one-tenth of an inch wide and deep, and of a length equal to the thickneſs of the rings *a*, *b*, and the intermediate collar of leathers. Theſe cavities are ſo placed on the piſton-rod, that, when the piſton is applied to the bottom of the barrel, the cavity *t s* in the upper end of the rod has its upper end oppoſite to the ring *a*, and its lower end oppoſite to the ring *b*, or to the mouth of the pipe *c d*. Therefore, if there be a void in the barrel, the air from the receiver will come from the pipe *c d* into the cavity in the piſton rod, and by it will get paſt the collar of leather between the rings, and thus will get into the ſmall interſtice between the rod and the upper ring, and then into the pipe *l m n*, and into the empty barrel. When the piſton is drawn up, the ſolid rod immediately ſhuts up this paſſage, and the piſton drives the air through the diſcharging valve *k*. When it has reached the top of the barrel, and is cloſely applied to it, the cavity *q r* is in the ſituation in which *t s* formerly was, and the communication is again opened between the receiver and the empty barrel, and the air is again diffuſed between them. Puſhing down the piſton expels the air by the lower diſcharging pipe and valve *b i*; and thus the operation may be continued.

This muſt be acknowledged to be a moſt ſimple and ingenious conſtruction, and can neither be called a cock nor a valve. It ſeems to oppoſe no obſtruction whatever: and it has the ſuperior advantage of rarefying both during the aſcent and the deſcent of the piſton, doubling the expedition of the performance, and the operator is not oppoſed by the preſſure of the atmoſphere except towards the end of each ſtroke. The expedition, however, is not ſo great as one ſhould expect: for nothing is going on while the piſton is in motion, and the operator muſt ſtop a while at the end of each ſtroke, that the air may have time to come through this long, narrow, and crooked paſſage, to fill the barrel. But the chief difficulty which occurred in the execution aroſe from the clammy oil with which it was neceſſary to impregnate the collar of leathers. Theſe were always in a ſtate of ſtrong compreſſion, that they might cloſely graſp the piſton rod, and prevent all paſſage of air during the motion of the piſton. Whenever therefore the cavities in the piſton rod come into the ſituations neceſſary for connecting the receiver and barrel, this oil is ſqueezed into them, and choaks them up. Hence it always happened that it was ſome time after the ſtroke before the air could force its way round the piſton rod, carrying with it the clammy oil which choaked up the tube *l m n*; and when the rarefaction had proceeded a certain length, the diminiſhed elaſticity of the air was not able to make its way through theſe obſtructions. The death of the ingenious author put a ſtop to the improvements by which he hoped to remedy this defect, and we have not heard that any other perſon has ſince attempted it. We have inſerted it here, becauſe its principle of conſtruction is not only very ingenious, but entirely different from all others, and may furniſh very uſeful hints to thoſe who are much engaged in the conſtruction of pneumatic engines.

In the 73d volume of the Philoſophical Tranſactions, Mr. Tiberius Cavallo has given the deſcription of an air-pump contrived and executed by Meſſrs. Haas and Hurter, inſtrument makers in London, where theſe artiſts have revived Guericke's method of opening the barrel-valve during the laſt ſtrokes of the pump by a force acting from without. We ſhall inſert ſo much of this deſcription as relates to this diſtinguiſhing circumſtance of its conſtruction.

In pl. 9. fig. 26. repreſents a ſection of the bottom of the barrel, where AA is the barrel and BB the bottom, which has in its middle a hollow circle CCFF, projecting about half an inch into the barrel at CC, and extending a good way downwards to FF. The ſpace between this projection and the ſides of the barrel is filled up by a braſs ring DD, over the top of which is ſtrained a piece of oiled ſilk EE, which performs the office of a valve, covering the hole CC. But this hole is filled up by a piece of braſs, or rather an aſſemblage of pieces ſcrewed together GGHHII. It conſiſts of three projecting fillets or ſhoulders GG, HH, II, which form two hollows between them, and which are filled with rings of oiled leather OO, PP, firmly ſcrewed together. The extreme fillets GG, II, are of equal diameter with the inſide of the cylinder, ſo as to fill it exactly, and the whole, ſtuffed with oiled leather, ſlide up and down without allowing any air to paſs. The middle fillet HH is not ſo broad, but thicker. In the upper fillet GG there is formed a ſhallow diſh about $\frac{1}{8}$ of an inch deep and $\frac{3}{4}$ wide. This diſh is covered with a thin plate pierced with a grating like Mr. Smeaton's valve plate. There is a perforation VX along the axis of this piece, which has a paſſage out at one ſide H, through the middle fillet. Oppoſite to this paſſage, and in the ſide of the cylinder CCFF, is a hole M, communicating with the conduit pipe MN, which leads to the receiver. Into the lower end of the perforation is ſcrewed the pin KL, whoſe tail L paſſes through the cap FF. The tail L is connected with a lever RQ, moveable round the joint Q. This lever is puſhed upwards by a ſpring, and thus the whole piece which we have been deſcribing is kept in contact with the ſlip of oiled ſilk or valve EE. This is the uſual ſituation of things.

Now ſuppoſe a void formed in the barrel by drawing up the piſton; the elaſticity of the air in the receiver, in the pipe NM, and in the paſſage XV, will preſs on the great ſurface of the valve expoſed through the grating, will raiſe it, and the pump will perform preciſely as Mr. Smeaton's does. But ſuppoſe the rarefaction to have been ſo long continued, that the air is no longer able to raiſe the valve; this will be ſeen by the mercury riſing no more in the pump-gage. When this is perceived, the operator muſt preſs with his foot on the end R of the lever RQ. This draws down the pin KL, and with it the whole hollow plug with its grated top. And thus, inſtead of raiſing the valve from its plate, the plate is here drawn down from the valve. The air now gets in without any obſtruction whatever, and the rarefaction proceeds as long as the piſton riſes. When it is at the top of the barrel, the operator takes his foot from the lever, and the ſpring preſſes up the plug again and ſhuts the valve. The piſton rod paſſes through a collar of leather, as in Mr. Smeaton's pump, and the air is finally diſcharged through an outward valve in the top of the barrel. Theſe parts have nothing peculiar in them.

This is an ingenious contrivance, ſimilar to what was adapted by Guericke himſelf; and we have no doubt of theſe pumps performing extremely well if carefully made: and it ſeems not difficult to keep the plug perfectly air-tight by ſupplying plenty of oil to the leathers. We cannot ſay, however, with preciſion what may be expected from it, as no account has been given of its effects beſides what Mr. Cavallo publiſhed in the Philoſophical Tranſactions 1783, where he only ſays, that when it had been long uſed, it had, in the courſe of ſome experiments, rarefied 600 times.

Aiming ſtill at the removing the obſtructions to the entry of the air from the receiver into the barrels, Mr. Prince, an American, has conſtructed a pump in which there is no valve or cock whatever between them. In this pump the piſton rod paſſes through a collar of leathers, and the air is finally diſcharged through a valve, as in the two laſt. But we are chiefly to attend, in this place, to the communication between the barrel and the receiver. The barrel widens below into a ſort of ciſtern ABCD (fig. 27.), communicating with the receiver by the pipe EF. As ſoon, therefore, as the piſton gets into this wider part, where there is a vacancy all round it, the air of the receiver expands freely through the paſſage FEE into the barrel, in which the deſcent of the piſton had made a void. When the piſton is again drawn up, as ſoon as it gets into the cylindric part of the barrel, which it exactly fills, it carries up the air before it, and expels it by the top valve; and, that this may be done more completely, this valve opens into a ſecond barrel or air-pump whoſe piſton is riſing at the ſame time, and therefore the valve of communication (which is the diſcharging valve of the primary pump) opens with the ſame facility as Mr. Smeaton's piſton valve. While the piſton is riſing, the air in the receiver expands into the barrel; and when the piſton deſcends, the air in the barrel again collapſes till the piſton gets again into the ciſtern; when the air paſſes out, and fills the evacuated barrel, to be expelled by the piſton as before.

No diſtinct account has as yet been given of the performance of this pump; we only learn that great inconveniences were experienced from the oſcillations of the mercury in the gage. As ſoon as the piſton comes into the ciſtern, the air from the receiver immédiately ruſhes into the barrel, and the mercury ſhoots up in the gage, and gets into a ſtate of oſcillation. The ſubſequent riſe of the piſton will frequently keep time with the ſecond oſcillation, and increaſe it. The deſcent of the piſton produces a downward oſcillation, by allowing the air below it to collapſe; and, by improperly timing the ſtrokes, this oſcillation becomes ſo great as to make the mercury enter the pump. To prevent this, and a greater irregularity of working as a condenſer, valves were put in the piſton; but as theſe require force to open them, the addition ſeemed rather to increaſe the evil, by rendering the oſcillations more ſimultaneous with the ordinary rate of working. If this could be got over, the conſtruction ſeems very promiſing.

It appears, however, of very difficult execution. It has many long, ſlender, and crooked paſſages, which muſt be drilled through broad plates of braſs, ſome of them appearing ſcarcely practicable. It is rare to find plates and other pieces of braſs without air-holes, which it would be very difficult to find out and to cloſe; and it muſt be very difficult to clear it of obſtructions; ſo that it appears rather a ſuggeſtion of theory than a thing warranted by its actual performance.

Mr. Lavoiſier, or ſome of the naturaliſts who were occupied in concert with him in the inveſtigation of the different ſpecies of gas which are diſengaged from bodies in the courſe of chemical operations, has contrived an air-pump which has great appearance of ſimplicity, and, being very different from all others, deſerves to be taken notice of.

It conſiſts of two barrels *l*, *m*, fig. 28. with ſolid piſtons *k k*. The pump-plate *a b* is pierced at its centre *c* with a hole which branches towards each of the barrels, as repreſented by *c d*, *c e*. Between the plate and the barrels ſlides another plate *h i*, pierced in the middle with a branched hole *f d g*, and near the ends with two holes *h h*, *i i*, which go from its underſide to the ends. The holes in theſe two plates are ſo adjuſted, that when the plate *h i* is drawn ſo far towards *h* that the hole *i* comes within the barrel *m*, the branch *d f* of the hole in the middle plate coincides with the branch *c d* of the upper plate, and the holes *e*, *g*, are ſhut. Thus a communication is eſtabliſhed between the barrel *l* and the receiver on the pump-plate, and between the barrel *m* and the external air. In this ſituation the barrel *l* will exhauſt, and *m* will diſcharge. When the piſton of *l* is at its mouth, and that of *m* touches its bottom, the ſliding plate is ſhifted over to the other ſide, ſo that *m* communicates with the receiver through the paſſage *gd*, *ec*, and *l* communicates with the air by the paſſages *h h*.

It is evident that this ſliding plate performs the office of four cocks in a very beautiful and ſimple manner, and that if the piſtons apply cloſe to the ends of the barrels, ſo as to expel the whole air, the pump will be perfect. It works, indeed, againſt the whole preſſure of the external air. But this may be avoided by putting valves on the holes *h*, *i*; and theſe can do no harm, becauſe the air remaining in them never gets back into the barrel till the piſton be at the further end, and the exhauſtion of that ſtroke completed. But the beſt workmen of London think that it will be incomparably more difficult to execute this cock (for it is a cock of an unuſual form) in ſuch a manner that it ſhall be air-tight and yet move with tolerable eaſe, and that it is much more liable to wearing looſe than common cocks. No accurate accounts have been received of its performance. It muſt be acknowledged to be ingenious, and it may ſuggeſt to an intelligent artiſt a method of combining common conical cocks upon one axis ſo as to anſwer the ſame purpoſes much more effectually; for which reaſon we have inſerted it here.

The laſt improvement which we ſhall mention is that publiſhed by Mr. Cuthbertſon, philoſophical inſtrument-maker in Amſterdam. His pump has given ſuch evidences of its perfection, that we can hardly expect or wiſh for any thing more complete. But we muſt be allowed to obſerve, beforehand, that the ſame conſtruction was invented, and in part executed, before the end of 1779, by Dr. Daniel Rutherford, now profeſſor of botany in the univerſity of Edinburgh, who was at that time engaged in experiments on the production of air during the combuſtion of bodies in contact with nitre, and who was vaſtly deſirous of procuring a more complete abſtraction of pure aerial matter than could be effected by Mr. Smeaton's pump. The compiler of this article had then an opportunity of peruſing the Doctor's diſſertation on this ſubject, which was read in the Philoſophical Society of Edinburgh. In this diſſertation the doctor appears fully appriſed of the exiſtence of pure vital air in the nitrous acid as its chief ingredient, and as the cauſe of its moſt remarkable phenomena, and to want but a ſtep to the diſcoveries which have ennobled the name of Mr. Lavoiſier. He was particularly anxious to obtain *apart* this diſtinguiſhing ingredient in its compoſition, and, for this purpoſe, to abſtract completely from the veſſel in which he ſubjected it to examination, every particle of elaſtic matter. The writer of this article propoſed to him to cover the bottom of Mr. Smeaton's piſton with ſome clammy matter, which ſhould take hold of the bottom valve, and *ſtart it* when the piſton was drawn up. A few days after, the Doctor ſhowed him a drawing of a pump, having a conical metal valve in the bottom, furniſhed with a long ſlender wire, ſliding in the inſide of the piſton-rod with a gentle friction, ſufficient for lifting the valve, and ſecured againſt all chance of failure by a ſpring a-top, which took hold of a notch in the inſide of the piſton-rod about a quarter of an inch from the lower end, ſo as certainly to lift the valve during the laſt quarter of an inch of the piſton's motion. Being an excellent mechanic, he had executed a valve on this principle, and was fully ſatisfied with its performance. But having already confirmed his doctrines reſpecting the nitrous acid by incontrovertible experiments, his wiſhes to improve the air pump loſt their incitement, and he thought no more of it; and not long after this, the ardour of the philoſophers of the Teylerian Society at Haerlem and Amſterdam excited the efforts of Mr. Cuthbertſon, their inſtrument-maker, to the ſame purpoſe, and produced the moſt perfect air-pump that has yet appeared. We ſhall give a deſcription of it, and an account of its performance, in the inventor's own words.

Cuthbertſon's *Air-Pump*.

In pl. 13. is a perſpective view of this pump, with its two principal gages ſcrewed into their places. Theſe need not be uſed together, except in caſes where the utmoſt exactneſs is required. In common experiments one of them is removed, and a ſtop-ſcrew put in its place. When the pear-gage is uſed, a ſmall round plate, on which the receiver may ſtand, muſt be firſt ſcrewed into the hole at A; but this hole is ſtopped on other occaſions with a ſcrew. When all the three gages are uſed, and the receiver is exhauſted, the ſtop ſcrew B, at the bottom of the pump, muſt be unſcrewed, to admit the air into the receiver; but when they are not all uſed, either of the other ſtop-ſcrews will anſwer this purpoſe.

A croſs-bar for preventing the barrels from being ſhaken by working the pump or by any accident, is repreſented by the dotted lines. It is confined in its place, and kept cloſe down on the barrels by two ſlips of wood NN, which muſt be drawn out, as well as the ſcrews OO, when the pump is to be taken aſunder.

Plate 14. is a ſection of all the working parts of the pump, except the wheel and rack, in which there is nothing uncommon.

Fig. 1. is a ſection of one of the barrels, with all its internal parts; and fig. 2, 3, 4, and 5, are different parts of the piſton, proportioned to the ſize of the barrel[*] and to one another.

In fig. 1. CD repreſents the barrel, F the collar of leathers, G a hollow cylindrical veſſel to contain oil. R is alſo an oil-veſſel to receive the oil which is drawn, along with the air, through the hole *a a*, when the piſton is drawn upwards; and, when this is full, the oil is carried over with the air, along the tube T, into the oil-veſſel G. *c c* is a wire which is driven upwards from the hole *a a* by the paſſage of the air; and as ſoon as this has eſcaped, it falls down again by its own weight, ſhuts up the hole, and prevents all return of the air into the barrel. At *d d* are fixed two pieces of braſs, to keep the wire *c c* in a vertical direction, that it may accurately ſhut the hole. H is a cylindrical wire or rod which carries the piſton I, and is made hollow to receive a long wire *g g*, which opens and ſhuts the hole L; and on the other end of the wire O is ſcrewed a nut, which, by ſtopping in the narroweſt part of the hole, prevents the wire from being driven up too far. This wire and ſcrew are more clearly ſeen in fig. 2. and 6; they ſlide in a collar of leather *r r*, fig. 2. and 5. in the middle piece of the piſton. Fig. 4. and 5. are the two mean parts which compoſe the piſton, and when the pieces 3. and 6. are added to it, the whole is repreſented by fig. 2. Fig. 5. is a piece of braſs of a conical form, with a ſhoulder at the bottom. A long hollow ſcrew is cut in it, about $\frac{2}{3}$ of its length, and the remainder of the hole, in which there is no ſcrew, is of about the ſame diameter with the ſcrewed part, except a thin plate at the end, which is of a width exactly equal to the thickneſs of *g g*. That part of the inſide of the conical braſs in which no thread is cut, is filled with oiled leathers with holes through which *g g* can ſlide ſtiffly. There is alſo a male ſcrew with a hole in it, fitted to *g g*, ſerving to compreſs the leathers *r r*. In fig. 4. *aaaa* is the outſide of the piſton, the inſide of which is turned ſo as exactly to fit the outſide of fig. 5. *b b* are round leathers about 60 in number, *c c* is a circular piece of braſs of the ſize of the leathers, and *d d* is a ſcrew ſerving to compreſs them. The ſcrew at the end of fig. 3. is made to fit the ſcrew in fig. 5. Now if fig. 6. be puſhed into fig. 5, this into fig. 4, and fig. 3. be ſcrewed into the end of fig. 5, theſe will compoſe the whole of the piſton, as repreſented in fig 2. H. in fig. 1. repreſents the ſame part as H in fig. 2, and is that to which the rack is fixed. If, therefore, this be drawn upwards, it will cauſe fig. 5. to ſhut cloſe into fig. 4, and drive out the air above it; and when it is puſhed downward, it will open as far as the ſhoulder *a a* will permit, and ſuffer air to paſs through. AA fig. 7. is the receiver plate. BB is a long ſquare piece of braſs, ſcrewed into the under ſide of the plate, through which a hole is drilled correſponding to that in the centre of the receiver-plate, and with three female ſcrews *b*, *b*, *c*.

The rarefaction of the air in the receiver is effected as follows: Suppoſe the piſton at the bottom of the barrel. The inſide of the barrel, from the top of the piſton to *a*, contains common air. When the rod is drawn up, the upper part of the piſton ſticks faſt in the barrel till the conical part connected with the rod ſhuts the conical hole, and its ſhoulder applies cloſe to its bottom. The piſton is now ſhut, and therefore the *whole* is drawn up by the rack-work, driving the air before it through the hole *a a*, into the oil veſſel at R, and out into the room by the tube T. The piſton will then be at the top of the barrel at *a*, and the wire *g g* will ſtand nearly as repreſented in the figure juſt raiſed from the hole L, and prevented from riſing higher by the nut O. During this motion the air will expand in the receiver, and come along the bent tube *m* into the barrel. Thus the barrel will be filled with air, which, as the piſton riſes, will be rarefied in proportion as the capacity of the receiver, pipes, and barrel is to the barrel alone. When the piſton is moved down again by the rack-work, it will force the conical part fig. 5. out of the hollow part fig. 4. as far as the ſhoulders *a a*. Fig. 2. will reſt on *a a* fig. 4, which will then be ſo far open as to permit the air to paſs freely through it, while at the ſame time the end of *g g* is forced againſt the top of the hole, and ſhuts it, in order to prevent any air from returning into the receiver. Thus, the piſton moving downwards ſuffers the air to paſs out between the ſides of fig. 4. and 5.; and, when it is at the bottom of the barrel, will have the column of air above it: and, conſequently, when drawn upwards it will ſhut, and drive out this air, and, by opening the hole L at the ſame time, will give a free paſſage to more air from the receiver. This proceſs being continued, the air of the receiver will be rarefied *as far as its expanſive power will permit.* For in this machine there are no valves to be forced open by the elaſticity of the air in the receiver, which at laſt it is unable to effect. There is therefore nothing to prevent the air from expanding to its utmoſt degree.

It may be ſuſpected here, that as the air muſt eſcape through the diſcharging paſſage *ac*, fig. 1. againſt the preſſure of a column of oil and the weight of the wire, there will remain in this paſſage a quantity of air of conſiderable denſity, which will expand again into the barrel during the deſcent of the piſton, and thus put a ſtop to the progreſs of rarefaction. This is the caſe in Mr. Smeaton's pump, and all which have valves in the piſton. But it is the peculiar excellency of this pump, that whatever be the denſity of the air remaining in *a c*, the rarefaction will ſtill go on. It is worth while to be perfectly convinced of this. Let us ſuppoſe that the air contained in *a c* is $\frac{1}{100}$ part of the common air which would fill the barrel, and that the capacity of the barrel is equal to that of the receiver and paſſages, and that the air in the receiver and barrel is of the ſame denſity, the piſton being at the bottom of the barrel: The barrel will therefore contain $\frac{10}{1000}$ parts of its natural quantity, and the receiver $\frac{10}{1000}$. Now let the piſton be drawn up. No air will be diſcharged at *a c*, becauſe it will contain the whole air which was in the barrel, and which has now collapſed into its ordinary bulk. But this does not in the leaſt hinder the air of the receiver from expanding into the barrel, and diffuſing itſelf equally between both. Each will now contain $\frac{5}{1000}$ of their ordinary quantity when the piſton is at the top, and *a c* will contain $\frac{1}{100}$ as before, or $\frac{10}{1000}$. Now puſh down the piſton. The hole L is inſtantly ſhut, and the air in *a c* expands into the barrel, and the barrel now contains $\frac{15}{1000}$. When the piſton has reached the bottom, let it be again drawn up. There will be $\frac{5}{1000}$ diſcharged through *c*, and the air in the receiver will again be equally diſtributed between it and the barrel. Therefore the receiver will now contain $\frac{2\frac{1}{2}}{1000}$. When the piſton reaches the bottom, there will be $\frac{12\frac{1}{2}}{1000}$ in the barrel. When again drawn up to the top, there will be $\frac{2\frac{1}{2}}{1000}$ diſcharged, and the receiver will contain $\frac{1\frac{1}{4}}{100}$; and when the piſton reaches the bottom, there will be $\frac{11\frac{1}{4}}{1000}$. At the next ſtroke the receiver will contain only $\frac{0.\frac{5}{8}}{1000}$, &c. &c.

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[*] The piſton and barrel are 1,65 inches in diameter, in proportion to which the ſcale is drawn. Figures 2, 3, 4, 5, are, however, of double ſize.

Thus it appears, that notwithſtanding the $\frac{10}{1000}$ which always expands back again out of the hole *a c* into the barrel, the rarity of the air in the receiver will be doubled at every ſtroke. There is therefore no need of a ſubſidiary air-pump at *c*, as in the American air-pump, and in the Swediſh attempt to improve Smeaton's.

In uſing this air-pump no particular directions are neceſſary, nor is any peculiar care neceſſary for keeping it in order, except that the oil-veſſel A be always kept about half full of oil. When the pump has ſtood long without being uſed, it will be proper to draw a table-ſpoonful of olive oil through it, by pouring it into the hole in the middle of the receiver-plate when the piſton is at the bottom of the barrel. Then, by working the piſton, the oil will be drawn through all the parts of the pump, and the ſurplus will be driven through the tube T into the oil-veſſel G. Near the top of the piſton-rod at H there is a hole which lets ſome oil into the inſide of the rod, which gets at the collar of leathers *r r*, and keeps the wire *g g* air-tight.

When the pump is uſed for condenſation at the ſame time that it rarefies, or ſeparately, the piece containing the bent tube T muſt be removed, and fig. 8. put into its place, and fixed by its ſcrews. Fig. 8. as drawn in the plate, is intended for a double-barrelled pump. But for a ſingle barrel only one piece is uſed, repreſented by *b a a*, the double piece being cut off at the dotted line *a a*. In this piece is a female ſcrew to receive the end of a long braſs tube, to which a bladder (if ſufficient for the experiment of condenſation), or a glaſs, properly ſecured for this purpoſe, muſt be ſcrewed. Then the air which is abſtracted from the receiver on the pump-plate will be forced into the bladder or glaſs. But if the pump be double, the apparatus fig. 8. is uſed, and the long braſs tube ſcrewed on at *c*.

Fig. 9. and 10. repreſent the two gages, which will be ſufficiently explained afterwards. Fig. 9. is ſcrewed into *c b*, or into the ſcrew at the other end of *c* fig. 7. and fig. 10. into the ſcrew *a b* fig. 7.

If it be uſed as a ſingle pump, either to rarefy or condenſe, the ſcrew K, which faſtens the rack to the piſton rod H, muſt be taken out. Then turning the winch till H is depreſſed as low as poſſible, the machine will be fitted to exhauſt as a ſingle pump; and if it be required to condenſe, the direction in No. 8. muſt be obſerved with regard to the tube T, and fig. 8.

"I took (ſays Mr. Cuthbertſon) two barometer-tubes of an equal bore with that fixed to the pump. Theſe were filled with mercury four times boiled. They were then compared, and ſtood exactly at the ſame height. The mercury in one of them was boiled in it four times more, without making any change in their height; they were therefore judged very perfect. One of theſe was immerſed in the ciſtern of the pump-gage, and faſtened in a poſition parallel to it, and a ſliding ſcale of one inch was attached to it. This ſcale, when the gage is uſed, muſt have its upper edge ſet equal with the ſurface of the mercury in the boiled tube after exhauſtion, and the difference between the height of the mercury in this and in the other barometer tube may be obſerved to the $\frac{1}{100}$ of an inch; and being cloſe together, no error ariſes from their not being exactly vertical, if they are only parallel. This gage will be better underſtood by inſpecting fig. 10.

"I uſed a ſecond gage, which I ſhall call a double ſyphon. See fig. 9. This was alſo prepared with the utmoſt care. I had a ſcale for meaſuring the difference between the height of the columns in the two legs. It was an inch long, and divided as the former, and kept in a truly vertical poſition, by ſuſpending it from a point with a weight hung to it, as repreſented in the figure. Upon comparing theſe two gages, I always found them to indicate the ſame degree of rarefaction. I alſo uſed a pear-gage, though the moſt imperfect of all, in order to repeat the curious experiments of Mr. Nairne and others."

When experiments require the utmoſt rarefying power of the pump, the receiver muſt not be placed on leather, either oiled or ſoaked in water, as is uſually done. The pump-plate and the edge of the receiver muſt be ground very flat and true, and this with very fine emery, that no roughneſs may remain. The plate of the pump muſt then be wiped very clean and very dry, and the receiver rubbed with a warm cloth till it become electrical. The receiver being now ſet on the plate, hog's lard, either alone, or mixed with a little oil which has been cleared of water by boiling, muſt be ſmeared round its outſide edge. In this condition the pump will rarefy its utmoſt, and what ſtill remains in the receiver will be permanent air. Or a little of this compoſition may be thinly ſmeared on the pump-plate; this will prevent all riſk of ſcratching it with the edge of the receiver. Leather of very uniform thickneſs, long dried before a fire, and well ſoaked in this compoſition, which muſt be cleared of all water by the firſt boiling, will anſwer very well, and is expeditious, when receivers are to be frequently ſhifted. Other leathers ſhould be at hand ſoaked in a compoſition containing a little roſin. This gives it a clammineſs which renders it impermeable to air, and is very proper at all joints of the pump, and all apparatus for pneumatic experiments. As it is impoſſible to render the pear-gage as dry as other parts of the apparatus, there will be generally ſome variation between this and the other gages.

When it is only intended to ſhow the utmoſt power of the pump, without intending to aſcertain the quality of the reſiduum, the receiver may be ſet on wet leather. If, in this condition, the air be rarefied as far as poſſible, the ſyphon and barometer gage will indicate a leſs degree of rarefaction than in the former experiments. But when the air is let in again, the pear-gage will point out a rarefaction ſome thouſands of times greater than it did before. If the true quality of permanent air after exhauſtion be required, the pear-gage will be neareſt the truth: for, when the air is rarefied to a certain degree, the moiſtened leather emits an expanſible fluid, which, filling the receiver, forces out the permanent air; and the two firſt gages indicate a degree of exhauſtion which relates to the whole elaſtic matter remaining in the receiver, *viz.* to the expanſible fluid together with the permanent air; whereas the pear-gage points out the degree of exhauſtion, with relation to the permanent air alone, which remains in the receiver; for, by the preſſure of the air admitted into the receiver, the elaſtic vapour is reduced to its former bulk, which is imperceptible.

Many bodies emit this elaſtic fluid when the preſſure of the air is much diminiſhed; a piece of leather, in its ordinary damp ſtate, about an inch ſquare, or a bit of green or dry wood, will ſupply this for a great while.

When ſuch fluids have been generated in any experiments, the pump muſt be carefully cleared of them; for they remain not only in the receiver, but in the barrels and paſſages, and will again expand when the exhauſtion has been carried far.

The beſt method of clearing the pump is to take a very large receiver, and to uſe every precaution to exhauſt it as far as poſſible. Then the expanſible matter lurking in the barrels and paſſes will be diffuſed through the receiver alſo, or will be carried off along with its air. It will be as much rarer than it was before, as the aggregate capacity of the receiver barrels and paſſes is larger than that of the two laſt.

The performance of the pump may be judged of from the four following experiments.

The two gages being ſcrewed into their places, and the hole in the receiver-plate ſhut up, the pump was made to exhauſt as far as it could. The mercury in the legs of the ſyphon was only $\frac{1}{40}$ of an inch out of the level, and that in the boiled barometer-tube $\frac{1}{40}$ of an inch higher than in the one ſcrewed to the pump. A ſtandard barometer then ſtood at 30 inches, and therefore the pump rarefied the permanent air 1200 times. This is twice as much as Mr. Nairne found Mr. Smeaton's do in its beſt ſtate. Mr. Cavallo ſeems diſpoſed to give a favourable (while we muſt ſuppoſe it a juſt) account of Haas and Hurter's pump, and it appears never to have exceeeded 600 times. Mr. Cuthbertſon has often found the mercury within $\frac{1}{100}$ of an inch of the level in the ſyphon-gage, indicating a rarefaction of 3000.

To one end of a glaſs tube, 2 inches diameter and 30 inches long, was fitted a braſs cap and collar of leather, through which a wire was inſerted, reaching about two inches within the tube. This was connected with the conductor of an electric machine. The other end was ground flat and ſet on the pump plate. When the gages indicated a rarefaction of 300, the light became ſteady and uniform, of a pale colour, though a little tinged with purple; at 600 the light was of a pale duſky white; when 1200 it diſappeared in the middle of the tube, and the tube conducted ſo well that the prime conductor only gave ſparks ſo faint and ſhort as to be ſcarcely perceptible. After taking off the tube, and making it as dry as poſſible, it was again connected with the conductor, which was giving ſparks two inches long. When the air in it was rarefied ten times, the ſparks were of the ſame length. Sometimes a pencil of light darted along the tube. When the rarefaction was 20, the ſpark did not exceed an inch, and light ſtreamed the whole length of the tube. When the rarefaction was 30, the ſparks were half an inch, and the light ruſhed along the tube in great ſtreams. When the rarefaction was 100, the ſparks were about $\frac{1}{8}$ long, and the light filled the tube in an uninterrupted body. When 300, the appearances were as before. When 600, the ſparks were $\frac{1}{10}$, and the light was of a faint white colour in the middle, but tinged with purple toward the ends. When 1200, the light was hardly perceptible in the middle, and was much fainter at the ends than before, but ſtill ruddy. When 1400, which was the moſt the pump could produce, ſix inches of the middle of the tube were quite dark, and the ends free of any tinge of red, and the ſparks did not exceed $\frac{1}{40}$ of an inch.

We truſt that our readers will not be diſpleaſed with the preceding hiſtory of the air-pump. The occaſional information which it gives will be of great uſe to every perſon much engaged in pneumatic experiments, and help him in the contrivance and conſtruction of the neceſſary apparatus.

We may be indulged in one remark, that although this noble inſtrument originated in Germany, all its improvements were made in this kingdom. Both the mechanical and pneumatical principles of Mr. Boyle's conſtruction were extremely different from the German, and, in reſpect of expedition and conveniency, much ſuperior. The double barrel and gage by Hawkeſbee were capital improvements, and on principle; and Mr. Smeaton's method of making the piſton work in rarefied air made a complete change in the whole proceſs.

Aided by this machine, we can make experiments eſtabliſhing and illuſtrating the gravity and elaſticity of the air in a much more perſpicuous manner than could be done by the ſpontaneous phenomena of nature.

It allows us in the firſt place to ſhow the materiality of air in a very diſtinct manner. Bodies cannot move about in the atmoſphere without diſplacing it. This requires force; and the reſiſtance of the air always diminiſhes the velocity of bodies moving in it. A heavy body therefore has the velocity of its fall diminiſhed; and if the quantity of air diſplaced be very great, the diminution will be very conſiderable. This is the reaſon why light bodies, ſuch as feathers, fall very ſlowly. Their moving force is very ſmall, and can therefore diſplace a great quantity of air only with a very ſmall velocity. But if the ſame body be dropped *in vacuo*, when there is no air to be diſplaced, it falls with the whole velocity competent to its gravity. Fig. 29. Plate 9. repreſents an apparatus by which a guinea and a downy feather are dropped at the ſame inſtant, by opening the forceps which holds them by means of the ſlip-wire in the top of the receiver. If this be done after the air has been pumped out, the guinea and the feather will be obſerved to reach the bottom at the ſame inſtant.

Fig. 30. repreſents another apparatus for ſhowing the ſame thing. It conſiſts of two ſets of braſs vanes put in ſeparate axles, in the manner of windmill ſails. One ſet has their edges placed in the direction of their whirling motion, that is, in a plane to which the axis is perpendicular. The planes of the other ſet paſs through the axis, and they are therefore trimmed ſo as directly to front the air through which they move. Two ſprings act upon pins projecting from the axis; and their ſtrength or tenſions are ſo adjuſted, that when they are diſengaged *in vacuo*, the two ſets continue in motion equally long. If they are diſengaged in the air, the vanes which beat the air with their planes will ſtop long before thoſe which cut it edgewiſe.

We can now abſtract the air almoſt completely from a dry veſſel, ſo as to know the preciſe weight of the air which filled it. The firſt experiment we have of this kind, done with accuracy, is that of Dr. Hocke, Feb. 10. 1664, when he found 114 pints of air to weigh 915 grains. One pint of water was $8\frac{7}{12}$ ounces. This gives for the ſpecific gravity of air $\frac{1}{850}$ nearly.

Since we are thus immerſed in a gravitating fluid, it follows, that every body preponderates only with the exceſs of its own weight above that of the air which it diſplaces; for every body loſes by this immerſion the weight of the diſplaced air. A cubic foot loſes about 521 grains in froſty weather. We ſee balloons even riſe in the air, as a piece of cork riſes in water. A maſs of water which really contains 850 pounds will load the ſcale of a balance with 849 only, and will be balanced by about $849\frac{1}{3}$ pounds of braſs. This is evinced by a very pretty experiment, repreſented in Pl. 9. fig. 31. A ſmall beam is ſuſpended within a receiver. To one end of the beam is appended a thin glaſs or copper ball, cloſe in every part. This is balanced by a ſmall piece of lead hung on the other arm. As the air is pumped out of the receiver, the ball will gradually preponderate, and will regain its equilibrium when the air is re-admitted.

Some naturaliſts have propoſed, and actually uſed, a large globe of light make, ſuſpended at a beam, for a barometer. If its capacity is a cubic foot, $1\frac{7}{10}$ grains will indicate the ſame change that is indicated by $\frac{1}{15}$ of an inch of an ordinary barometer. But a veſſel of this ſize will load a balance too much to leave it ſufficiently ſenſible to ſmall changes of denſity. Beſides, it is affected by heat and cold, and would require a very troubleſome equation to correct their effects.

It may perhaps be worth while to attend to this in buying and ſelling precious commodities; ſuch as pearls, diamonds, ſilk, and ſome drugs. As they are generally ſold by braſs or leaden weights, the buyer will have ſome advantage when the air is heavy and the barometer high. On the other hand, he will have the advantage in buying gold and mercury when the air is light. It is needleſs to confine this obſervation to precious commodities, for the advantage is the ſame in all in proportion to their levity.

There is a caſe in which this obſervation is of conſequence to the philoſopher: we mean the meaſuring of time by pendulums. As the accelerating force on a pendulum is not its whole weight, but the exceſs of its weight over that of the diſplaced air, it follows that a pendulum will vibrate more ſlowly in the air than *in vacuo*. A pendulum compoſed of lead, iron, and braſs, may be about 8400 times heavier than the air which it diſplaces when the barometer is at 30 inches and the thermometer at 32°, and the accelerating force will be diminiſhed about $\frac{1}{8400}$. This will cauſe a ſecond pendulum to make about five vibrations leſs in a day than it would do *in vacuo*. In order therefore to deduce the accelerative power of gravity from the length of a pendulum vibrating in the air, we muſt make an allowance of 0″,17, or $\frac{17}{100}$ of a ſecond, per day for every inch that the barometer ſtands lower than 30 inches. But we muſt alſo note the temperature of the air; becauſe when the air is warm it is leſs denſe when ſupporting by its elaſticity the ſame weight of atmoſphere, and we muſt know how much its denſity is diminiſhed by an increaſe of temperature. The correction is ſtill more complicated; for the change of denſity affects the reſiſtance of the air, and this affects the time of the vibration, and this by a law that is not yet well aſcertained. As far as we can determine from any experiments that have been made, it appears that the change ariſing from the altered reſiſtance takes off about $\frac{2}{5}$ of the change produced by the altered denſity, and that a ſecond pendulum makes but three vibrations a day more *in vacuo* than in the open air. This is a very unexpected reſult; but it muſt be owned that the experiments have neither been numerous nor very nicely made.

The air-pump alſo allows us to ſhow the effects of the air's preſſure in a great number of amuſing and inſtructive phenomena.

When the air is abſtracted from the receiver, it is ſtrongly preſſed to the pump-plate by the incumbent atmoſphere, and it ſupports this great preſſure in conſequence of its circular form. Being equally compreſſed on all ſides, there is no place where it ſhould give way rather than another; but if it be thin, and not very round, which is ſometimes the caſe, it will be cruſhed to pieces. If we take a ſquare thin phial, and apply an exhauſting ſyringe to its mouth, it will not fail being cruſhed.

As the operation of pumping is ſomething like ſucking, many of theſe phenomena are in common diſcourſe aſcribed to ſuction, a word much abuſed; and this abuſe miſleads the mind exceedingly in its contemplation of natural phenomena. Nothing is more uſual than to ſpeak of the ſuction of a ſyringe, the ſuction and draught of a chimney, &c. The following experiment puts the true cauſe of the ſtrong adheſion of the receiver beyond a doubt.

Place a ſmall receiver or cupping-glaſs on the pump-plate without covering the central hole, as repreſented in Pl. 10. fig. 32. and cover it with a larger receiver. Exhauſt the air from it; then admit it as ſuddenly as poſſible. The outer receiver, which after the rarefaction adhered ſtrongly to the plate, is now looſe, and the cupping-glaſs will be found ſticking faſt to it. While the rarefaction was going on, the air in the ſmall receiver alſo expanded, eſcaped from it, and was abſtracted by the pump. When the external air was ſuddenly admitted, it preſſed on the ſmall receiver, and forced it down to the plate, and thus ſhut up all entry. The ſmall receiver muſt now adhere; and there can be no ſuction, for the pipe of the pump was on the outſide of the cupping-glaſs.

This experiment ſometimes does not ſucceed, becauſe the air ſometimes finds a paſſage under the brim of the cupping-glaſs. But if the cupping-glaſs be preſſed down by the hand on the greaſy leather or plate, every thing will be made ſmooth, and the glaſs will be ſo little raiſed by the expanſion of its air during the pumping, that it will inſtantly clap cloſe when the air is re-admitted.

In like manner, if a thin ſquare phial be furniſhed with a valve, opening from within, but ſhutting when preſſed from without, and if this phial be put under a receiver, and the air be abſtracted from the receiver, the air in the phial will expand during the rarefaction, will eſcape through the valve, and be at laſt in a very rarefied ſtate within the phial. If the air be now admitted into the receiver, it will preſs on the flat ſides of the included phial and cruſh it to pieces. See fig. 33.

If a piece of wet ox bladder be laid over the top of a receiver whoſe orifice is about four inches wide, and the air be exhauſted from within it, the incumbent atmoſphere will preſs down the bladder into a hollow form, and then burſt it inward with a prodigious noiſe. See fig. 34. Or if a piece of thin flat glaſs be laid over the receiver, with an oiled leather between them to make the juncture air-tight, the glaſs will be broken downwards. This muſt be done with caution, becauſe the pieces of glaſs ſometimes fly about with great force.

If there be formed two hemiſpherical cups of braſs, with very flat thick brims, and one of them be fitted with a neck and ſtop-cock, as repreſented by fig. 35. the air may be abſtracted from them by ſcrewing the neck into the hole in the pump-plate. To prevent the inſinuation of air, a ring of oiled leather may be put between the rims. Now unſcrew the ſphere from the pump, and fix hooks to each, and ſuſpend them from a ſtrong nail, and hang a ſcale to the loweſt. It will require a conſiderable weight to ſeparate them; namely, about 15 pounds for every ſquare inch of the great circle of the ſphere. If this be four inches diameter, it will require near 190 pounds. This pretty experiment was firſt made by Otto Guericke, and on a very great ſcale. His ſphere was of a large ſize, and, when exhauſted, the hemiſpheres could not be drawn aſunder by 20 horſes. It was exhibited, along with many others equally curious and magnificent, to the emperor of Germany and his court, at the breaking up of the diet of Ratiſbon in 1654.

If the loaded ſyringe, formerly mentioned, be ſuſpended by its piſton from the hook in the top plate of the receiver, as in fig. 36. and the air be abſtracted by the pump, the ſyringe will gradually deſcend (becauſe the elaſticity of the air, which formerly balanced the preſſure of the atmoſphere, is now diminiſhed by its expanſion, and is therefore no longer able to preſs the ſyringe to the piſton), and it will at laſt drop off. If the air be admitted before this happens, the ſyringe will immediately riſe again.

Screw a ſhort braſs pipe into the neck of a tranſporter, on which is ſet a tall receiver, and immerſe it into a ciſtern of water. On opening the cork the preſſure of the air on the ſurface of the water in the ciſtern will force it up through the pipe, and cauſe it to ſpout into the receiver with a ſtrong jet, becauſe there is no air within to balance by its elaſticity the preſſure of the atmoſphere. See fig. 37.

It is in the ſame way that the gage of the air-pump performs its office. The preſſure of the atmoſphere raiſes the mercury in the gage till the weight of the mercury, together with the remaining elaſticity of the air in the receiver, are in equilibrio with the whole preſſure of the atmoſphere: therefore the height and weight of the mercury in the gage is the exceſs of the weight of the atmoſphere above the elaſticity of the included air; and the deficiency of this height from that of the mercury in the Torricellian tube is the meaſure of this remaining elaſticity.

If a Torricellian tube be put under a tall receiver, as ſhown in fig. 38. and the air be exhauſted, the mercury in the tube will deſcend while that in the gage will riſe; and the ſum of their heights will always be the ſame, that is, equal to the height in an ordinary barometer. The height of the mercury in the receiver is the effect and meaſure of the remaining elaſticity of the included air, and the height in the pump gage is the unbalanced preſſure of the atmoſphere. This is a very inſtructive experiment, perfectly ſimilar to Mr. Auzout's already mentioned, and completely eſtabliſhes and illuſtrates the whole doctrine of atmoſpheric preſſure.

We get a ſimilar illuſtration and confirmation (if ſuch a thing be now needed) of the cauſe of the riſe of water in pumps, by ſcrewing a ſyringe into the top plate of a receiver, which ſyringe has a ſhort glaſs pipe plunging into a ſmall cup of water. See fig. 39. When the piſton-rod is drawn up, the water riſes in the glaſs pipe, as in any other pump, of which this is a miniature repreſentation. But if the air has been previouſly exhauſted from the receiver, there is nothing to preſs on the water in the little jar; and it will not riſe in the glaſs pipe though the piſton of the ſyringe be drawn to the top.

Analogous to the riſe of water in pumps is its riſe and motion in ſyphons. Suppoſe a pipe ABCD, fig. 40. bent at right angles at B and C, and having its two ends immerſed in the ciſterns of water A and D. Let the leg CD be longer than the leg BA, and let the whole be full of water. The water is preſſed upwards at A with a force equal to the weight of the column of air EA reaching to the top of the atmoſphere; but it is preſſed downwards by the weight of the column of water BA. The water at E is preſſed downwards by the weight of the column CD, and upwards by the weight of the column of air FD reaching to the top of the atmoſphere. The two columns of air differ very little in their weight, and may without any ſenſible error be conſidered as equal. Therefore there is a ſuperiority of preſſure downwards at D, and the water will flow out there. The preſſure of the air will raiſe the water in the leg AB, and thus the ſtream will be kept up till the veſſel A is emptied as low as the orifice of the leg BA, provided the height of AB is not greater than what the preſſure of the atmoſphere can balance, that is, does not exceed 32 or 33 feet for water, 30 inches for mercury, &c.

A ſyphon then will always run from that veſſel whoſe ſurface is higheſt; the form of the pipe is indifferent, becauſe the hydroſtatical preſſures depend on the vertical height only. It muſt be filled with water by ſome other contrivance, ſuch as a funnel, or a pump applied at top; and the funnel muſt be ſtopped up, otherwiſe the air would get in, and the water would fall in both legs.

If the ſyphon have equal legs, as in fig. 41. and be turned up at the ends, it will remain full of water, and be ready for uſe. It need only be dipped into any veſſel of water, and the water will then flow out at the other end of the ſyphon. This is called the *Wirtemberg ſyphon*, and is repreſented in fig. 41. Syphons will afterwards be conſidered more minutely under the title of *Pneumatical Engines*, at the end of this article.

What is called the *ſyphon fountain*, conſtructed on this principle, is ſhown in fig. 42. where AB is a tall receiver, ſtanding in a wide baſon DE, which is ſupported on the pedeſtal H by the hollow pillar FG. In the centre of the receiver is a jet pipe C, and in the top a ground ſtopper A. Near the baſe of the pillar is a cock N, and in the pedeſtal is another cock G.

Fill the baſon DE with water within half an inch of the brim. Then pour in water at the top of the receiver (the cock N being ſhut) till it is about half full, and then put in the ſtopper. A little water will run out into the veſſel DE. But before it runs over, open the cock N, and the water will run into the ciſtern H; and by the time that the pipe C appears above water, a jet will riſe from it, and continue as long as water is ſupplied from the baſon DE. The paſſage into the baſe ciſtern may be ſo tempered by the cock N that the water within the receiver ſhall keep at the ſame height, and what runs into the baſe may be received from the cock O into another veſſel, and returned into DE, to keep up the ſtream.

This pretty philoſophical toy may be conſtructed in the following manner. BB, Pl. 10. fig. 42. No. 2. is the ferril or cap into which the receiver is cemented. From its centre deſcends the jet pipe C *a*, ſloping outward, to give room for the diſcharging pipe *b d* of larger diameter, whoſe lower extremity *d* fits tightly into the top of the hollow pillar FG.

The operation of the toy is eaſily underſtood. Suppoſe the diſtance from C to H (No. 1.) three feet, which is about $\frac{1}{11}$ of the height at which the atmoſphere would ſupport a column of water. The water poured into AB would deſcend through FG (the hole A being ſhut) till the air has expanded $\frac{1}{10}$, and then it would ſtop. If the pipe C *a* be now opened, the preſſure of the air on the ſurface of the water in the ciſtern DE will cauſe it to ſpout through C to the height of three feet nearly, and the water will continue to deſcend through the pipe FG. By tempering the cock N ſo as to allow the water to paſs through it as faſt as it is ſupplied by the jet, the amuſement may be continued a long time. It will ſtop at laſt, however; becauſe, as the jet is made into rarefied air, a little air will be extricated from the water, which will gradually accumulate in the receiver, and diminiſh its rarefaction, which is the moving cauſe of the jet. This indeed is an inconvenience felt in every employment of ſyphons, ſo much the more remarkably as their top is higher than the ſurface of the water in the ciſtern of ſupply.

Caſes of this employment of a ſyphon are not unfrequent. When water collected at A (fig. 43.) is to be conducted in a pipe to C, ſituated in a lower part of the country, it ſometimes happens, as between Lochend and Leith, that the intervening ground is higher than the fountain-head as at B. A forcing pump is erected at A, and the water forced along the pipe. Once it runs out at C, the pump may be removed, and the water will continue to run on the ſyphon principle, provided BD do not exceed 33 feet. But the water in that part of the conduit which is above the horizontal plane AD, is in the ſame ſtate as in a receiver of rarefied air, and gives out ſome of the air which is chemically united with it. This gradually accumulates in the elevated part of the conduit, and at laſt choaks it entirely. When this happens, the forcing pump muſt again be worked. Although the elevation in the Leith conduit is only about eight or ten feet, it will ſeldom run for 12 hours. N. B. This air cannot be diſcharged by the uſual air cocks; for, if there were an opening at B, the air would ruſh in, and immediately ſtop the motion.

This combination of air with water is very diſtinctly ſeen by means of the air-pump. If a ſmall glaſs containing cold water, freſh drawn from the ſpring, be expoſed, as in fig. 44. under the receiver, and the air rarefied, ſmall bubbles will be obſerved to form on the inner ſurface of the glaſs, or on the ſurface of any body immerſed in it, which will increaſe in ſize, and then detach themſelves from the glaſs and reach the top: as the rarefaction advances, the whole water begins to ſhow very minute air-bubbles riſing to the top; and this appearance will continue for a very long time, till it be completely diſengaged. Warming the water will occaſion a ſtill further ſeparation of air, and a boiling heat will ſeparate all that can be diſengaged. The reaſon aſſigned for theſe air-bubbles firſt appearing on the ſurface of the glaſs, &c. is, that air is attracted by bodies, and adheres to their ſurface. This may be ſo. But it is more probably owing to the attraction of the water for the glaſs, which cauſes it to quit the air which it held in ſolution, in the ſame manner as we ſee it happen when it is mixed with ſpirits of wine, with vitriolic acid, &c. or when ſalts or ſugar are diſſolved in it. For, if we pour out the water which has been purged of air by boiling *in vacuo*, and fill the glaſs with freſh water, we ſhall obſerve the ſame thing, although a film of the purified water was left adhering to the glaſs. In this caſe there can be no air adhering to the glaſs.

Water thus purged of air by boiling (or even without boiling) *in vacuo*, will again abſorb air when expoſed to the atmoſphere. The beſt demonſtration ot this is to fill with this water a phial, leaving about the ſize of a pea not filled. Immerſe this in a veſſel of water, with the mouth undermoſt, by which means the air-bubble will mount up to the bottom of the phial. After ſome days ſtanding in this condition the air-bubble will be completely abſorbed, and the veſſel quite filled with water.

The air in this ſtate of chemical ſolution has loſt its elaſticity, for the water is not more compreſſible than common water. It is alſo found that water brought up from a great depth under ground contains much more air than water at the ſurface. Indeed fountain waters differ exceedingly in this reſpect. The water which now comes into the city of Edinburgh by pipes contains ſo much as to throw it into a conſiderable ebullition *in vacuo*. Other liquors contain much greater quantities of elaſtic fluids in this looſely combined ſtate. A glaſs of beer treated in the ſame way will be almoſt wholly converted into froth by the eſcape of its fixed air, and will have loſt entirely the prickling ſmartneſs which is ſo agreeable, and become quite vapid.

The air-pump gives us, in the next place, a great variety of experiments illuſtrative of the air's elaſticity and expanſibility. The very operation of exhauſtion, as it is called, is an inſtance of its great, and hitherto unlimited expanſibility. But this is not palpably exhibited to view. The following experiments ſhow it moſt diſtinctly.

1ſt, Put a flaccid bladder, of which the neck is firmly tied with a thread, under a receiver, and work the pump. The bladder will gradually ſwell, and will even be fully diſtended. Upon re-admitting the air into the receiver, the bladder gradually collapſes again into its former dimenſions: while the bladder is flaccid, the air within is of the ſame denſity and elaſticity with the ſurrounding air, and its elaſticity balances the preſſure of the atmoſphere. When part of the air of the receiver is abſtracted, the remainder expands ſo as ſtill to fill the receiver: but by expanding its elaſticity is plainly diminiſhed; for we ſee by the fact, that the elaſticity of the air of the receiver no longer balances the elaſticity of that in the bladder, as it no longer keeps it in its dimenſions. The air in the bladder expands alſo: it expands till its diminiſhed elaſticity is again in equilibrio with the diminiſhed elaſticity of the air in the receiver; that is, till its denſity is the ſame. When all the wrinkles of the bladder have diſappeared, its air can expand no more, although we continue to diminiſh the elaſticity of the air of the receiver by further rarefaction. The bladder now tends to burſt; and if it be pierced by a point or knife faſtened to the ſlip-wire, the air will ruſh out, and the mercury deſcend rapidly in the gage.

If a phial or tube be partly filled with water, and immerſed in a veſſel of water with the mouth downwards, the air will occupy the upper part of the phial. If this apparatus be put under a receiver, and the air be abſtracted, the air in the phial will gradually expand, allowing the water to run out by its weight, till the ſurface of the water be on a level within and without. When this is the caſe, we muſt grant that the denſity and elaſticity of the air in the phial is the ſame with that in the receiver. When we work the pump again, we ſhall obſerve the air in the phial expand ſtill more, and come out of the water in bubbles. Continuing the operation, we ſhall ſee the air continually eſcaping from the phial: when this is over, it ſhows that the pump can rarefy no more. If we now admit the air into the receiver, we ſhall ſee the water riſe into the phial, and at laſt almoſt completely fill it, leaving only a very ſmall bubble of air at top. This bubble had expanded ſo as to fill the whole phial. See this repreſented in fig. 45.

Every one muſt have obſerved a cavity at the big end of an egg between the ſhell and the white. The white and yolk are contained in a thin membrane or bladder which adheres looſely to the ſhell, but is detached from it at that part; and this cavity increaſes by keeping the egg in a dry place. One may form a judgment of its ſize, and therefore of the freſhneſs of the egg, by touching it with the tongue; for the ſhell, where it is not in contact with the contents, will preſently feel warm, being quickly heated by the tongue, while the reſt of the egg will feel cold.

If a hole be made in the oppoſite end of the egg, and it be ſet on a little tripod, and put under a receiver, the expanſion of the air in the cavity of the egg will force the contents through the hole till the egg be quite emptied: or, if nearly one half of the egg be taken away at the other end, and the white and yolk taken out, and the ſhell be put under a receiver, and the air abſtracted, the air in the cavity of the egg will expand, gradually detaching the membrane from the ſhell, till it cauſes it to ſwell out, and gives the whole the appearance of an entire egg. In like manner ſhrivelled apples and other fruits will ſwell in vacuo by the expanſion of the air confined in their cavities.

If a piece of wood, a twig with green leaves, charcoal, plaſter of Paris, &c. be kept under water in vacuo, a prodigious quantity of air will be extracted; and if we re-admit the air into the receiver, it will force the water into the pores of the body. In this caſe the body will not ſwim in water as it did before, ſhowing that the vegetable fibres are ſpecifically heavier than water. It is found, however, that the air contained in the pith and bark, ſuch as cork, is not all extricated in this way; and that much of it is contained in veſicles which have no outlet: being ſecreted into them in the proceſs of vegetation, as it is ſecreted into the air-bladder of fiſhes, where it is generally found in a pretty compreſſed ſtate, conſiderably denſer than the ſurrounding air. The air-bladder of a fiſh is ſurrounded by circular and longitudinal muſcles, by which the fiſh can compreſs the air ſtill further; and, by ceaſing to act with them, allow it to ſwell out again. It is in this manner that the fiſh can ſuit its ſpecific gravity to its ſituation in the water, ſo as to have no tendency either to riſe or ſink; but if the fiſh be put into the receiver of an air-pump, the rarefaction of the air obliges the fiſh to act more ſtrongly with theſe contracting muſcles, in order to adjuſt its ſpecific gravity; and if too much air has been abſtracted from the receiver, the fiſh is no longer able to keep its air-bladder in the proper degree of compreſſion. It becomes therefore too buoyant, and comes to the top of the water, and is obliged to ſtruggle with its tail and fins in order to get down; frequently in vain. The air-bladder ſometimes burſts, and the fiſh goes to the bottom, and can no longer keep above without the continual action of its tail and fins. When fiſhes die, they commonly float at top, their contractive action being now at an end. All this may be illuſtrated (but very imperfectly) by a ſmall half-blown bladder, to which is appended a bit of lead, juſt ſo heavy as to make it ſink in water: when this is put under a receiver, and the air abſtracted, the bubble will riſe to the top; and, by nicely adjuſting the rarefaction, it may be kept at any height. See fig. 46.

The play-things called *Carteſian devils* are ſimilar to this: they are hollow figures, having a ſmall aperture in the lower part of the figures, as at the point of the foot; their weight is adjuſted ſo that they ſwim upright in water. When put into a tall jar filled to the top, and having a piece of leather tied over it, they will ſink in the water, by preſſing on the leather with the ball of the hand: this, by compreſſing the water, forces ſome of it to enter into the figure, and makes it heavier than the water; for which reaſon it ſinks, but riſes again on removing the preſſure of the hand. See fig. 47, No. 1. and 2.

If a half-blown ox-bladder be put into a box, and great weights laid on it, and the whole be put under a receiver, and the air abſtracted; the air will, by expanding, lift up the weights, 'though above a hundred pounds. See fig. 48.

By ſuch experiments the great expanſibility of the air is abundantly illuſtrated, as its compreſſibility was formerly by means of the condenſing ſyringe. We now ſee that the two ſets of experiments form an uninterrupted chain; and that there is no particular ſtate of the air's denſity where the compreſſibility and expanſibility are remarkably diſſimilar. Air in its ordinary ſtate expands; becauſe its ordinary ſtate is a ſtate of compreſſion by the weight of the atmoſphere: and if there were a pit about 33 miles deep, the air at the bottom would probably be as denſe as water; and if it were 50 miles deep, it would be as denſe as gold, if it did not become a liquid before this depth: nay, if a bottle with its mouth undermoſt were immerſed ſix miles under water, it would probably be as denſe as water; we ſay probably, for this depends on the nature of its compreſſibility; that is, on the relation which ſubſiſts between the compreſſion and the force which produces it.

This is the circumſtance of its conſtitution, which we now proceed to examine; and it is evidently a very important circumſtance. We have long ago obſerved, that the great compreſſibility and permanent fluidity of air, obſerved in a vaſt variety of phenomena, is totally inexplicable, on the ſuppoſition that the particles of air are like ſo many balls of ſponge or ſo many foot-balls. Give to thoſe what compreſſibility you pleaſe, common air could no more be fluid than a maſs of clay; it could no more be fluid than a maſs of ſuch balls preſſed into a box. It can be demonſtrated (and indeed hardly needs a demonſtration), that before a parcel of ſuch balls, juſt touching each other, can be ſqueezed into half their preſent dimenſions, their globular ſhape will be entirely gone, and each will have become a perfect cube, touching ſix other cubes with its whole ſurface; and theſe cubes will be ſtrongly compreſſed together, ſo that motion could never be performed through among them by any ſolid body without a very great force. Whereas we know that in this ſtate air is juſt as permeable to every body as the common air that we breathe. There is no way in which we can repreſent this fluidity to our imagination but by conceiving air to conſiſt of particles, not only diſcrete, but diſtant from each other, and actuated by repulſive forces, or ſomething analogous to them. It is an idle ſubterfuge, to which ſome naturaliſts have recourſe, ſaying, that they are kept aſunder by an intervening æther, or elaſtic fluid of any other name. This is only removing the difficulty a ſtep further off: for the elaſticity of this fluid requires the ſame explanation; and therefore it is neceſſary, in obedience to the rules of juſt reaſoning, to begin the inquiry here; that is, to determine from the phenomena what is the analogy between the diſtances of the particles and the repulſive forces exerted at theſe diſtances, proceeding in the ſame way as in the examination of planetary gravitation. We ſhall learn the analogy by attending to the analogy between the compreſſing force and the denſity.

For the denſity depends on the diſtance between the particles; the nearer they are to each other, the denſer is the air. Suppoſe a ſquare pipe one inch wide and eight inches long, ſhut at one end, and filled with common air; then ſuppoſe a plug ſo nicely fitted to this pipe that no air can paſs by its ſides; ſuppoſe this piſton thruſt down to within an inch of the bottom: it is evident that the air which formerly filled the whole pipe now occupies the ſpace of one cubic inch, which contains the ſame number of particles as were formerly diffuſed over eight cubic inches.

The condenſation would have been the ſame if the air which fills a cube whoſe ſide is two inches had been ſqueezed into a cube of one inch, for the cube of two inches alſo contains eight inches. Now, in this caſe, it is evident that the diſtance between the particles would be reduced to its half in every direction. In like manner, if a cube whoſe ſide is three inches, and which therefore contains 27 inches, be ſqueezed into one inch, the diſtance of the particles will be one-third of what it was: in general, the diſtance of the particles will be as the cube-root of the ſpace into which they are compreſſed. If the ſpace be $\frac{1}{8}$, $\frac{1}{27}$, $\frac{1}{64}$, $\frac{1}{125}$, &c. of its former dimenſions, the diſtance of the particles will be $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{5}$, &c. Now the term *denſity*, in its ſtrict ſenſe, expreſſes the vicinity of the particles; *denſi arbores* are trees growing near each other. The meaſure of this vicinity therefore is the true meaſure of the denſity; and when 27 inches of air are compreſſed into one, we ſhould ſay that it is three times as denſe; but we ſay, that it is 27 times denſer.

Denſity is therefore uſed in a ſenſe different from its ſtricteſt acceptation: it expreſſes the comparative number of equidiſtant particles contained in the ſame bulk. This is alſo abundantly preciſe, when we compare bodies of the ſame kind, differing in denſity only; but we alſo ſay, that gold is 19 times denſer than water, becauſe the ſame bulk of it is 19 times heavier. This aſſertion proceeds on the aſſumption, or the fact, that every ultimate atom of terreſtrial matter is equally heavy; a particle of gold may contain more or fewer atoms of matter than a particle of water. In ſuch a caſe, therefore, the term denſity has little or no reference to the vicinity of the particles; and is only a term of compariſon of other qualities or accidents.

But, when we ſpeak of the reſpective denſities of the ſame ſubſtance in its different ſtates of compreſſion, the word *denſity* is ſtrictly connected with vicinity of particles, and we may ſafely take either of the meaſures. We ſhall abide by the common acceptation, and call that air eight times as denſe which has eight times as many particles in the ſame bulk, although the particles are only twice as near to each other.

Thus then we ſee that, by obſerving the analogy between the compreſſing force and the denſity, we ſhall diſcover the analogy between the compreſſing force and the diſtance of the particles. Now, the force which is neceſſary for compreſſing two particles of air to a certain vicinity is a proper meaſure of the elaſticity of the particles correſponding to that vicinity or diſtance; for it balances it, and forces which balance muſt be eſteemed equal. Elaſticity is a diſtinctive name for that corpuſcular force which keeps the particles at that diſtance: therefore obſervations made on the analogy between the compreſſing force and the denſity of air will give us the law of its corpuſcular force, in the ſame way that obſervations on the ſimultaneous deflections of the planets towards the ſun give us the law of celeſtial gravitation.

But the ſenſible compreſſing force which we are able to apply is at once exerted on unknown thouſands of particles, while it is the law of action of a ſingle particle that we want to diſcover. We muſt therefore know the *proportion* of the numbers of particles on which the compreſſing force is exerted. It is eaſy to ſee, that ſince the diſtance of the particles is as the cube root of the denſity inverſely, the number of particles in phyſical contact with the compreſſing ſurface muſt be as the ſquare of this root. Thus, when a cube of 8 inches is compreſſed into one inch, and the particles are twice as near each other as they were before, there muſt be four times the number of particles in contact with each of the ſides of this cubical inch; or, when we have puſhed down the ſquare piſton of the pipe ſpoken of above to within an inch of the bottom, there will be four times the number of particles *immediately* contiguous to the piſton, and reſiſting the compreſſion; and in order to obtain the force really exerted on one particle, and the elaſticity of that particle, we muſt divide the whole compreſſing force by 4. In like manner, if we have compreſſed air into $\frac{1}{27}$ of its former bulk, and brought the particles to $\frac{1}{3}$ of their former diſtance, we muſt divide the compreſſing force by 9. In general, if d expreſs the denſity, $\frac{1}{\sqrt[3]{d}}$ will expreſs the diſtance x of the particles; $\sqrt[3]{d}$, or $d^{\frac{1}{3}}$, will expreſs the vicinity or real denſity; and $d^{\frac{2}{3}}$ will expreſs the number of particles acting on the compreſſing ſurface: and if f expreſs the accumulated external compreſſing force, $\frac{f}{d^{\frac{2}{3}}}$ will expreſs the force acting on one particle; and therefore the elaſticity of that particle correſponding to the diſtance x.

We may now proceed to conſider the experiments by which the law of compreſſion is to be eſtabliſhed.

The firſt experiments to this purpoſe were thoſe made by Mr. Boyle, publiſhed in 1661 in his *Defenſio Doctrinæ de Aeris Elatere contra Linum*, and exhibited before the Royal Society the year before. Mariotte made experiments of the ſame kind, which were publiſhed in 1676 in his *Eſſai ſur la Nature de l'Air* and *Traité des Mouvemens des Eaux*. The moſt copious experiments are thoſe by Sulzer (*Mem. Berlin*. ix.), thoſe by Fontana (*Opuſc. Phyſico-Math.*), and thoſe by Sir George Shuckburgh and Gen. Roy.

In order to examine the compreſſibility of air that is not rarer than the atmoſphere at the ſurface of the earth, we employ a bent tube or ſyphon ABCD (pl. 10. fig. 49.), hermetically ſealed at A and open at D. The ſhort leg AB muſt be very accurately divided in the proportion of its ſolid contents, and fitted with a ſcale whoſe units denote equal increments, not of length, but of capacity. There are various ways of doing this; but it requires the moſt ſcrupulous attention, and without this the experiments are of no value. In particular, the arched form at A muſt be noticed. A ſmall quantity of mercury muſt then be poured into the tube, and paſſed backwards and forwards till it ſtands (the tube being held in a vertical poſition) on a level at B and C. Then we are certain that the included air is of the ſame denſity with that of the contiguous atmoſphere. Mercury is now poured into the leg DC, which will fill it, ſuppoſe to G, and will compreſs the air into a ſmaller ſpace AE. Draw the horizontal line EF: the new bulk of the compreſſed air is evidently AE, meaſured by the adjacent ſcale, and the addition made to the compreſſing force of the atmoſphere is the weight of the column GF. Produce GF downwards to H, till FH is equal to the height ſhown by a Torricellian tube filled with the *ſame mercury*; then the whole compreſſing force is HG. This is evidently the meaſure of the elaſticity of the compreſſed air in AE, for it balances it. Now pour in more mercury, and let it riſe to g, compreſſing the air into A e. Draw the horizontal line $e f$, and make $f h$ equal to FH; then A e will be the new bulk of the compreſſed air, $\frac{\mathrm{AB}}{\mathrm{A}\,e}$ will be its new denſity, and $h g$ will be the meaſure of the new elaſticity. This operation may be extended as far as we pleaſe, by lengthening the tube CD, and taking care that it be ſtrong enough to reſiſt the great preſſure. Great care muſt be taken to keep the whole in a conſtant temperature, becauſe the elaſticity of air is greatly affected by heat, and the change by any increaſe of temperature is different according to its denſity or compreſſion.

The experiments of Boyle, Mariotte, Amontons, and others, were not extended to very great compreſſions, the denſity of the air not having being quadrupled in any of them; nor do they ſeem to have been made with very great nicety. It may be collected from them in general, that the elaſticity of the air is very nearly proportioned to its denſity; and accordingly this law was almoſt immediately acquieſced in, and was called the *Boylean law*: it is accordingly aſſumed by almoſt all writers on the ſubject as exact. Of late years, however, there occurred queſtions in which it was of importance that this point ſhould be more ſcrupulouſly ſettled, and the former experiments were repeated and extended. Sulzer and Fontana have carried them further than any other. Sulzer compreſſed air into $\frac{1}{8}$ of its former dimenſions.

Conſiderable varieties and irregularities are to be obſerved in theſe experiments. It is extremely difficult to preſerve the temperature of the apparatus, particularly of the leg AB, which is moſt handled. A great quantity of mercury muſt be employed; and it does not appear that philoſophers have been careful to have it preciſely ſimilar to that in the barometer, which gives us the unit of compreſſing force and of elaſticity. The mercury in the barometer ſhould be pure and boiled. If the mercury in the ſyphon is adulterated with biſmuth and tin, which it commonly is to a conſiderable degree, the compreſſing force, and conſequently the elaſticity, will appear greater than the truth. If the barometer has not been nicely fitted, it will be lower than it ſhould be, and the compreſſing force will appear too great, becauſe the unit is too ſmall; and this error will be moſt remarkable in the ſmaller compreſſions.

The greateſt ſource of error and irregularity in the experiments is the very heterogeneous nature of the air itſelf. Air is a ſolvent of all fluids, all vapours, and perhaps of many ſolid bodies. It is highly improbable that the different compounds ſhall have the ſame elaſticity, or even the ſame law of elaſticity: and it is well known that air loaded with water or other volatile bodies is much more expanſible by heat than pure air; nay, it would appear, from many experiments, that certain determinate changes both of denſity and of temperature cauſe air to let go the vapours which it holds in ſolution. Cold cauſes it to precipitate water, as appears in dew; ſo does rarefaction, as is ſeen in the receiver of an air pump.

In general, it appears that the elaſticity of air does not increaſe quite ſo faſt as its denſity. This will be beſt ſeen by the following tables, calculated from the experiments of Mr. Sulzer. The column E in each ſet of experiments expreſſes the length of the column GH, the unit being FH, while the column D expreſſes $\frac{\mathrm{AB}}{\mathrm{AE}}$.

1ſt Set.		2d Set.		3d Set.	
D	E	D	E	D	E
1,000	1,000	1,000	1,000	1,000	1,000
1,100	1,093	1,236	1,224	1,091	1,076
1,222	1,211	1,294	1,288	1,200	1,183
1,375	1,284	1,375	1,332	1,333	1,303
1,571	1,559	1,466	1,417	1,500	1,472
1,692	1,669	1,571	1,515	1,714	1,659
1,833	1,795	1,692	1,647		
2,000	1,958	2,000	1,964	2,000	1,900
2,288	2,130				
2,444	2,375	2,444	2,392	2,400	2,241
3,143	2 936	3,143	3,078	3,000	2,793
3,666	3,391	3,666	3,575		
4,000	3,706			4,000	3,631
4·444	4,035	4,444	4,320		
4,888	4,438				
5,500	4,922	5,500	5,096		
5,882	5,522			6,000	5,297
		7,333	6,694		
				8,000	6,835

There appear in theſe experiments ſufficient grounds for calling in queſtion the Boylean law; and the writer of this article thought it incumbent on him to repeat them with ſome precautions, which probably had not been attended to by Mr. Sulzer. He was particularly anxious to have the air as free as poſſible from moiſture. For this purpoſe, having detached the ſhort leg of the ſyphon, which was 34 inches long, he boiled mercury in it, and filled it with mercury boiling hot. He took a tinplate veſſel of ſufficient capacity, and put into it a quantity of powdered quicklime juſt taken from the kiln; and having cloſed the mouth, he agitated the lime through the air in the veſſel, and allowed it to remain there all night. He then emptied the mercury out of the ſyphon into this veſſel, keeping the open end far within it. By this means the ſhort leg of the ſyphon was filled with very dry air. The other part was now joined, and boiled mercury put into the bend of the ſyphon; and the experiment was then proſecuted with mercury which had been recently boiled, and was the ſame with which the barometer had been carefully filled.

The reſults of the experiments are expreſſed in the following table.

Dry Air.		Moiſt Air.		Camp. Air.	
D	E	D	E	D	E
1,000	1,000	1,000	1,000	1,000	1,000
2,000	1,957	2,000	1,920	2,000	1,909
3,000	2,848	3,000	2,839	3,000	2,845
4,000	3,737	4,000	3,726	4,000	3,718
5,500	4,930	5,500	5,000	5,500	5,104
6,000	5,342	6,000	5,452	6,000	5,463
7,620	6,490	7,620	6,775	7,620	6,812

Here it appears again in the cleareſt manner that the elaſticities do not increaſe as faſt as the denſities, and the differences are even greater than in Mr. Sulzer's experiments.

The ſecond table contains the reſults of experiments made on very damp air in a warm ſummer's morning. In theſe it appears that the elaſticities are almoſt preciſely proportional to the denſities + a ſmall conſtant quantity, nearly 0,11, deviating from this rule chiefly between the denſities 1 and 1,5, within which limits we have very nearly $D = E^{1.0017}$. As this air is nearer to the conſtitution of atmoſpheric air than the former, this rule may be ſafely followed in caſes where atmoſpheric air is concerned, as in meaſuring the depths of pits by the barometer.

The third table ſhows the compreſſion and elaſticity of air ſtrongly impregnated with the vapours of camphire. Here the Boylean law appears pretty exact, or rather the elaſticity ſeems to increaſe a little faſter than the denſity.

Dr. Hooke examined the compreſſion of air by immerſing a bottle to great depths in the ſea, and weighing the water which got into it without any eſcape of air. But this method was liable to great uncertainty, on account of the unknown temperature of the ſea at great depths.

Hitherto we have conſidered only ſuch air as is not rarer than what we breathe; we muſt take a very different method for examining the elaſticity of rarefied air.

Let $g\,h$ (Pl. 11. fig. 50.) be a long tube, formed a-top into a cup, and of ſufficient diameter to receive another ſmaller tube $a\,f$, open at firſt at both ends. Let the outer tube and cup be filled with mercury, which will riſe in the inner tube to the ſame level. Let $a\,f$ now be ſtopped at a. It contains air of the ſame denſity and elaſticity with the adjoining atmoſphere. Note exactly the ſpace $a\,b$ which it occupies. Draw it up into the poſition of fig. 51. and let the mercury ſtand in it at the height $d\,e$, while $c\,e$ is the height of the mercury in the barometer. It is evident that the column $d\,e$ is in equilibrio between the preſſure of the atmoſphere and the elaſticity of the air included in the ſpace $a\,d$. And ſince the weight of $c\,e$ would be in equilibrio with the whole preſſure of the atmoſphere, the weight of $c\,d$ is equivalent to the elaſticity of the included air. While therefore $c\,e$ is the meaſure of the elaſticity of the ſurrounding atmoſphere, $c\,d$ will be the meaſure of the elaſticity of the included air; and ſince the air originally occupied the ſpace $a\,b$, and has now expanded into $a\,d$, we have $\frac{a\,b}{a\,d}$ for the meaſure of its denſity. N. B. $c\,e$ and $c\,d$ are meaſured by the *perpendicular heights* of the columns, but $a\,b$ and $a\,d$ muſt be meaſured by their *ſolid capacities*.

By raiſing the inner tube ſtill higher, the mercury will alſo riſe higher, and the included air will expand ſtill further, and we obtain another $c\,d$, and another $\frac{a\,b}{a\,d}$; and in this manner the relation between the denſity and elaſticity of rarefied air may be diſcovered.

This examination may be managed more eaſily by means of the air-pump. Suppoſe a tube $a\,e$ (fig. 52.) containing a ſmall quantity of air $a\,b$, ſet up in a ciſtern of mercury, which is ſupported in the tube at the height $e\,b$, and let $e\,c$ be the height of the mercury in the barometer. Let this apparatus be ſet under a tubulated receiver on the pump-plate, and let $g\,n$ be the pump-gage, and $m\,n$ be made equal to $c\,e$.

Then, as has been already ſhown, $c\,b$ is the meaſure of the elaſticity of the air in $a\,b$, correſponding to the bulk $a\,b$. Now let ſome air be abſtracted from the receiver. The elaſticity of the remainder will be diminiſhed by its expanſion; and therefore the mercury in the tube $a\,e$ will deſcend to ſome point d. For the ſame reaſon, the mercury in the gage will riſe to ſome point o, and $m\,o$ will expreſs the elaſticity of the air in the receiver. This would ſupport the mercury in the tube $a\,e$ at the height $e\,r$, if the ſpace $a\,r$ were entirely void of air. Therefore $r\,d$ is the effect and meaſure of the elaſticity of the included air when it has expanded to the bulk $a\,d$; and thus its elaſticity, under a variety of other bulks, may be compared with its elaſticity when of the bulk $a\,b$. When the air has been ſo far abſtracted from the receiver that the mercury in $a\,e$ deſcends to e, then $m\,o$ will be the preciſe meaſure of its elaſticity.

In all theſe caſes it is neceſſary to compare its bulk $a\,b$ with its natural bulk, in which its elaſticity balances the preſſure of the atmoſphere. This may be done by laying the tube $a\,e$ horizontally, and then the air will collapſe into its ordinary bulk.

Another eaſy method may be taken for this examination. Let an apparatus $a\,b\,c\,d\,e\,f$ (fig. 53.) be made, conſiſting of a horizontal tube $a\,e$ of even bore, a ball $d\,g\,e$ of a large diameter, and a ſwan-neck tube $b\,f$. Let the ball and part of the tube $g\,e\,b$ be filled with mercury, ſo that the tube may be in the ſame horizontal plane with the ſurface $d\,e$ of the mercury in the ball. Then ſeal up the end a, and connect f with an air-pump. When the air is abſtracted from the ſurface $d\,e$, the air in $a\,b$ will expand into a larger bulk $a\,c$, and the mercury in the pump-gage will riſe to ſome diſtance below the barometric height. It is evident that this diſtance, without any further calculation, will be the meaſure of the elaſticity of the air preſſing on the ſurface $d\,e$, and therefore of the air in $a\,c$.

The moſt exact of all methods is to ſuſpend in the receiver of an air-pump a glaſs veſſel, having a very narrow mouth, over a ciſtern of mercury, and then abſtract the air till the gage riſes to ſome determined height. The difference e between this height and the barometric height determines the elaſticity of the air in the receiver and in the ſuſpended veſſel. Now lower down that veſſel by the ſlip wire till its mouth is immerſed into the mercury, and admit the air into the receiver; it will preſs the mercury into the little veſſel. Lower it ſtill further down, till the mercury within it is level with that without; then ſtop its mouth, take it out and weigh the mercury, and let its weight be w. Subtract this weight from the weight v of the mercury, which would completely fill the whole veſſel; then the natural bulk of the air will be $v-w$, while its bulk, when of the elaſticity e in the rarefied receiver, was the bulk or capacity w of the veſſel. Its denſity, therefore, correſponding to this elaſticity e, was $\frac{v-w}{w}$. And thus may the relation between the denſity and elaſticity in all caſes be obtained.

A great variety of experiments to this purpoſe have been made, with different degrees of attention, according to the intereſt which the philoſophers had in the reſult. Thoſe made by M. de Luc, General Roy, Mr. Trembley, and Sir George Shuckburgh, are by far the moſt accurate; but they are all confined to very moderate rarefactions. The general reſult has been, that the elaſticity of rarefied air is very nearly proportional to its denſity. We cannot ſay with confidence that any regular deviation from this law has been obſerved, there being as many obſervations on one ſide as on the other; but we think that it is not unworthy the attention of philoſophers to determine it with preciſion in the caſes of extreme rarefaction, where the irregularities are moſt remarkable. The great ſource of error is a certain adheſive ſluggiſhneſs of the mercury when the impelling forces are very ſmall; and other fluids can hardly be uſed, becauſe they either ſmear the inſide of the tube and diminiſh its capacity, or they are converted into vapour, which alters the law of elaſticity.

Let us, upon the whole, aſſume the Boylean law, *viz.* that the elaſticity of the air is proportional to its denſity. The law deviates not in any ſenſible degree from the truth in thoſe caſes which are of the greateſt practical importance, that is, when the denſity does not much exceed or fall ſhort of that of ordinary air.

Let us now ſee what information this gives us with reſpect to the action of the particles on each other.

The inveſtigation is extremely eaſy. We have ſeen that a force eight times greater than the preſſure of the atmoſphere will compreſs common air into the eighth part of its common bulk, and give it eight times its common denſity: and in this caſe we know, that the particles are at half their former diſtance, and that the number which are now acting on the ſurface of the piſton employed to compreſs them is quadruple of the number which act on it when it is of the common denſity. Therefore, when this eightfold compreſſing force is diſtributed over a fourfold number of particles, the portion of it which acts on each is double. In like manner, when a compreſſing force 27 is employed, the air is compreſſed into $\frac{1}{27}$ of its former bulk, the particles are at $\frac{1}{3}$ of their former diſtance, and the force is diſtributed among 9 times the number of particles; the force on each is therefore 3. In ſhort, let $\frac{1}{x}$ be the diſtance of the particles, the number of them in any given veſſel, and therefore the denſity will be as x^3, and the number preſſing by their elaſticity on its whole internal ſurface will be as x^2. Experiment ſhows, that the compreſſing force is as x^3, which being diſtributed over the number as x^2, will give the force on each as x. Now this force is an immediate equilibrium with the elaſticity of the particle immediately contiguous to the compreſſing ſurface. This elaſticity is therefore as x: and it follows from the nature of perfect fluidity, that the particle adjoining to the compreſſing ſurface preſſes with an equal force on its adjoining particles on every ſide. Hence we muſt conclude, that the corpuſcular repulſions exerted by the adjoining particles are inverſely as their diſtances from each other, or that the adjoining particles tend to recede from each other with forces inverſely proportional to their diſtances.

Sir Iſaac Newton was the firſt who reaſoned in this manner from the phenomena. Indeed he was the firſt who had the patience to reflect on the phenomena with any preciſion. His diſcoveries in gravitation naturally gave his thoughts this turn, and he very early hinted his ſuſpicions that all the characteriſtic phenomena of tangible matter were produced by forces which were exerted by the particles at ſmall and inſenſible diſtances: And he conſiders the phenomena of air as affording an excellent example of this inveſtigation, and deduces from them the law which we have now demonſtrated; and ſays, that air conſiſts of particles which avoid the adjoining particles with forces inverſely proportional to their diſtances from each other. From this he deduces (in the 2d book of his Principles) ſeveral beautiful propoſitions, determining the mechanical conſtitution of the atmoſphere.

But it muſt be noticed that he limits this action to the *adjoining* particles: and this is a remark of immenſe conſequence, though not attended to by the numerous experimenters who adopt the law.

It is plain that the particles are ſuppoſed to act at a diſtance, and that this diſtance is variable, and that the forces diminiſh as the diſtances increaſe. A very ordinary air-pump will rarefy the air 125 times. The diſtance of the particles is now 5 times greater than before; and yet they ſtill repel each other: for air of this denſity will ſtill ſupport the mercury in a ſyphon gage at the height of 0,24, or $\frac{24}{100}$ of an inch; and a better pump will allow this air to expand twice as much, and ſtill leave it elaſtic. Thus we ſee that whatever is the diſtance of the particles of common air, they can act five times further off. The queſtion comes now to be, Whether, in the ſtate of common air, they really do act five times further than the diſtance of the adjoining particles? While the particle *a* acts on the particle *b* with the force 5, does it alſo act on the particle *c* with the force 2,5, on the particle *d* with the force 1,667, on the particle *e* with the force 1,25, on the particle *f* with the force 1, on the particle *g* with the force 0,8333, &c.?

Sir Iſaac Newton ſhows in the plaineſt manner, that this is by no means the caſe; for, if this were the caſe, he makes it appear that the ſenſible phenomena of condenſation would be totally different from what we obſerve. The force neceſſary for a quadruple condenſation would be eight times greater, and for a nonuple condenſation the force muſt be 27 times greater. Two ſpheres filled with condenſed air muſt repel each other, and two ſpheres containing air that is rarer than the ſurrounding air muſt attract each other, &c. &c. All this will appear very clearly, by applying to air the reaſoning which Sir Iſaac Newton has employed in deducing the ſenſible law of mutual tendency of two ſpheres, which conſiſt of particles attracting each other with forces proportional to the ſquare of the diſtance inverſely.

If we could ſuppoſe that the particles of air repelled each other with invariable forces at all diſtances within ſome ſmall and inſenſible limit, this would produce a compreſſibility and elaſticity ſimilar to what we obſerve. For, if we conſider a row of particles, within this limit, as compreſſed by an external force applied to the two extremities, the action of the whole row on the extreme points would be proportional to the number of particles, that is, to their diſtance inverſely and to their denſity: and a number of ſuch parcels, ranged in a ſtraight line, would conſtitute a row of any ſenſible magnitude having the ſame law of compreſſion. But this law of corpuſcular force is unlike every thing we obſerve in nature, and to the laſt degree improbable.

We muſt therefore continue the limitation of this mutual repulſion of the particles of air, and be contented for the preſent with having eſtabliſhed it as an experimental fact, that the *adjoining* particles of air are kept aſunder by forces inverſely proportional to their diſtances; or perhaps it is better to abide by the ſenſible law, that *the denſity of air is proportional to the compreſſing force.* This law is abundantly ſufficient for explaining all the ſubordinate phenomena, and for giving us a complete knowledge of the mechanical conſtitution of our atmoſphere.

And, in the firſt place, this view of the compreſſibility of the air muſt give us a very different notion of the height of the atmoſphere from what we deduced on a former occaſion from our experiments. It is found, that when the air is of the temperature 32° of Fahrenheit's thermometer, and the mercury in the barometer ſtands at 30 inches, it will deſcend one-tenth of an inch if we take it to a place 87 feet higher. Therefore, if the air were equally denſe and heavy throughout, the height of the atmoſphere would be $30 \times 10 \times 87$ feet, or 5 miles and 100 yards. But the looſe reaſoning adduced on that occaſion was enough to ſhow us that it muſt be much higher; becauſe every ſtratum as we aſcend muſt be ſucceſſively rarer as it is leſs compreſſed by incumbent weight. Not knowing to what degree air expanded when the compreſſion was diminiſhed, we could not tell the ſucceſſive diminutions of denſity and conſequent augmentation of bulk and height; we could only ſay, that ſeveral atmoſpheric appearances indicated a much greater height. Clouds have been ſeen much higher; but the phenomenon of the twilight is the moſt convincing proof of this. There is no doubt that the viſibility of the ſky or air is owing to its want of perfect tranſparency, each particle (whether of matter purely aerial or heterogeneous) reflecting a little light.

Let *b* (pl. 10. fig. 54.) be the laſt particle of illuminated air which can be ſeen in the horizon by a ſpectator at A. This muſt be illuminated by a ray SD *b*, touching the earth's ſurface at ſome point D. Now it is a known fact, that the degree of illumination called *twilight* is perceived when the ſun is 18° below the horizon of the ſpectator, that is, when the angle E *b* S or ACD is 18 degrees; therefore *b* C is the ſecant of 9 degrees (it is leſs, viz. about 8½ degrees, on account of refraction). We know the earth's radius to be about 3970 miles: hence we conclude *b* B to be about 45 miles; nay, a very ſenſible illumination is perceptible much further from the ſun's place than this, perhaps twice as far, and the air is ſufficiently denſe for reflecting a ſenſible light at the height of nearly 200 miles.

We have now ſeen that air is prodigiouſly expanſible. None of our experiments have diſtinctly ſhown us any limit. But it does not follow that it is expanſible without end; nor is this at all likely. It is much more probable that there is a certain diſtance of the parts in which they no longer repel each other; and this would be the diſtance at which they would arrange themſelves if they were not heavy. But at the very ſummit of the atmoſphere they will be a very ſmall matter nearer to each other, on account of their gravitation to the earth. Till we know preciſely the law of this mutual repulſion, we cannot ſay what is the height of the atmoſphere.

But if the air be an elaſtic fluid whoſe denſity is always proportionable to the compreſſing force, we can tell what is its denſity at any height above the ſurface of the earth: and we can compare the denſity ſo calculated with the denſity diſcovered by obſervation: for this laſt is meaſured by the height at which it ſupports mercury in the barometer. This is the direct meaſure of the preſſure of the external air; and as we know the law of gravitation, we can tell what would be the preſſure of air having the calculated denſity in all its parts.

Let us therefore ſuppoſe a priſmatic or cylindric column of air reaching to the top of the atmoſphere. Let this be divided into an indefinite number of ſtrata of very ſmall and equal depths or thickneſs; and let us, for greater ſimplicity, ſuppoſe at firſt that a particle of air is of the ſame weight at all diſtances from the centre of the earth.

The abſolute weight of any one of theſe ſtrata will on theſe conditions be proportional to the number of particles or the gravity of air contained in it; and ſince the depth of each ſtratum is the ſame, this quantity of air will evidently be as the denſity of the ſtratum: but the denſity of any ſtratum is as the compreſſing force; that is, as the preſſure of the ſtrata above it; that is, as their weight; that is, as their quantity of matter—therefore the quantity of air in each ſtratum is proportional to the quantity of air above it; but the quantity in each ſtratum is the difference between the column incumbent on its bottom and on its top: theſe differences are therefore proportional to the quantities of which they are the differences. But when there is a ſeries of quantities which are proportional to their own differences, both the quantities and their differences are in continual or geometrical progreſſion: for let *a*, *b*, *c*, be three ſuch quantities that

$b : c = a - b : b - c$, then, by altern.
$b : a - b = c : b - c$ and by compoſ.
$b : a = c : b$
and $a : b = b : c$

therefore the denſities of theſe ſtrata decreaſe in a geometrical progreſſion; that is, when the elevations above the centre or ſurface of the earth increaſe, or their depths under the top of the atmoſphere decreaſe, in an arithmetical progreſſion, the denſities decreaſe in a geometrical progreſſion.

Let ARQ (pl. 11. fig. 55.) repreſent the ſection of the earth by a plane through its centre O, and let *m* OAM be a vertical line, and AE perpendicular to OA will be a horizontal line through A, a point on the earth's ſurface. Let AE be taken to repreſent the denſity of the air at A: and let DH, parallel to AE, be taken to AE as the denſity at D is to the denſity at A: it is evident, that if a logiſtic or logarithmic curve EHN be drawn, having AN for its axis, and paſſing through the points E and H, the denſity of the air at any other point C, in this vertical line, will be repreſented by CG, the ordinate to the curve in that point: for it is the property of this curve, that if portions AB, AC, AD, of its axis be taken in arithmetical progreſſion, the ordinates AE, BF, CG, DH, will be in geometrical progreſſion.

It is another fundamental property of this curve, that if EK or HS touch the curve in E or H, the ſubtangent AK or DS is a conſtant quantity.

And a third fundamental property is, that the infinitely extended area MAEN is equal to the rectangle KAEL of the ordinate and ſubtangent; and, in like manner, the area MDHN is equal to SD × DH, or to KA × DH; conſequently the area lying beyond any ordinate is proportional to that ordinate.

Theſe geometrical properties of this curve are all analogous to the chief circumſtances in the conſtitution of the atmoſphere, on the ſuppoſition of equal gravity. The area MCGN repreſents the whole quantity of aerial matter which is above C: for CG is the denſity at C, and CD is the thickneſs of the ſtratum between C and D: and therefore CGHD will be as the quantity of matter or air in it; and in like manner of all the others, and of their ſums, or the whole area MCGN: and as each ordinate is proportional to the area above it, ſo each denſity, and the quantity of air in each ſtratum, is proportional to the quantity of air above it: and as the whole area MAEN is equal to the rectangle KAEL, ſo the whole air of variable denſity above A might be contained in a column KA, if, inſtead of being compreſſed by its own weight, it were without weight, and compreſſed by an external force equal to the preſſure of the air at the ſurface of the earth. In this caſe, it would be of the uniform denſity AE, which it has at the ſurface of the earth, making what we have repeatedly called the homogeneous atmoſphere.

Hence we derive this important circumſtance, that the height of the homogeneous atmoſphere is the ſubtangent of that curve whoſe ordinates are as the denſities of the air at different heights, on the ſuppoſition of equal gravity. This curve may with propriety be called the ATMOSPHERICAL LOGARITHMIC: and as the different logarithmics are all characteriſed by their ſubtangents, it is of importance to determine this one.

It may be done by comparing the denſities of mercury and air. For a column of air of uniform denſity, reaching to the top of the homogeneous atmoſphere, is in equilibrio with the mercury in the barometer. Now it is found, by the beſt experiments, that when mercury and air are of the temperature 32° of Fahrenheit's thermometer, and the barometer ſtands at 30 inches, the mercury is nearly 10440 times denſer than air. Therefore the height of the homogeneous atmoſphere is 10440 times 30 inches, or 26100 feet, or 8700 yards, or 4350 fathoms, or 5 miles wanting 100 yards.

Or it may be found by obſervations on the barometer. It is found, that when the mercury and air are of the above temperature, and the barometer on the ſea-ſhore ſtands at 30 inches, if we carry it to a place 884 feet higher it will fall to 29 inches. Now, in all logarithmic curves having equal ordinates, the portions of the axes intercepted between the correſponding pairs of ordinates are proportional to the ſubtangents. And the ſubtangent of the curve belonging to our common tables is 0,4342945, and the difference of the logarithms of 30 and 29 (which is the portion of the axis intercepted between the ordinates 30 and 29), or 0,0147233, is to 0,4342945 as 883 is to 26058 feet, or 8686 yards, or 4343 fathoms, or 5 miles wanting 114 yards. This determination is 14 yards leſs than the other, and it is uncertain which is the moſt exact. It is extremely difficult to meaſure the reſpective denſities of mercury and air; and in meaſuring the elevation which produces a fall of one inch in the barometer, an error of $\frac{1}{20}$ of an inch would produce all the difference. We prefer the laſt, as depending on fewer circumſtances.

But all this inveſtigation proceeds on the ſuppoſition of equal gravity, whereas we know that the weight of a particle of air decreaſes as the ſquare of its diſtance from the centre of the earth increaſes. In order, therefore, that a ſuperior ſtratum may produce an equal preſſure at the ſurface of the earth, it muſt be denſer, becauſe a particle of it gravitates leſs. The denſity, therefore, at equal elevations, muſt be greater than on the ſuppoſition of equal gravity, and the law of diminution of denſity muſt be different.

$$\begin{aligned} \text{Make } \mathrm{OD} : \mathrm{OA} &= \mathrm{OA} : \mathrm{O}d; \\ \mathrm{OC} : \mathrm{OA} &= \mathrm{OA} : \mathrm{O}c; \\ \mathrm{OB} : \mathrm{OA} &= \mathrm{OA} : \mathrm{O}b, \ \&c; \end{aligned}$$

ſo that $\mathrm{O}d$, $\mathrm{O}c$, $\mathrm{O}b$, OA, may be reciprocals to OD, OC, OB, OA; and through the points A, b, c, d, draw the perpendiculars AE, bf, cg, db, making them proportional to the denſities in A, B, C, D: and let us ſuppoſe CD to be exceedingly ſmall, ſo that the denſity may be ſuppoſed uniform through the whole ſtratum. Thus we have

$$\begin{aligned} & \mathrm{OD} \times \mathrm{O}d = \mathrm{OA}^2, = \mathrm{OC} \times \mathrm{O}c \\ \text{and } & \mathrm{O}c : \mathrm{O}d = \mathrm{OD} : \mathrm{OC}; \\ \text{and } & \mathrm{O}c : \mathrm{O}c - \mathrm{O}d = \mathrm{OD} : \mathrm{OD} - \mathrm{OC}, \\ \text{or } & \mathrm{O}c : cd = \mathrm{OD} : \mathrm{DC}; \\ \text{and } & cd : \mathrm{CD} = \mathrm{O}c : \mathrm{OD}; \end{aligned}$$

or, becauſe OC and OD are ultimately in the ratio of equality, we have

$$cd : \mathrm{CD} = \mathrm{O}c : \mathrm{OC} = \mathrm{OA}^2 : \mathrm{OC}^2,$$

and $cd = \mathrm{CD} \times \frac{\mathrm{OA}^2}{\mathrm{OC}^2}$, and $cd \times cg = \mathrm{CD} \times cg \times \frac{\mathrm{OA}^2}{\mathrm{OC}^2}$; but $\mathrm{CD} \times cg \times \frac{\mathrm{OA}^2}{\mathrm{OC}^2}$ is as the preſſure at C ariſing from the abſolute weight of the ſtratum CD. For this weight is as the bulk, as the denſity, and as the gravitation of each particle jointly. Now CD expreſſes the bulk, cg the denſity, and $\frac{\mathrm{OA}^2}{\mathrm{OC}^2}$ the gravitation of each particle. Therefore, $cd \times cg$ is as the preſſure on C ariſing from the weight of the ſtratum DC; but $cd \times cg$ is evidently the element of the curvilineal area A$mn$E, formed by the curve E$fgbn$ and the ordinates AE, bf, cg, ab, &c. mn. Therefore the ſum of all the elements, ſuch as $cdbg$, that is, the area $cmng$ below cg, will be as the *whole* preſſure on C, ariſing from the gravitation of all the air above it; but, by the nature of air, this whole preſſure is as the denſity which it produces, that is, as cg. Therefore the curve Egn is of ſuch a nature that the area lying below or beyond any ordinate cg is proportional to that ordinate. This is the property of the logarithmic curve, and Egn is a logarithmic curve.

But further, this curve is the ſame with EGN. For let B continually approach to A, and ultimately coincide with it. It is evident that the ultimate ratio of BA to Ab, and of BF to bf, is that of equality; and if EFK, Efk, be drawn, they will contain equal angles with the ordinate AE, and will cut off equal ſubtangents AK, Ak. The curves EGN, Egn are therefore the ſame, but in oppoſite poſitions.

Laſtly, if OA, $\mathrm{O}b$, $\mathrm{O}c$, $\mathrm{O}d$, &c. be taken in arithmetical progreſſion decreaſing, their reciprocals OA, OB, OC, OD, &c. will be in harmonical progreſſion increaſing, as is well known: but, from the nature of the logarithmic curve, when OA, $\mathrm{O}b$, $\mathrm{O}c$, $\mathrm{O}d$, &c. are in arithmetical progreſſion, the ordinates AE, bf, cg, db, &c. are in geometrical progreſſion. Therefore when OA, OB, OC, OD, &c. are in harmonical progreſſion, the denſities of the air at A, B, C, D, &c. are in geometrical progreſſion; and thus may the denſity of the air at all elevations be diſcovered. Thus to find the denſity of the air at K the top of the homogeneous atmoſphere, make OK : OA = OA : OL, and draw the ordinate LT, LT is the denſity at K.

The celebrated Dr. Halley was the firſt who obſerved the relation between the denſity of the air and the ordinates of the logarithmic curve, or common logarithms. This he did on the ſuppoſition of equal gravity; and his diſcovery is acknowledged by Sir Iſaac Newton in *Princip.* ii. *prop.* 22. *ſchol.* Halley's diſſertation on the ſubject is in No. 185 of the Phil. Tranſ. Newton, with his uſual ſagacity, extended the ſame relation to the true ſtate of the caſe, where gravity is as the ſquare of the diſtance inverſely; and ſhowed that when the diſtances from the earth's centre are in harmonic progreſſion, the denſities are in geometric progreſſion. He ſhows indeed, in general, what progreſſion of the diſtance, on any ſuppoſition of gravity, will produce a geometrical progreſſion of the denſities, ſo as to obtain a ſet of lines OA, $\mathrm{O}b$, $\mathrm{O}c$, $\mathrm{O}d$, &c. which will be logarithms of the denſities. The ſubject was afterwards treated in a more familiar manner by Cotes in his *Hydroſt. Lect.* and in his *Harmonia Menſurarum*; alſo by Dr. Brooke Taylor, *Meth. Increment.*; Wolf in his *Aerometria*; Herman in his *Phoronomia*; &c. &c. and lately by Horſley, Phil. Tranſ. tom. lxiv.

An important corollary is deducible from theſe principles, viz. that the air has a finite denſity at an infinite diſtance from the centre of the earth, namely, ſuch as will be repreſented by the ordinate OP drawn through the centre. It may be objected to this concluſion, that it would infer an infinity of matter in the univerſe, and that it is inconſiſtent with the phenomena of the planetary motions, which appear to be performed in a ſpace void of all reſiſtance, and therefore of all matter. But this fluid muſt be ſo rare at great diſtances, that the reſiſtance will be inſenſible, even though the retardation occaſioned by it has been accumulated for ages. Even at the very moderate diſtance of 500 miles, the rarity is ſo great that a cubic inch of common air expanded to that degree would occupy a ſphere equal to the orbit of Saturn; and the whole retardation which this planet would ſuſtain after ſome millions of years would not exceed what would be occaſioned by its meeting one bit of matter of half a grain weight.

This being the caſe, it is not unreaſonable to ſuppoſe the viſible univerſe occupied by air, which, by its gravitation, will accumulate itſelf round every body in it, in a proportion depending on their quantities of matter, the larger bodies attracting more of it than the ſmaller ones, and thus forming an atmoſphere about each. And many appearances warrant this ſuppoſition. Jupiter, Mars, Saturn, and Venus, are evidently ſurrounded by atmoſpheres. The conſtitution of theſe atmoſpheres may differ exceedingly from other cauſes. If the planet has nothing on its ſurface which can be diſſolved by the air or volatiliſed by heat, the atmoſphere will be continually clear and tranſparent, like that of the moon.

Mars has an atmoſphere which appears preciſely like our own, carrying clouds, or depoſiting ſnows: for when, by the obliquity of his axis to the plane of his ecliptic, he turns his north pole towards the ſun, it is obſerved to be occupied by a broad white ſpot. As the ſummer of that region advances, this ſpot gradually waſtes, and ſometimes vaniſhes, and then the ſouth pole comes in ſight, ſurrounded in like manner with a white ſpot, which undergoes ſimilar changes. This is preciſely the appearance which the ſnowy circumpolar regions of this earth will exhibit to an aſtronomer on Mars. It may not, however, be ſnow that we ſee; thick clouds will have the ſame appearances.

The atmoſphere of the planet Jupiter is alſo very ſimilar to our own. It is diverſified by ſtreaks or belts parallel to his equator, which frequently change their appearance and dimenſions, in the ſame manner as thoſe tracks of ſimilar ſky which belong to different regions of this globe. There is a certain kind of weather that more properly belongs to a particular climate than to any other. This is nothing but a certain general ſtate of the atmoſphere which is prevalent there, though with conſiderable variations. This muſt appear to a ſpectator in the moon like a ſtreak ſpread over that climate, diſtinguiſhing it from others. But the moſt remarkable ſimilarity is in the motion of the clouds on Jupiter. They have plainly a motion from eaſt to weſt relative to the body of the planet: for there is a remarkable ſpot on the ſurface of the planet, which is obſerved to turn round the axis in 9h. 51′ 16″; and there frequently appear variable and periſhing ſpots in the belts, which ſometimes laſt for ſeveral revolutions. Theſe are obſerved to circulate in 9. 55. 05. Theſe numbers are the reſults of a long ſeries of obſervations by Dr. Herſchel. This plainly indicates a general current of the clouds weſtward, preciſely ſimilar to what a ſpectator in the moon muſt obſerve in our atmoſphere ariſing from the trade-winds. Mr. Schroeter has made the atmoſphere of Jupiter a ſtudy for many years; and deduces from his obſervations that the motion of the variable ſpots is ſubject to great variations, but is always from eaſt to weſt. This indicates variable winds.

The atmoſphere of Venus appears alſo to be like ours, loaded with vapours, and in a ſtate of continual change of abſorption and precipitation. About the middle of laſt century the ſurface of Venus was pretty diſtinctly ſeen for many years chequered with irregular ſpots, which are deſcribed by Campani, Bianchini, and other aſtronomers in the ſouth of Europe, and alſo by Caſſini at Paris, and Hooke and Townley in England. But the ſpots became gradually more faint and indiſtinct; and for near a century, have diſappeared. The whole ſurface appears now of one uniform brilliant white. The atmoſphere is probably filled with a reflecting vapour, thinly diffuſed through it, like water faintly tinged with milk. A great depth of this muſt appear as white as a ſmall depth of milk itſelf; and it appears to be of a *very great* depth, and to be refractive like our air. For Dr. Herſchel has obſerved, by the help of his fine teleſcopes, that the illuminated part of Venus is conſiderably more than a hemiſphere, and that the light dies gradually away to the bounding margin. This is the very appearance that the earth would make if furniſhed with ſuch an atmoſphere. The boundary of illumination would have a penumbra reaching about nine degrees beyond it. If this be the conſtitution of the atmoſphere of Venus, ſhe may be inhabited by beings like ourſelves. They would not be dazzled by the intolerable ſplendor of a ſun four times as big and as bright, and ſixteen times more glaring, than ours; for they would ſeldom or never ſee him, but inſtead of him an uniformly bright and white ſky. They would probably never ſee a ſtar or planet, unleſs the dog-ſtar and Mercury; and perhaps the earth might pierce through the bright haze which ſurrounds their planet. For the ſame reaſon the inhabitants would not perhaps be incommoded by the ſun's heat. It is indeed a very queſtionable thing, whether the ſun would cauſe any heat, even here, if it were not for the chemical action of his rays on our air. This is rendered not improbable by the intenſe cold felt on the tops of the higheſt mountains, in the cleareſt air, and even under a vertical ſun in the torrid zone.

The atmoſphere of comets ſeems of a nature totally different. This ſeems to be of inconceivable rarity, even when it reflects a very ſenſible light. The tail is always turned nearly away from the ſun. It is thought that this is by the impulſe of the ſolar rays. If this be the caſe, we think it might be diſcovered by the aberration and the refraction of the light by which we ſee the tail: for this light muſt come to our eye with a much ſmaller velocity than the ſun's light, if it be reflected by repulſive or elaſtic forces, which there is every reaſon in the world to believe; and therefore the velocity of the reflected light will be diminiſhed by all the velocity communicated to the reflecting particles. This is almoſt inconceivably great. The comet of 1680 went half round the ſun in ten hours, and had a tail at leaſt a hundred millions of miles long, which turned round at the ſame time, keeping nearly in the direction oppoſite to the ſun. The velocity neceſſary for this is prodigious, approaching to that of light. And perhaps the tail extends much further than we ſee it, but is viſible only as far as the velocity with which its particles recede from the ſun is leſs than a certain quantity, namely, what would leave a ſufficient velocity for the reflected light to enable it to affect our eyes. And it may be demonſtrated, that although the real form of the viſible tail is concave on the anterior ſide to which the comet is moving, it may appear convex on that ſide, in conſequence of the very great aberration of the light by which the remote parts are ſeen. All this may be diſcovered by properly contrived obſervations; and the conjecture merits attention. But of this digreſſion there is enough; and we return to our ſubject, the conſtitution of our air.

We have ſhown how to determine *à priori* the denſity of the air at different elevations above the ſurface of the earth. But the denſities may be diſcovered in all acceſſible elevations by experiments; namely, by obſerving the heights of the mercury in the barometer. This is a direct meaſure of the preſſure of the incumbent atmoſphere; and this is proportional to the denſity which it produces.

Therefore, by means of the relation ſubſiſting between the denſities and the elevations, we can diſcover the elevations by obſervations made on the denſities by means of the barometer; and thus we may meaſure elevations by means of the barometer; and, with very little trouble, take the level of any extenſive tract of country. Of this we have an illuſtrious example in the ſection which the Abbé Chappe d'Auteroche has given of the whole country between Breſt and Ekaterinenburgh in Siberia. This is a ſubject which deſerves a minute conſideration: we ſhall therefore preſent it under a very ſimple and familiar form; and trace the method through its various ſteps of improvement by De Luc, Roy, Shuckburgh, &c.

We have already obſerved oftener than once, that if the mercury in the barometer ſtands at 30 inches, and if the air and mercury be of the temperature 32 degrees in Fahrenheit's thermometer, a column of air 87 feet thick has the ſame weight with a column of mercury $\frac{1}{10}$ of an inch thick. Therefore, if we carry the barometer to a higher place, ſo that the mercury ſinks to 29.9, we have aſcended 87 feet. Now, ſuppoſe we carry it ſtill higher, and that the mercury ſtands at 29.8; it is required to know what height we have now got to? We have evidently aſcended through another ſtratum of equal weight with the former: but it muſt be of greater thickneſs, becauſe the air in it is rarer, being leſs compreſſed. We may call the denſity of the firſt ſtratum 300, meaſuring the denſity by the number of tenths of an inch of mercury which its elaſticity proportional to its denſity enables it to ſupport. For the ſame reaſon, the denſity of the ſecond ſtratum muſt be 299: but when the weights are equal, the bulks are inverſely as the denſities; and when the baſes of the ſtrata are equal, the bulks are as the thickneſſes. Therefore, to obtain the thickneſs of this ſecond ſtratum, ſay 299 : 300 = 87 : 87,29; and this fourth term is the thickneſs of the ſecond ſtratum, and we have aſcended in all 174,29 feet. In like manner we may riſe till the barometer ſhows the denſity to be 298: then ſay, 298 : 30 = 87 : 87,584 for the thickneſs of the third ſtratum, and 261,875 or 261$\frac{7}{8}$ for the whole aſcent; and we may proceed in the ſame way for any number of mercurial heights, and make a table of the correſponding elements as follows: where the firſt column is the height of the mercury in the barometer, the ſecond column is the thickneſs of the ſtratum, or the elevation above the preceding ſtation; and the third column is the whole elevation above the firſt ſtation.

Bar.	Strat.	Elevat.
30	00,000	00,000
29.9	87,000	87,000
29,8	87,291	174,291
29,7	87,584	261,875
29,6	87,879	349,754
29,5	88,176	437,930
29,4	88,475	526,405
29,3	88,770	615,181
29,2	89,079	704,260
29,1	89,384	793,644
29	89,691	883,335

Having done this, we can now meaſure any elevation within the limits of our table, in this manner.

Obſerve the barometer at the lower and at the upper ſtations, and write down the correſponding elevations. Subtract the one from the other, and the remainder is the height required. Thus, ſuppoſe that at the lower ſtation the mercurial height was 29,8, and that at the upper ſtation it was 29,1.

29,1 793,644
29,8 174,291

619,353 = Elevation.

We may do the ſame thing with tolerable accuracy without the table, by taking the medium m of the mercurial heights, and their difference d in tenths of an inch; and then ſay, As m to 300, ſo is $87d$ to the height required b: or $b = \frac{300 \times 87d}{m} = \frac{26100d}{m}$. Thus, in the foregoing example, m is 294,5, and d is $= 7$; and therefore $b = \frac{7 \times 26100}{294,5} = 620,4$, differing only one foot from the former value.

Either of theſe methods is ſufficiently accurate for moſt purpoſes, and even in very great elevations will not produce any error of conſequence: the whole error of the elevation 883 feet four inches, which is the extent of the above table, is only $\frac{3}{4}$ of an inch.

But we need not confine ourſelves to methods of approximation, when we have an accurate and ſcientific method that is equally eaſy. We have ſeen that, upon the ſuppoſition of equal gravity, the denſities of the air are as the ordinates of a logarithmic curve, having the line of elevations for its axis. We have alſo ſeen that, in the true theory of gravity, if the diſtances from the centre of the earth increaſe in a harmonic progreſſion, the logarithm of the denſities will decreaſe in an arithmetical progreſſion; but if the greateſt elevation above the ſurface be but a few miles, this harmonic progreſſion will hardly differ from an arithmetical one. Thus, if Ab, Ac, Ad, are 1, 2, and 3 miles, we ſhall find that the correſponding elevations AB, AC, AD are ſenſibly in arithmetical progreſſion alſo: for the earth's radius AC is nearly 4000 miles. Hence it plainly follows, that BC – AB is $\frac{1}{4000 \times 4001}$, or $\frac{1}{16004000}$ of a mile, or $\frac{1}{250}$ of an inch; a quantity quite inſignificant. We may therefore affirm, without heſitation, that in all acceſſible places, the elevations increaſe in an arithmetical progreſſion, while the denſities decreaſe in a geometrical progreſſion. Therefore the ordinates are proportional to the numbers which are taken to meaſure the denſities, and the portions of the axis are proportional to the logarithms of theſe numbers. It follows, therefore, that we may take ſuch a ſcale for meaſuring the denſities that the logarithms of the numbers of this ſcale ſhall be the very portions of the axis; that is, of the vertical line in feet, yards, fathoms, or what meaſure we pleaſe: and we may, on the other hand, chooſe ſuch a ſcale for meaſuring our elevations, that the logarithms of our ſcale of denſities ſhall be parts of this ſcale of elevations; and we may find either of theſe ſcales ſcientifically. For it is a known property of the logarithmic curves, that when the ordinates are the ſame, the intercepted portions of the abſciſſæ are proportional to their ſubtangents. Now we know the ſubtangent of the atmoſpherical logarithmic: it is the height of the homogeneous atmoſphere in any meaſure we pleaſe, ſuppoſe fathoms: we find this height by comparing the gravities of air and mercury, when both are of ſome determined denſity. Thus, in the temperature of 32° of Fahrenheit's thermometer, when the barometer ſtands at 30 inches, it is known (by many experiments) that mercury is 10423,068 times heavier than air; therefore the height of the balancing column of homogeneous air will be 10423,068 times 30 inches; that is, 4342,945 Engliſh fathoms. Again, it is known that the ſubtangent of our common logarithmic tables, where one is the logarithm of the number 10, is 0,4342945. Therefore the number 0,4342945 is to the difference D of the logarithms of any two barometric heights as 4342,945 fathoms are to the fathoms F contained in the portion of the axis of the atmoſpherical logarithmic, which is intercepted between the ordinates equal to theſe barometrical heights; or that 0,4342945 : D = 4342,945 : F, and 0,4342,945 : 4342,945 = D : F; but 0,4342945 is the ten-thouſandth part of 4342,945, and therefore D is the ten-thouſandth part of F.

And thus it happens, by mere chance, that the logarithms of the denſities, meaſured by the inches of mercury which their elaſticity ſupports in the barometer, are juſt the ten-thouſandth part of the fathoms contained in the correſponding portions of the axis of the atmoſpherical logarithmic. Therefore, if we multiply our common logarithms by 10000, they will expreſs the fathoms of the axis of the atmoſpherical logarithmic. Nothing is more eaſily done. Our logarithms contain what is called the index or characteriſtic, which is an integer and a number of decimal places. Let us juſt remove the integer-place four figures to the right hand: thus the logarithm of 60 is 1.7781513, which is one integer and $\frac{7781513}{10000000}$. Multiply this by 10,000, and we obtain $\frac{513}{1001}$ 17781,513, or 17781 $\frac{513}{1000}$,

The practical application of all this reaſoning is obvious and eaſy: obſerve the heights of the mercury in the barometer at the upper and lower ſtations in inches and decimals; take the logarithms of theſe, and ſubtract the one from the other: the difference between them (accounting the four firſt decimal figures as integers) is the difference of elevation of fathoms.

Example.

Merc. Height at the lower ſtation 29,8	- -	1.4742163
upper ſtation 29,1	- -	1.4638930
Diff. of Log. × 10000	- - - -	0.0103,233

or 103 fathoms and $\frac{233}{1000}$ of a fathom, which is 619,392 feet, or 619 feet 4¾ inches; differing from the approximated value formerly found about ½ an inch.

Such is the general nature of the barometric meaſurement of heights firſt ſuggeſted by Dr. Halley; and it has been verified by numberleſs compariſons of the heights calculated in this way with the ſame height meaſured geometrically. It was indeed in this way that the preciſe ſpecific gravity of air and mercury was moſt accurately determined; namely, by obſerving, that when the temperature of air and mercury was 32, the difference of the logarithms of the mercurial heights were preciſely the fathoms of elevation. But it requires many corrections to adjuſt this method to the circumſtances of the caſe; and it was not till very lately that it has been ſo far adjuſted to them as to become uſeful. We are chiefly indebted to Mr. de Luc for the improvements. The great elevations in Switzerland enabled him to make an immenſe number of obſervations, in almoſt every variety of circumſtances. Sir George Shuckburgh alſo made a great number with moſt accurate inſtruments in much greater elevations, in the ſame country; and he made many chamber experiments for determining the laws of variation in the ſubordinate circumſtances. General Roy alſo made many to the ſame purpoſe. And to theſe two gentlemen we are chiefly obliged for the corrections which are now generally adopted.

It is eaſy to perceive that the method, as already expreſſed, cannot apply to every caſe: it depends on the ſpecific gravity of air and mercury, combined with the ſuppoſition that this is affected *only by a change of preſſure*. But ſince all bodies are expanded by heat, and as there is no reaſon to ſuppoſe that they are equally expanded by it, it follows that a change of temperature will change the relative gravity of mercury and air, even although both ſuffer the ſame change of temperature: and ſince the air may be warmed or cooled when the mercury is not, or may change its temperature independent of it, we may expect ſtill greater variations of ſpecific gravity.

The general effect of an augmentation of the ſpecific gravity of the mercury muſt be to increaſe the ſubtangent of the atmoſpherical logarithmic; in which caſe the logarithms of the denſities, as meaſured by inches of mercury, will expreſs meaſures that are greater than fathoms in the ſame proportion that the ſubtangent is increaſed; or, when the air is more expanded than the mercury, it will require a greater height of homogeneous atmoſphere to balance 30 inches of mercury, and a given fall of mercury will then correſpond to a thicker ſtratum of air.

In order, therefore, to perfect this method, we muſt learn by experiment how much mercury expands by an increaſe of temperature; we muſt alſo learn how much the air expands by the ſame or any change of temperature; and how much its elaſticity is affected by it. Both theſe circumſtances muſt be conſidered in the caſe of air; for it might happen that the elaſticity of the air is not ſo much affected by heat as its bulk is.

It will, therefore, be proper to ſtate in this place the experiments which have been made for aſcertaining theſe two expanſions.

The moſt accurate, and the beſt adapted experiments for aſcertaining the expanſion of mercury, are thoſe of General Roy, publiſhed in the 67th volume of the Philoſophical Tranſactions. He expoſed 30 inches of mercury, actually ſupported by the atmoſphere in a barometer, in a nice apparatus, by which it could be made of one uniform temperature through its whole length; and he noted the expanſion of it in decimals of an inch. Theſe are contained in the following table; where the firſt column expreſſes the temperature by Fahrenheit's thermometer, the ſecond column expreſſes the bulk of the mercury, and the third column the expanſion of an inch of mercury for an increaſe of one degree in the adjoining temperatures.

Table A.

Temp.	Bulk of ☿.	Expan. for 1°
212°	30,5117	0,0000763
202	30,4888	0,0000787
192	30,4652	0,0000810
182	30,4409	0,0000833
172	30,4159	0,0000857
162	30,3902	0,0000880
152	30,3638	0,0000903
142	30,3367	0,0000923
132	30,3090	0,0000943
122	30,2807	0,0000963
112	30,2518	0,0000983
102	30,2223	0,0001003
92	30,1922	0,0001023
82	30,1615	0,0001043
72	30,1302	0,0001063
62	30,0984	0,0001077
52	30,0661	0,0001093
42	30,0333	0,0001110
32	30,0000	0,0001127
22	29,9662	0,0001143
12	29,9319	0,0001160
2	29,8971	0,0001177
0	29,8901	

This table gives riſe to ſome reflections. The ſcale of the thermometer is conſtructed on the ſuppoſition that the ſucceſſive degrees of heat are meaſured by equal increments of bulk in the mercury of the thermometer. How comes it, therefore, that this is not accompanied by equal increments of bulk in the mercury of the column, but that the correſponding expanſions of this column do continually diminiſh? General Roy attributes this to the gradual detachment of elaſtic matter from the mercury by heat, which preſſes on the top of the column, and therefore ſhortens it. He applied a boiling heat to the vacuum a-top, without producing any further depreſſion; a proof that the barometer had been carefully filled. It had indeed been boiled through its whole length. He had attempted to meaſure the mercurial expanſion in the uſual way, by filling 30 inches of the tube with boiled mercury, and expoſing it to the heat with the open end uppermoſt. But here it is evident that the expanſion of the tube, and its ſolid contents, muſt be taken into the account. The expanſion of the tube was found ſo exceedingly irregular, and ſo incapable of being determined with preciſion for the tubes which were to be employed, that he was obliged to have recourſe to the method with the real barometer. In this no regard was neceſſary to any circumſtance but the perpendicular height. There was, beſides, a propriety in examining the mercury in the very condition in which it was uſed for meaſuring the preſſure of the atmoſphere; becauſe, whatever complication there was in the reſults, it was the ſame in the barometer in actual uſe.

The moſt obvious manner of applying theſe experiments on the expanſion of mercury to our purpoſe, is to reduce the obſerved height of the mercury to what it would have been if it were of the temperature 32. Thus, ſuppoſe that the obſerved mercurial height is 29,2, and that the temperature of the mercury is 72°, make 30,1302 : 30=29,2 : 29,0738. This will be the true meaſure of the denſity of the air of the ſtandard temperature. In order that we may obtain the exact temperature of the mercury, it is proper that the obſervation be made by means of a thermometer attached to the barometer-frame, ſo as to warm and cool along with it.

Or, this may be done without the help of a table, and with ſufficient accuracy, from the circumſtance that the expanſion of an inch of mercury for one degree diminiſhes very nearly $\frac{1}{500}$th part in each ſucceeding degree. If therefore we take from the expanſion at 32° its thouſandth part for each degree of any range above it, we obtain a mean rate of expanſion for that range. If the obſerved temperature of the mercury is below 32°, we muſt *add* this correction to obtain the mean expanſion. This rule will be made more exact if we ſuppoſe the expanſion at 32° to be = 0,0001127. Then multiply the obſerved mercurial height by this expanſion, and we obtain the correction, to be ſubtracted or added according as the temperature of the mercury was above or below 32°. Thus, to abide by the former example of 72°. This exceeds 32° by 40: therefore take 40 from 0,0001127, and we have 0,0001087 for the medium expanſion for that range. Multiply this by 40, and we have the whole expanſion of one inch of mercury, = 0,004348. Multiply the inches of mercurial height, viz. 29,2, by this expanſion, and we have for the correction 0,12696; which being ſubtracted from the obſerved height leaves 29,07304, differing from the accurate quantity leſs than the thouſandth part of an inch. This rule is very eaſily kept in the memory, and ſuperſedes the uſe of a table.

This correction may be made with all neceſſary exactneſs by a rule ſtill more ſimple; namely, by multiplying the obſerved height of the mercury by the difference of its temperature from 32°, and cutting off four cyphers before the decimals of the mercurial height. This will ſeldom err $\frac{1}{100}$ of an inch. We even believe that it is the moſt exact method within the range of temperatures that can be expected to occur in meaſuring heights: for it appears, by comparing many experiments and obſervations, that General Roy's meaſure of the mercurial expanſion is too great, and that the expanſion of an inch of mercury between 20° and 70 of Fahrenheit's thermometer does not exceed 0,000102 *per* degree. Having thus corrected the obſerved mercurial heights by reducing them to what they would have been if the mercury had been of the ſtandard temperature, the logarithms of the corrected heights are taken, and their difference, multiplied by 10000, will give the difference of elevations in Engliſh fathoms.

There is another way of applying this correction, fully more expeditious and equally accurate. The difference of the logarithms of the mercurial heights is the meaſure of the ratio of thoſe heights. In like manner the difference of the logarithms of the obſerved and corrected heights at any ſtation is the meaſure of the ratio of thoſe heights. Therefore this laſt difference of the logarithms is the meaſure of the correction of this ratio. Now the obſerved height is to the corrected height nearly as 1 to 1,000102. The logarithm of this ratio, or the difference of the logarithms of 1 and 1,000102, is 0,0000444. This is the correction for each degree that the temperature of the mercury differs from 32. Therefore multiply 0,0000444 by the difference of the mercurial temperatures from 32, and the products will be the corrections of the reſpective logarithms.

But there is ſtill an eaſier way of applying the logarithmic correction. If both the mercurial temperatures are the ſame, the differences of their logarithms will be the ſame, although each may be a good deal above or below the ſtandard temperature, if the expanſion be very nearly equable. The correction will be neceſſary only when the temperatures at the two ſtations are different, and will be proportional to this difference. Therefore, if the difference of the mercurial temperatures be multiplied by 0,0000444, the product will be the correction to be made on the difference of the logarithms of the mercurial heights.

But further, ſince the differences of the logarithms of the mercurial heights are alſo the differences of elevation in Engliſh fathoms, it follows that the correction is alſo a difference of elevation in Engliſh fathoms, or that the correction for one degree of difference of mercurial temperature is $\frac{444}{1000}$ of a fathom, or 32 inches, or 2 feet 8 inches.

This correction of 2.8 for every degree of difference of temperature muſt be ſubtracted from the elevation found by the general rate, when the mercury at the upper ſtation is colder than that at the lower. For, when this is the caſe, the mercurial column at the upper ſtation will appear too ſhort, the preſſure of the atmoſphere too ſmall, and therefore the elevation in the atmoſphere will appear greater than it really is.

Therefore the rule for this correction will be to multiply 0,0000444 by the degrees of difference between the mercurial temperatures at the two ſtations, and to add or ſubtract the product from the elevation found by the general rule, according as the mercury at the upper ſtation is hotter or colder than that at the lower.

If the experiments of General Roy on the expanſion of the mercury in a real barometer be thought moſt deſerving of attention, and the expanſion be conſidered as variable, the logarithmic difference correſponding to this expanſion for the *mean* temperature of the two barometers may be taken. Theſe logarithmic differences are contained in the following table, which is carried as far as 112°, beyond which it is not probable that any obſervations will be made. The number for each temperature is the difference between the logarithms of 30 inches, of the temperature 32, and of 30 inches expanded by that temperature.

TABLE B.

Temp.	Log. diff.	Dec. of Fath.	Ft. In.
112°			
102	0.0000427	,427	2.7
92	0.0000436	,436	2.7
82	0.0000444	,444	2.8
72	0.0000453	,453	2.9
62	0.0000460	,460	2.9
52	0.0000468	,468	2.10
42	0.0000475	,475	2.10
32	0.0000482	,482	2.11
22	0.0000489	,489	2.11
12	0.0000497	,497	3.0
0	0.0000504	,504	3.0

It is alſo neceſſary to attend to the temperature of the air; and the change that is produced by heat in its denſity is of much greater conſequence than that of the mercury. The relative gravity of the two, on which the ſubtangent of the logarithmic curve depends, and conſequently the unit of our ſcale of elevations, is much more affected by the heat of the air than by the heat of the mercury.

This adjuſtment is of incomparably greater difficulty than the former, and we can hardly hope to make it perfect. We ſhall narrate the chief experiments which have been made on the expanſion of air, and deduce from them ſuch rules as appear to be neceſſary conſequences of them, and then notice the circumſtances which leave the matter ſtill imperfect.

General Roy compared a mercurial and an air thermometer, each of which was graduated arithmetically, that is, the units of the ſcales were equal bulks of mercury, and equal bulks (perhaps different from the former) of air. He found their progreſs as in the following table.

TABLE C.

Merc.	Diff.	Air.	Diff.
212	20	212,0	17,6
192	20	194,4	18,2
172	20	176,2	18,8
152	20	157,4	19,4
132	20	138,0	20,0
112	20	118,0	20,8
92	20	97,2	21,6
72	20	75,6	22,6
52	20	53,0	21,6
32	20	31,4	20,0
12		11,4	

It has been eſtabliſhed by many experiments that equal increments of heat produce equal increments in the bulk of mercury. The differences of temperature are therefore expreſſed by the ſecond column, and may be conſidered as equal; and the numbers of the third column muſt be allowed to expreſs the ſame temperatures with thoſe of the firſt. They *directly* expreſs the *bulks* of the air, and the numbers of the fourth column expreſs the differences of theſe bulks. Theſe are evidently unequal, and ſhow that common air expands moſt of all when of the temperature 62 nearly.

The next point was to determine what was the *actual* increaſe of bulk by ſome known increaſe of heat. For this purpoſe he took a tube, having a narrow bore, and a ball at one end. He meaſured with great care the capacity of both the ball and the tube, and divided the tube into equal ſpaces which bore a determined proportion to the capacity of the ball. This apparatus was ſet in a long cylinder filled with frigorific mixtures or with water, which could be uniformly heated up to the boiling temperature, and was accompanied by a nice thermometer. The expanſion of the air was meaſured by means of a column of mercury which roſe or ſunk in the tube. The tube being of a ſmall bore, the mercury did not drop out of it; and the bore being choſen as equable as poſſible, this column remained of an uniform length, whatever part of the tube it chanced to occupy. By this contrivance he was able to examine the expanſibility of air of various denſities. When the column of mercury contained only a ſingle drop or two, the air was nearly of the denſity of the external air. If he wiſhed to examine the expanſion of air twice or thrice as denſe, he uſed a column of 30 or 60 inches long: and to examine the expanſion of air that is rarer than the external air, he placed the tube with the ball uppermoſt, the open end coming through a hole in the bottom of the veſſel containing the mixtures or water. By this poſition the column of mercury was hanging in the tube, ſupported by the preſſure of the atmoſphere; and the elaſticity of the included air was meaſured by the difference between the ſuſpended column and the common barometer.

The following table contains the expanſion of 1000 parts of air, nearly of the common denſity, by heating it from 0 to 212. The firſt column contains the height of the barometer; the ſecond contains this height augmented by the ſmall column of mercury in the tube of the manometer, and therefore expreſſes the denſity of the air examined; the third contains the total expanſion of 1000 parts; and the fourth contains the expanſion for 1°, ſuppoſing it uniform throughout.

TABLE D.

Barom.	Denſity of Air examined.	Expanſion of 1000 pts. by 212°.	Expanſion by 1°
29,95	31,52	483,89	2,2825
30,07	30,77	482,10	2,2741
29,48	29,90	480,74	2,2676
29,90	30,73	485,86	2,2918
29,96	30,92	489,45	2,3087
29,90	30,55	476,04	2,2455
29,95	30,60	487,55	2,2998
30,07	30,60	482,80	2,2774
29,48	30,00	489,47	2,3087
Mean	30,62	484,21	2,2840

Hence it appears, that the mean expanſion of 1000 parts of air of the denſity 30,62 by one degree of Fahrenheit's thermometer is 2,284, or that 1000 becomes 1002,284.

If this expanſion be ſuppoſed to follow the ſame rate that was obſerved in the compariſon of the mercurial and air thermometer, we ſhall find that the expanſion of a thouſand parts of air for one degree of heat at the different intermediate temperatures will be as in the following table.

TABLE E.

Temp.	Total Expanſion	Expanſion for 1°
212	484,210	2,0099
192	444,011	2,0080
172	402,452	2,1475
152	359,503	2,2155
132	315,193	2,2840
112	269,513	2,3754
92	222,006	2,4211
82	197,795	2,5124
72	172,071	2,5581
62	147,090	2,6037
52	121,053	2,5124
42	95,929	2,4211
32	71,718	2,3297
22	48,421	2,2383
12	26,038	2,1698
0		

If we would have a mean expanſion for any particular range, as between 12° and 92°, which is the moſt likely to comprehend all the geodætical obſervations, we need only take the difference of the bulks 26,038 and 222,006 = 195,968, and divide this by the interval of temperature 80°, and we obtain 2,4496, or 2,45 for the mean expanſion for 1°.

It would perhaps be better to adapt the table to a maſs of 1000 parts of air of the ſtandard temperature 32°; for in its preſent form it ſhows the expanſibility of air originally of the temperature 0. This will be done with ſufficient accuracy by ſaying (for 212°) 1071,718 : 1484,210 = 1000, : 13849, and ſo of the reſt. Thus we ſhall conſtruct the following table of the expanſion of 10,000 parts of air.

Table F.

Temp.	Bulk	Differ.	Expanſ. for 1°
212	13489		
192	13474	375	18,7
172	13087	387	19,3
152	12685	392	19,6
132	12272	413	20,6
112	11846	426	21,3
92	11403	443	22,1
82	11177	226	22,6
72	10942	235	23,5
62	10704	238	23,8
52	10461	243	24,3
42	10226	235	23,5
32	10000	226	22,6
22	9783	217	21,7
12	9574	209	20,9
0	9331	243	20,2

This will give for the mean expanſion of 1000 parts of air between 12° and 92 = 2,29.

Although it cannot happen that in meaſuring the differences of elevation near the earth's ſurface, we ſhall have occaſion to employ air greatly exceeding the common denſity, we may inſert the experiments made by General Roy on ſuch airs. They are expreſſed in the following table; where column firſt contains the denſities meaſured by the inches of mercury that they will ſupport when of the temperature 32°; column ſecond is the expanſion of of 1000 parts of ſuch air by being heated from 0 to 212; and column third is the mean expanſion for 1°.

Table G.

	Denſity	Expanſion for 212	Expanſ. for 1°
	101,7	451,54	2,130
	92,3	423,23	1,996
	80,5	412,09	1,944
	54,5	439,87	2,075
	49,7	443,24	2,091
Mean	75,7	434	2,047

We have much more frequent occaſion to operate in air that is rarer than the ordinary ſtate of the ſuperficial atmoſphere. General Roy accordingly made many experiments on ſuch airs. He found, in general, that their expanſibility by heat was analogous to that of air in its ordinary denſity, being greateſt about the temperature 60°. He found, too, that its expanſibility by heat diminiſhed with its denſity, but he could not determine the law of gradation. When reduced to about $\frac{1}{5}$ of the denſity of common air, its expanſion was as follows:

Table H.

Temp.	Bulk	Difference	Expanſ. for 1°
212	1141,504		
192	1134,429	7,075	0,354
172	1122,165	12,264	0,613
152	1108,015	14,150	0,708
132	1093,864	14,151	0,708
112	1079,636	14,228	0,711
92	1064,699	14,937	0,747
72	1043,788	20,911	1,045
52	1017,845	25,943	1,297
32	1000,000	17,845	0,892
		Mean expanſion	0,786

From this very extenſive and judicious range of experiments, it is evident that the expanſibility of air by heat is greateſt when the air is about its ordinary denſity, and that in ſmall denſities it is greatly diminiſhed. It appears alſo, that the law of compreſſion is altered; for in this ſpecimen of the rare air half of the whole expanſion happens about the temperature 99°, but in air of ordinary denſity at 105°. This being the caſe, we ſee that the experiments of Mr. Amontons, narrated in the Memoirs of the Academy at Paris 1702, &c. are not inconſiſtent with thoſe more perſpicuous experiments of General Roy. Amontons found, that whatever was the denſity of the air, at leaſt in caſes much denſer than ordinary air, the change of 180° of temperature increaſed its elaſticity in the ſame proportion: for he found, that the column of mercury which it ſupported when of the temperature 50, was increaſed $\frac{1}{3}$ at the temperature 212. Hence he haſtily concluded, that its expanſibility was increaſed in the ſame proportion; but this by no means follows, unleſs we are certain that in every temperature the elaſticity is proportional to the denſity. This is a point which ſtill remains undecided; and it merits attention, becauſe, if true, it eſtabliſhes a remarkable law concerning the action of heat, which would ſeem to go to prove that the elaſticity of fluids is the property of the matter of fire, which it ſuperinduces on every body with which it combines in the form of vapour.

After this account of the expanſion of air, we ſee that the height through which we muſt riſe in order to produce a given fall of the mercury in the barometer, or the thickneſs of the ſtratum of air equiponderant with a tenth of an inch of mercury, muſt increaſe with the expanſion of air; and that if $\frac{2,29}{1000}$ be the expanſion for one degree, we muſt multiply the exceſs of the temperature of the air above 32° by 0,00229, and multiply the product by 87, in order to obtain the thickneſs of the ſtratum where the barometer ſtands at 30 inches; or whatever be the elevation indicated by the difference of the barometrical heights, upon the ſuppoſition that the air is of the temperature 32°, we muſt multiply this by 0,00229 for every degree that the air is warmer or colder than 32. The product muſt be added to the elevation in the firſt caſe, and ſubtracted in the latter.

Sir George Shuckburgh deduces 0,0024 from his experiments as the mean expanſion of air in the ordinary caſes: and this is probably nearer the truth; becauſe General Roy's experiments were made on air which was freer from damp than the ordinary air in the fields; and it appears from his experiments, that a very minute quantity of damp increaſes its expanſibility by heat in a prodigious degree.

The great difficulty is how to apply this correction; or rather, how to determine the temperature of the air in thoſe extenſive and deep ſtrata in which the elevations are meaſured. It feldom or never happens that the ſtratum is of the ſame temperature throughout. It is commonly much colder aloft; it is alſo of different conſtitutions. Below it is warm, loaded with vapour, and very expanſible; above it is cold, much drier, and leſs expanſible, both by its dryneſs and its rarity. The currents of wind are often diſpoſed in ſtrata, which long retain their places; and, as they come from different regions, are of different temperatures and different conſtitutions. We cannot therefore determine the expanſion of the whole ſtratum with preciſion, and muſt content ourſelves with an approximation: and the beſt approximation that we can make is, by ſuppoſing the whole ſtratum of a mean temperature between thoſe of its upper and lower extremity, and employ the expanſion correſponding to that mean temperature.

This, however, is founded on a gratuitous ſuppoſition, that the whole intermediate ſtratum expands alike, and that the expanſion is equable in the different intermediate temperatures; but neither of theſe are warranted by experiment. Rare air expands leſs than what is denſer; and therefore the general expanſion of the whole ſtratum renders its denſity more uniform. Dr. Horſley has pointed out ſome curious conſequences of this in Phil. Tranſ. vol. lxiv. There is a particular elevation at which the general expanſion, inſtead of diminiſhing the denſity of the air, increaſes it by the ſuperior expanſion of what is below; and we know that the expanſion is not equable in the intermediate temperatures: but we cannot find out a rule which will give us a more accurate correction than by taking the expanſion for the mean temperature.

When we have done this, we have carried the method of meaſuring heights by the barometer as far as it can go; and this ſource of remaining error makes it needleſs to attend to ſome other very minute equations which theory points out. Such is the diminution of the weight of the mercury by the change of diſtance from the centre of the earth. This accompanies the diminution of the weight of the air, but neither ſo as to compenſate it, nor to go along with it *pari paſſu*.

After all, there are found caſes where there is a regular deviation from thoſe rules, of which we cannot give any very ſatisfactory account. Thus it is found, that in the province of Quito in Peru, which is at a great elevation above the ſurface of the ocean, the heights obtained by theſe rules fall conſiderably ſhort of the real heights; and at Spitſbergen they conſiderably exceed them. It appears that the air in the circumpolar regions is denſer than the air of the temperate climates when of the ſame heat and under the ſame preſſure; and the contrary ſeems to be the caſe with the air in the torrid zone. It would ſeem that the ſpecific gravity of air to mercury is at Spitſbergen about 1 to 10224, and in Peru about 1 to 13100. This difference is with great probability aſcribed to the greater dryneſs of the circumpolar air.

This ſource of error will always remain; and it is combined with another, which ſhould be attended to by all who practiſe this method of meaſuring heights, namely, a difference in the ſpecific gravity of the quick-ſilver. It is thought ſufficiently pure for a barometer when it is cleared of all calcinable matter, ſo as not to drag, or fully the tube. In this ſtate it may contain a conſiderable portion of other metals, particularly of ſilver, biſmuth, and tin, which will diminiſh its ſpecific gravity. It has been obtained by revivification from cinnabar of the ſpecific gravity 14,229, and it is thought very fine if 13,65. Sir George Shuckburgh found the quickſilver which agreed preciſely with the atmoſpherical obſervations on which the rules are founded to have the ſpecific gravity 13,61. It is ſeldom obtained ſo heavy. It is evident that theſe variations will change the whole reſults; and that it is abſolutely neceſſary, in order to obtain preciſion, that we know the denſity of the mercury employed. The ſubtangent of the atmoſpherical logarithmic, or the height of the homogeneous atmoſphere, will increaſe in the ſame proportion with the denſity of the mercury; and the elevation correſponding to $\frac{1}{10}$ of an inch of barometric height will change in the ſame proportion.

We muſt be contented with the remaining imperfections: and we can readily ſee, that, for any purpoſe that can be anſwered by ſuch meaſurements of great heights, the method is ſufficiently exact; but it is quite inadequate to the purpoſe of taking accurate levels, for directing the conſtruction of canals, aqueducts, and other works of this kind, where extreme preciſion is abſolutely neceſſary.

We ſhall now deduce from all that has been ſaid on this ſubject ſets of eaſy rules for the practice of this mode of meaſurement, illuſtrating them by an example.

1. M. de Luc's *Method.*

I. Subtract the logarithm of the barometrical height at the upper ſtation from the logarithm of that at the lower, and count the index and four firſt decimal figures of the remainder as fathoms, the reſt as a decimal fraction. Call this the *elevation.*

II. Note the different temperatures of the mercury at the two ſtations, and the mean temperature. Multiply the logarithmic expanſion correſponding to this mean temperature (in Table B, p. 126.) by the difference of the two temperatures, and ſubtract the product from the elevation if the barometer has been coldeſt at the upper ſtation, otherwiſe add it. Call the difference or the ſum the *approximated elevation.*

III. Note the difference of the temperatures of the air at the two ſtations by a detached thermometer, and alſo the mean temperature and its difference from 32°. Multiply this difference by the expanſion of air for the mean temperature, and multiply the approximate elevation by 1 ± this product, according as the air is above or below 32°. The product is the correct elevation in fathoms and decimals.

Example.

Suppoſe that the mercury in the barometer at the lower ſtation was at 29,4 inches, that its temperature was 50°, and the temperature of the air was 45: and let the height of the mercury at the upper ſtation be 25,19 inches, its temperature 46, and the temperature of the air 39. Thus we have

☿al Heights.	Temp. ☿.	Mean.	Temp. Air.	Mean.
29,4	50	48	45	42
25,19	46		39	

I. Log. of 29,4	-	-	1.4683473
Log. of 25,19	-	-	1.4012282
Elevation in fathoms	-	-	671,191
II. Expanſ. for 48°	,473		
Multiply by	4	-	1,892
Approximated elevation		-	669,299
III. Expanſ. of air at 42	00,0238		
× 42—32, = 10°	10		
	0,0238		
Multiply	-	-	669,2990
By	-	-	1,0238
Product = the correct elevation		-	685,228

2. *Sir* George Shuckburgh's *Method.*

I. Reduce the barometric heights to what they would be if they were of the temperature 32°.

II. The difference of the logarithms of the reduced barometrical heights will give the approximate elevation.

III. Correct the approximated elevation as before.

Same Example.

I. Mean expanſ. for 1° from Tab. A, p. 253. is 0,000111.

$18° \times 0,000111 \times 29,4 =$ - -	0,059
Subtract this from - - -	29,4
Reduced barometric height - -	29,341

Expanſ. from Tab. A, p. 253. is 0,000111.

$14° \times 0,000111 \times 25,19$ - -	0,029
Subtract from - - -	25,190
Reduced barometric height - -	25,151
II. Log. 29,341 - - -	1,4674749
Log. 25,151 - - -	1,4005553
Approximated elevation - -	669,196
III. This multiplied by 1,0238 gives -	685,125

Remark 1. If 0,000101 be ſuppoſed the mean expanſion of mercury for 1°, as Sir George Shuckburgh determines it, the reduction of the barometric heights will be had ſufficiently exact by multiplying the obſerved heights of the mercury by the difference of its temperatures from 32, and cutting off four more decimal places; thus $29,4\frac{\times 18}{10000}$ gives for the reduced height 29,347, and $25,19 \times \frac{14}{10000}$ gives 25,155, and the difference of their logarithms gives 669,4 fathoms for the approximated elevation, which differs from the one given above by no more than 15 inches.

Remark 2. If 0,0024 be taken for the expanſion of air for one degree, the correction for this expanſion will be had by multiplying the approximated elevation by 12, and this product by the ſum of the differences of the temperatures from 32°, counting that difference as negative when the temperature is below 32, and cutting off four places; thus $669,196 \times 12 \times \overline{13+07} \times \frac{1}{10000} = 16,061$, which added to 669,196 gives 685,257, differing from the former only 9 inches.

From the ſame premiſes we may derive a rule, which is abundantly exact for all geodætical purpoſes, and which requires no tables of any kind, and is eaſily remembered.

1. The height through which we muſt riſe in order to produce any fall of the mercury in the barometer, is inverſely proportional to the denſity of the air, that is, to the height of the mercury in the barometer.

2. When the barometer ſtands at 30 inches, and the air and quickſilver are of the temperature 32, we muſt riſe through 87 feet, in order to produce a depreſſion of $\frac{1}{10}$ of an inch.

3. But if the air be of a different temperature, this 87 feet muſt be increaſed or diminiſhed by 0,21 of a foot for every degree of difference of the temperature from 32°.

4. Every degree of difference of the temperatures of the mercury at the two ſtations makes a change of 2,833 feet, or 2 feet 10 inches in the elevation.

Hence the following rule.

1. Take the difference of the barometric heights in tenths of an inch. Call this *d*.

2. Multiply the difference *a* between 32, and the mean temperature of the air by 21, and take the ſum or difference of this product and 87 feet. This is the height through which we muſt riſe to cauſe the barometer to fall from 30 inches to 29,9. Call this height *b*.

Let *m* be the mean between the two barometric heights. Then $\frac{30\,d\,b}{m}$ is the approximated elevation very nearly.

Multiply the difference δ of the mercurial temperatures by 2,83 feet, and add this product to the approximated elevation if the upper barometer has been the warmeſt, otherwiſe ſubtract it. The reſult, that is, the ſum or difference, will be the corrected elevation.

Same Example.

$$d = 294 + \cdot\, 251,9 = 42,1$$
$$b = 87 + 10 \times 0,21, = 89,1$$
$$m = \frac{29,4 + 25,19}{2} = 27,29$$

$$\text{Approx. elevation} = \frac{30 \times 42,1 \times 89,1}{27,29}, = 4123,24 \text{ feet.}$$

Corr. for temp. of mercury, $= 4 \times 2,83$	11,32
Corrected elevation in feet -	4111,92
Ditto in fathoms - -	635,32

Differing from the former only 15 inches.

This rule may be expreſſed by the following ſimple and eaſily remembered formula, where *a* is the difference between 32° and the mean temperature of the air, *d* is the difference of barometric heights in tenths of an inch, *m* is the mean barometric height, δ the difference between the mercurial temperatures, and E is the correct elevation. $E = \frac{30(87 \pm 0,21a)d}{m} \pm \delta \times 2,83.$

We ſhall now conclude this ſubject by an account of ſome of the moſt remarkable mountains, &c. on the earth above the ſurface of the ocean in feet.

Mount Puy de Domme in Auvergne, the firſt mountain meaſured by the barometer		5088
Mount Blanc	Alps	15662
Monte Roſa		15084
Aiguille d'Argenture		13402
Monaſtery of St. Bernard		7944
Mount Cenis		9212
Pic de los Reyes	Pyrennees.	7620
Pic du Medi		9370
Pic d'Oſſano		11700
Canegou		8544
Lake of Geneva		1232
Mount Ætna		10954
Mount Veſuvius		3938
Mount Heela in Iceland		4887
Snowdon		3555
Ben Moir		3723
Ben Laurs.		3858
Ben Gloe		3472
Shihallion		3461
Ben Lomond		3180
Tinto		2342
Table Hill, Cape of Good Hope		3454
Gondar city in Abyſſinia		8440
Source of the Nile		8082
Pic of Teneriffe		14026
Chimboraçon		19595
Cayambourow		19391
Antiſana		19230
Pichinha		15670
City of Quito		9977
Caſpian Sea below the ocean		306

This laſt is ſo ſingular, that it is neceſſary to give the authority on which this determination is founded. It is deduced from nine years obſervations with the barometer at Aſtracan by Mr.

Lecre, compared with a ſeries of obſervations made with the ſame barometer at St. Peterſburgh.

This employment of the barometer has cauſed it to become a very intereſting inſtrument to the philoſopher and to the traveller; and many attempts have been made of late to improve it, and render it more portable. The improvements have either been directed to the enlargement of its range, or to the more accurate meaſurement of its preſent ſcale. Of the firſt kind are Hook's wheel barometer, the diagonal barometer, and the horizontal barometer, deſcribed in a former volume of this work. See BAROMETER. In that place are alſo deſcribed two very ingenious contrivances of Mr. Rowning's, which are evidently not portable. Of all the barometers with an enlarged ſcale the beſt is that invented by Dr. Hooke in 1668, and deſcribed in the Phil. Tranſ. No. 185. The invention was alſo claimed by Huyghens and by De la Hire; but Hooke's was publiſhed long before.

It conſiſts of a compound tube ABCDEFG (fig. 56, pl. 11), of which the parts AB and DE are equally wide, and EFG as much narrower as we would amplify the ſcale. The parts AB and EG muſt alſo be as perfectly cylindrical as poſſible. The part HBCDI is filled with mercury, having a vacuum above in AB. IF is filled with a light fluid, and FG with another light fluid which will not mix with that in IF. The ciſtern G is of the ſame diameter as AB. It is eaſy to ſee that the range of the ſeparating ſurface at F muſt be as much greater than that of the ſurface I as the area of I is greater than that of F. And this ratio is in our choice. This barometer is free from all the bad qualities of thoſe formerly deſcribed, being moſt delicately moveable; and is by far the fitteſt for a chamber, for amuſement by obſervations on the changes of the atmoſpheric preſſure. The ſlighteſt breeze cauſes it to riſe and fall, and it is continually in motion.

But this, and all other contrivances of the kind, are inferior to the common barometer for meaſurement of heights, on account of their bulk and cumberſomeneſs: nay, they are inferior for all philoſophical purpoſes in point of accuracy; and this for a reaſon that admits of no reply. Their ſcale muſt be determined in all its parts by the common barometer; and therefore, notwithſtanding their great range, they are ſuſceptible of no greater accuracy than that with which the ſcale of a common barometer can be obſerved and meaſured. This will be evident to any perſon who will take the trouble of conſidering how the points of their ſcale muſt be aſcertained. The moſt accurate method for graduating ſuch a barometer as we have now deſcribed would be to make a mixture of vitriolic acid and water, which ſhould have one-tenth of the denſity of mercury. Then, let a long tube ſtand vertical in this fluid, and connect its upper end with the open end of the barometer by a pipe which has a branch to which we can apply the mouth. Then if we ſuck through this pipe, the fluid will riſe both in the barometer and in the other tube; and 10 inches riſe in this tube will correſpond to one inch deſcent in the common barometer. In this manner may every point of the ſcale be adjuſted in due proportion to the reſt. But it ſtill remains to determine what particular point of the ſcale correſponds to ſome determined inch of the common barometer. This can only be done by an actual compariſon; and this being done, the whole becomes equally accurate. Except therefore for the mere purpoſe of chamber amuſement, in which caſe the barometer laſt deſcribed has a decided preference, the common barometer is to be preferred; and our attention ſhould be entirely directed to its improvement and portability.

For this purpoſe it ſhould be furniſhed with two microſcopes or magnifying glaſſes, one of them ſtationed at the beginning of the ſcale; which ſhould either be moveable, ſo that it may always be brought to the ſurface of the mercury in the ciſtern, or the ciſtern ſhould be ſo contrived that its ſurface may always be brought to the beginning of the ſcale. The glaſs will enable us to ſee the coincidence with accuracy. The other microſcope muſt be moveable, ſo as to be ſet oppoſite to the ſurface of the mercury in the tube; and the ſcale ſhould be furniſhed with a vernier which divides an inch into 1000 parts, and be made of materials of which we know the expanſion with great preciſion.

For an account of many ingenious contrivances to make the inſtrument accurate, portable, and commodious, conſult Magellan, *Diſſer. de diverſes Inſtr. de Phyſ.*; *Phil. Tranſ.* lxvii. lxviii.; *Journ. de Phyſ.* xix. 108. 346. xvi. 392. xviii. 391. xxi. 436. xxii. 390.; Sulzer, *Act. Helvet.* iii. 259.; De Luc, *Recherches ſur les Modifications de l'Atmoſphere*, i. 401. ii. 459. 490. De Luc's ſeems the moſt ſimple and perfect of them all. Cardinal de Luynes (*Mem. Par.* 1768); Prin. De Luc, *Recherches*, § 63; Van Swinden's *Poſitiones Phyſicæ*; *Com. Acad. Petrop.* i.; *Com. Acad. Petrop. Nov.* ii. 200. viii.

THUS we have given an elementary account of the diſtinguiſhing properties of air as a heavy and compreſſible fluid, and of the general phenomena which are immediate conſequences of theſe properties. This we have done in a ſet of propoſitions analogous to thoſe which form the doctrines of hydroſtatics. It remains to conſider it in another point of view, namely, as moveable and inert. The phenomena conſequent on theſe properties are exhibited in the velocities which air acquires by preſſure, in the reſiſtance which bodies meet with to their motion through the air, and in the impreſſion which air in motion gives to bodies expoſed to its action.

We ſhall firſt conſider the motions of which air is ſuſceptible when the equilibrium of preſſure (whether ariſing from its weight or its elaſticity) is removed; and, in the next place, we ſhall conſider its action on ſolid bodies expoſed to its current, and the reſiſtance which it makes to their motion through it.

In this conſideration we ſhall avoid the extreme of generality, which renders the diſcuſſion too abſtract and difficult, and adapt our inveſtigation to the circumſtances in which compreſſible fluids (of which air is taken for the repreſentative) are moſt commonly found. We ſhall conſider air therefore as it is commonly found in acceſſible ſituations, as acted on by equal and parallel gravity; and we ſhall conſider it in the ſame order in which water is treated in a ſyſtem of hydraulics.

In that ſcience the leading problem is to determine with what velocity the water will move through a given orifice when impelled by ſome known preſſure; and it has been found, that the beſt form in which this moſt difficult and intricate propoſition can be put, is to determine the velocity of water flowing through this orifice when impelled by its weight alone. Having determined this, we can reduce to this caſe every queſtion which can be propoſed; for, in place of the preſſure of any piſton or other mover, we can always ſubſtitute a perpendicular column of water or air whoſe weight ſhall be equal to the given preſſure.

The firſt problem, therefore, is to determine with what velocity air will ruſh into a void when impelled by its weight alone. This is evidently analogous to the hydraulic problem of water flowing out of a veſſel.

And here we muſt be contented with referring our readers to the ſolutions which have been given of that problem, and the demonſtration that it flows with the velocity which a heavy body would acquire by falling from a height equal to the depth of the hole under the ſurface of the water in the veſſel. In whatever way we attempt to demonſtrate that propoſition, every ſtep, nay, every word, of the demonſtration applies equally to the air, or to any fluid whatever. Or, if our readers ſhould wiſh to ſee the connexion or analogy of the caſes, we only deſire them to recollect an undoubted maxim in the ſcience of motion, that *when the moving force and the matter to be moved* *vary in the ſame proportion, the velocity will be the ſame.* If therefore there be ſimilar veſſels of air, water, oil, or any other fluid, all of the height of a homogeneous atmoſphere, they will all run through equal and ſimilar holes with the ſame velocity; for, in whatever proportion the quantity of matter moving through the hole be varied by a variation of denſity, the preſſure, which forces it out, by acting in circumſtances perfectly ſimilar, varies in the ſame proportion by the ſame variation of denſity.

We muſt therefore aſſume it as the leading propoſition, that *air ruſhes from the atmoſphere into a void with the velocity which a heavy body would acquire by falling from the top of a homogeneous atmoſphere.*

It is known that air is about 840 times lighter than water, and that the preſſure of the atmoſphere ſupports water at the height of 33 feet nearly. The height therefore of a homogeneous atmoſphere is nearly 33 × 840, or 27720 feet: Moreover, to know the velocity acquired by any fall, recollect that a heavy body by falling one foot acquires the velocity of 8 feet per ſecond; and that the velocities acquired by falling through different heights are as the ſquare roots of the heights. Therefore, to find the velocity correſponding to any height, expreſſed in feet per ſecond, multiply the ſquare root of the height by 8. We have therefore in the preſent inſtance $V = 8\sqrt{27220}, = 8 \times 166{,}493, = 1332$ feet per ſecond. This therefore is the velocity with which common air will ruſh into a void; and this may be taken as a ſtandard number in pneumatics, as 16 and 32 are ſtandard numbers in the general ſcience of mechanics, expreſſing the action of gravity at the ſurface of the earth.

It is eaſy to ſee that greater preciſion is not neceſſary in this matter. The height of a homogeneous atmoſphere is a variable thing, depending on the temperature of the air. If this reaſon ſeem any objection againſt the uſe of the number 1332, we may retain $8\sqrt{H}$ in place of it, where H expreſſes the height of a homogeneous atmoſphere of the given temperature. A variation of the barometer makes no change in the velocity, nor in the height of the homogeneous atmoſphere, becauſe it is accompanied by a proportional variation in the denſity of the air. When it is increaſed $\frac{1}{10}$, for inſtance, the denſity is alſo increaſed $\frac{1}{10}$; and thus the expelling force and the matter to be moved are changed in the ſame proportion, and the velocity remains the ſame. N. B. We do not here conſider the velocity which the air acquires after its iſſuing into the void by its continual expanſion. This may be aſcertained by the 39th prop. of Newton's *Principia*, b. i. Nay, which appears very paradoxical, if a cylinder of air, communicating in this matter with a void, be compreſſed by a piſton loaded with a weight, which preſſes it down as the air flows out, and thus keeps it of the ſame denſity, the velocity of efflux will ſtill be the ſame however great the preſſure may chance to be: for the firſt and immediate effect of the load on the piſton is to reduce the air in the cylinder to ſuch a denſity that its elaſticity ſhall exactly balance the load; and becauſe the elaſticity of air is proportional to its denſity, the denſity of the air will be increaſed in the ſame proportion with the load, that is, with the expelling power (for we are neglecting at preſent the weight of the included air, as too inconſiderable to have any ſenſible effect). Therefore, ſince the matter to be moved is increaſed in the ſame proportion with the preſſure, the velocity will be the ſame as before.

It is equally eaſy to determine the velocity with which the air of the atmoſphere will ruſh into a ſpace containing rarer air. Whatever may be the denſity of this air, its elaſticity, which follows the proportion of its denſity, will balance a proportional part of the preſſure of the atmoſphere; and it is the exceſs of this laſt only which is the moving force. The matter to be moved is the ſame as before. Let D be the natural denſity of the air, and δ the denſity of the air contained in the veſſel into which it is ſuppoſed to run, and let P be the preſſure of the atmoſphere, and therefore equal to the force which impels it into a void; and let π be the force with which this rarer air would run into a void. We have $D : \delta = P : \pi$, and $\pi = \frac{P\delta}{D}$. Now the moving force in the preſent inſtance is $P - \pi$, or $P - \frac{P\delta}{D}$. Laſtly, let V be the velocity of air ruſhing into a void, and v the velocity with which it will ruſh into this rarefied air.

It is a theorem in the motion of fluids, that the preſſures are as the ſquares of the velocities of efflux. Therefore $P : P - \frac{P\delta}{D} = V^2 : v^2$: Hence we derive $v^2 = V^2 \times \overline{1 - \frac{\delta}{D}}$, and $v = V \times \sqrt{1 - \frac{\delta}{D}}\Big|$. We do not here conſider the reſiſtance which the air of the atmoſphere will meet with from the inertia of that in the veſſel which it muſt diſplace in its motion.

Here we ſee that there will always be a current into the veſſel while δ is leſs than D.

We alſo learn the gradual diminution of the velocity as the veſſel fills; for δ continually increaſes, and therefore $1 - \frac{\delta}{D}$ continually diminiſhes.

It remains to determine the time t expreſſed in ſeconds, in which the air of the atmoſphere will flow into this veſſel from its ſtate of vacuity till the air in the veſſel has acquired any propoſed denſity δ.

For this purpoſe let H, expreſſed in feet, be the height through which a heavy body muſt fall in order to acquire the velocity V, expreſſed alſo in feet per ſecond. This we ſhall expreſs more briefly in future, by calling it the height producing the velocity V. Let C repreſent the capacity of the veſſel, expreſſed in cubic feet, and O the area or ſection of the orifice, expreſſed in ſuperficial or ſquare feet; and let the natural denſity of the air be D.

Since the quantity of aerial matter contained in a veſſel depends on the capacity of the veſſel and the denſity of the air jointly, we may expreſs the air which would fill this veſſel by the ſymbol CD when the air is in its ordinary ſtate, and by $C\delta$ when it has the denſity δ. In order to obtain the rate at which it fills, we muſt take the fluxion of this quantity $C\delta$. This is $C\delta$; for C is a conſtant quantity, and δ is a variable or flowing quantity.

But we alſo obtain the rate of influx by our knowledge of the velocity, and the area of the orifice, and the denſity. The velocity is V, or $8\sqrt{H}$, at the firſt inſtant; and when the air in the veſſel has acquired the denſity δ, that is, at the end of the time t, the velocity is $8\sqrt{H}\sqrt{1 - \frac{\delta}{D}}$, or $8\sqrt{H}\sqrt{\frac{D - \delta}{D}}$, or $8\sqrt{H}\frac{\sqrt{D - \delta}}{\sqrt{D}}$.

The rate of influx therefore (which may be conceived as meaſured by the little maſs of air which will enter during the time $\dot{t}$ with this velocity) will be $\frac{8\sqrt{H}OD\sqrt{D - \delta}\,\dot{t}}{\sqrt{D}}$, or $8\sqrt{H}O\sqrt{D}\sqrt{D - \delta}\,\dot{t}$, multiplying the velocity by the orifice and by the denſity.

Here then we have two values of the rate of influx. By ſtating them as equal we have a fluxionary equation, from which we may obtain the fluents, that is, the time t in ſeconds neceſſary for bringing the air in the veſſel to the denſity δ, or the denſity δ which will be produced at the end of any time t. We have the equation $8\sqrt{HO}\sqrt{D}\sqrt{D-\delta}\,\dot{t} = C\,\dot{\delta}$. Hence we derive $\dot{t} = \frac{C}{8\sqrt{HO}\sqrt{D}} \times \frac{\dot{\delta}}{\sqrt{D-\delta}}$. Of this the fluent is $t = \frac{C}{4\sqrt{HO}\sqrt{D}} \times \sqrt{D-\delta} + A$, in which A is a conditional conſtant quantity. The condition which determines it is, that t muſt be nothing when δ is nothing, that is, when $\sqrt{D-\delta} = \sqrt{D}$; for this is evidently the caſe at the beginning of the motion. Hence it follows, that the conſtant quantity is $\sqrt{D}$, and the complete fluent, ſuited to the caſe, is $\frac{C}{4\sqrt{HO}\sqrt{D}} \times \overline{\sqrt{D} - \sqrt{D-\delta}}$.

The motion ceaſes when the air in the veſſel has acquired the denſity of the external air; that is, when $\delta = D$, or when $t = \frac{C}{4\sqrt{HO}\sqrt{D}} \times \sqrt{D}, = \frac{C}{4\sqrt{HO}}$. Therefore the time of completely filling the veſſel is $\frac{C}{4\sqrt{HO}}$.

Let us illuſtrate this by an example in numbers.

Suppoſing then that air is 840 times lighter than water, and the height of the homogeneous atmoſphere 27720 feet, we have $4\sqrt{H} = 666$. Let us further ſuppoſe the veſſel to contain 8 cubic feet, which is nearly a wine hogſhead, and that the hole by which the air of the ordinary denſity, which we ſhall make $= 1$, enters, is an inch ſquare, or $\frac{1}{144}$ of a ſquare foot. Then the time in ſeconds of completely filling it will be $\frac{8''}{\frac{1}{144}666}$, or $\frac{1152''}{666}$, or $1{,}7297''$. If the hole be only $\frac{1}{100}$ of a ſquare inch, that is, if its ſide be $\frac{1}{10}$ of an inch, the time of completely filling the hogſhead will be 173″ very nearly, or ſomething leſs than three minutes.

If we make the experiment with a hole cut in a thin plate, we ſhall find the time greater nearly in the proportion of 63 to 100. for reaſons obvious to all who have ſtudied hydraulics. In like manner we can tell the time neceſſary for bringing the air in the veſſel to $\frac{3}{4}$ of its ordinary denſity. The only variable part of our fluent is the coefficient $-\sqrt{D-\delta}$, or $\sqrt{1-\delta}$. Let δ be $= \frac{3}{4}$, then $\sqrt{1-\delta} = \sqrt{\frac{1}{4}} = \frac{1}{2}$, and $1 - \sqrt{1-\delta} = \frac{1}{2}$; and the time is $86\frac{1}{2}''$ very nearly when the hole is $\frac{1}{10}$ of an inch wide.

Let us now ſuppoſe that the air in the veſſel ABCD (pl. 11. fig. 64.) is compreſſed by a weight acting on the cover AD, which is moveable down the veſſel, and is thus expelled into the external air.

The immediate effect of this external preſſure is to compreſs the air and give it another denſity. The denſity D of the external air correſponds to its preſſure P. Let the additional preſſure on the cover of the veſſel be p, and the denſity of the air in the veſſel be d. We ſhall have $P : P + p = D : d$; and therefore $p = P \times \frac{d-D}{D}$. Then, becauſe the preſſure which expels the air is the difference between the force which compreſſes the air in the veſſel and the force which compreſſes the external air, the expelling force is p. And becauſe the quantities of motion are as the forces which ſimilarly produce them, we ſhall have $P : P \times \frac{d-D}{D} = MV : mv$; where M and m expreſs the quantities of matter expelled, V expreſſes the velocity with which air ruſhes into a void, and v expreſſes the velocity ſought. But becauſe the quantities of aerial matter which iſſue from the ſame orifice in a moment are as the denſities and velocities jointly, we ſhall have $MV : mv = DVV : dvv, = DV^2 : dv^2$. Therefore $P : p\frac{d-D}{D} = DV^2 : dv$. Hence we deduce $v = V\sqrt{\frac{d-D}{d}}$.

We may have another expreſſion of the velocity without conſidering the denſity. We had $P : P + p = D : d$; therefore $d = \frac{D \times \overline{P+p}}{P}$, and $d - D = \frac{D \times \overline{P+p}}{P} - D, = \frac{D \times \overline{P+p} - DP}{P}$, and $\frac{d-D}{d} = \frac{D \times \overline{P+p} - DP}{D \times \overline{P+p}}, = \frac{P+p-P}{P+p}, = \frac{p}{P+p}$: therefore $v = V \times \sqrt{\frac{p}{P+p}}$, which is a very ſimple and convenient expreſſion.

Hitherto we have conſidered the motion of air as produced by its weight only. Let us now conſider the effect of its elaſticity.

Let ABCD (fig. 64.) be a veſſel containing air of any denſity D. This air is in a ſtate of compreſſion; and if the compreſſing force be removed, it will expand, and its elaſticity will diminiſh along with its denſity. Its elaſticity in any ſtate is meaſured by the force which keeps it in that ſtate. The force which keeps common air in its ordinary denſity is the weight of the atmoſphere, and is the ſame with the weight of a column of water 33 feet high. If therefore we ſuppoſe that this air, inſtead of being confined by the top of the veſſel, is preſſed down by a moveable piſton carrying a column of water 33 feet high, its elaſticity will balance this preſſure as it balances the preſſure of the atmoſphere; and as it is a fluid, and propagates through every part the preſſure exerted on any one part, it will preſs on any little portion of the veſſel by its elaſticity in the ſame manner as when loaded with this column.

The conſequence of this reaſoning is, that if this ſmall portion of the veſſel be removed, and thus a paſſage be made into a void, the air will begin to flow out with the ſame velocity with which it would flow when impelled by its weight alone, or with the velocity acquired by falling from the top of a homogeneous atmoſphere, or 1332 feet in a ſecond nearly.

But as ſoon as ſome air has come out, the denſity of the remaining air is diminiſhed, and its elaſticity is diminiſhed; therefore the expelling force is diminiſhed. But the matter to be moved is diminiſhed in the very ſame proportion, becauſe the denſity and elaſticity are found to vary according to the ſame law; therefore the velocity will continue the ſame from the beginning to the end of the efflux.

This may be ſeen in another way. Let P be the preſſure of the atmoſphere, which being the counterbalance and meaſure of the initial elaſticity, is equal to the expelling force at the firſt inſtant. Let D be the initial denſity, and V the initial velocity. Let d be its denſity at the end of the time t of efflux, and v the contemporaneous velocity. It is plain that at the end of this time we ſhall have the expelling force $\pi = \frac{Pd}{D}$; for $D : d = P : \pi \left(= \frac{Pd}{D}\right)$.

Theſe forces are proportional to the quantities of motion which they produce; and the quantities of motion are proportional to the quantities of matter M and m and the velocities V and v jointly: therefore we have $P : \frac{Pd}{D} = MV : m\,v$. But the quantities of matter which eſcape through a given orifice are as the denſities and velocities jointly; that is, $M : m =$

$DV : dv$; therefore $P : \frac{Pd}{D} = DV^2 : dv^2$, and $P \times dv^2 = \frac{PdDV^2}{D} = PdV^2$, and $V^2 = v^2$, and $V = v$, and the velocity of efflux is conſtant. Hence follows, what appears very unlikely at firſt ſight, that however much the air in the veſſel is condenſed, it will always iſſue into a void with the ſame velocity.

In order to find the quantity of aerial matter which will iſſue during any time t, and conſequently the denſity of the remaining air at the end of this time, we muſt get the rate of efflux. In the element of time $\dot{t}$ there iſſues (by what has been ſaid above) the bulk $8\sqrt{HO}\,\dot{t}$ (for the velocity V is conſtant); and therefore the quantity $8\sqrt{HO}d\dot{t}$· On the other hand, the quantity of air at the beginning was CD, C being the capacity of the veſſel; and when the air has acquired the denſity d, the quantity is $C\,d$, and the quantity run out is $CD - C\,d$: therefore the quantity which has run out in the time t muſt be the fluxion of $CD - C\,d$, or $-C\dot{d}$ Therefore we have the equation $8\sqrt{HO}d\dot{t} = -C\dot{d}$, and $\dot{t} = \frac{-C\dot{d}}{8\sqrt{HO}d}$; $= \frac{C}{8\sqrt{HO}} \times -\frac{\dot{d}}{d}$.

The fluent of this is $t = \frac{C}{8\sqrt{HO}}$ log. d. This fluent muſt be ſo taken that t may be $= o$ when $d = D$. Therefore the correct fluent will be $t = \frac{C}{8\sqrt{HO}}$ log. $\frac{D}{d}$, for log. $\frac{D}{D} =$ log 1, $= o$. We deduce from this, that it requires an infinite time for the whole air of a veſſel to flow out of it into a void. N. B. By log. d, &c. is meant the hyperbolic logarithm of d, &c.

Let us next ſuppoſe that the veſſel, inſtead of letting out its air into a void, emits it into air of a leſs denſity, which remains conſtant during the efflux, as we may ſuppoſe to be the caſe when a veſſel containing condenſed air emits it into the ſurrounding atmoſphere. Let the initial denſity of the air in the veſſel be δ, and that of the atmoſphere D. Then it is plain that the expelling force is $P - \frac{PD}{\delta}$, and that after the time t it is $\frac{Pd}{\delta} - \frac{PD}{\delta}$. We have therefore $P - \frac{PD}{\delta} : \frac{Pd}{\delta} - \frac{PD}{\delta} = MV : mv, = \delta V^2 : dv^2$. Whence we derive $v = V\sqrt{\frac{\delta\,\overline{d-D}}{d\,\overline{\delta-D}}}$

From this equation we learn that the motion will be at an end when $d = D$: and if $\delta = D$ there can be no efflux.

To find the relation between the time and the denſity, let H as before be the height producing the velocity V. The height producing the velocity of efflux v muſt be $H \times \frac{\delta\,\overline{d-D}}{d\,\overline{\delta-D}}$, and the little parcel of air which will flow out in the time $\dot{t}$ will be $= 8\sqrt{HO}d\dot{t}\sqrt{\frac{\delta\,\overline{d-D}}{d\,\overline{\delta-D}}}$. On the other hand, it is $= -C\dot{d}$.

Hence we deduce the fluxionary equation $\dot{t} = \frac{C\sqrt{\delta-D}}{8\sqrt{HO}\sqrt{\delta}} \times \frac{-\dot{d}}{\sqrt{d^2-Dd}}$. The fluent of this, corrected ſo as to make $t = O$ when $d = \delta$, is $t = \frac{C\sqrt{\delta-D}}{8\sqrt{HO}\sqrt{\delta}} \times \log.\left(\frac{\delta - \frac{1}{2}D + \sqrt{\delta^2 - D\delta}}{d - \frac{1}{2}D + \sqrt{d^2 - Dd}}\right)$. And the time of completing the efflux, when $d = D$, is $t = \frac{C\sqrt{\delta-D}}{8\sqrt{HO}\sqrt{\delta}} \times \log.\left(\frac{\delta - \frac{1}{2}D + \sqrt{\delta^2 - D\delta}}{D}\right)$.

Laſtly, let ABCD, CFGH (fig. 65.) be two veſſels containing airs of different denſities, and communicating by the orifice C, there will be a current from the veſſel containing the denſer air into that containing the rarer: ſuppoſe from ABCD into CFGH.

Let P be the elaſtic force of the air in ABCD, Q its denſity, and V its velocity, and D the denſity of the air in CFGH. And, after the time t, let the denſity of the air in ABCD be q, its velocity v, and the denſity of the air in CFGH be δ. The expelling force from ABCD will be $P - \frac{PD}{Q}$ at the firſt inſtant, and at the end of the time t it will be $\frac{Pq}{Q} - \frac{P\delta}{Q}$. Therefore we ſhall have $P - \frac{PD}{Q} : \frac{Pq}{Q} - \frac{P\delta}{Q} = QV^2 : qv^2$, which gives $v = V \times \sqrt{\frac{Q(q-\delta)}{q(Q-D)}}$, and the motion will ceaſe when $\delta = q$.

Let A be the capacity of the firſt veſſel, and B that of the 2d. We have the ſecond equation $AQ + BD = Aq + B\delta$, and therefore $\delta = \frac{A(Q-q)+BD}{B}$. Subſtituting this value of δ in the former value of v, we have $v = V \times \sqrt{\frac{Q[B(q-D) - A(Q-q)]}{qB(Q-D)}}$, which gives the relation between the velocity v and the denſity q.

In order to aſcertain the time when the air in ABCD has acquired the denſity q, it will be convenient to abridge the work by ſome ſubſtitutions. Therefore make $Q(B+A) = M$, $BQD + BQ^2 = N$, $BQ - BD = R$, and $\frac{N}{M} = m$. Then, proceeding as before, we obtain the fluxionary equation $8\sqrt{HO}q\frac{\sqrt{Mq-N}}{\sqrt{R}\sqrt{q}}\dot{t} = \overline{AQ - Aq} = -A\dot{q}$ whence $\dot{t} = \frac{A\sqrt{R}}{8\sqrt{HO}\sqrt{M}} \times \frac{\dot{q}}{\sqrt{q^2 - mq}}$ of which the fluent, completed ſo that $t = o$ when $q = Q$, is $t = \frac{A\sqrt{R}}{8\sqrt{HO}\sqrt{M}} \times \text{Log.}\left(\frac{Q - \frac{1}{2}m + \sqrt{(Q^2 mQ}}{q - \frac{1}{2}m + \sqrt{(q^2 mq)}}\right)$

Some of theſe queſtions are of difficult ſolution, and they are not of frequent uſe in the more important and uſual applications of the doctrines of pneumatics, at leaſt in their preſent form. The caſes of greateſt uſe are when the air is expelled from a veſſel by an external force, as when bellows are worked, whether of the ordinary form or conſiſting of a cylinder fitted with a moveable piſton. This laſt caſe merits a particular conſideration; and fortunately the inveſtigation is extremely eaſy.

Let AD, pl. 11. fig. 64. be conſidered as a piſton moving downward with the uniform velocity f, and let the area of the piſton be n times the area of the hole of efflux, then the velocity of efflux ariſing from the motion of the piſton will be nf. Add this to the velocity V produced by the elaſticity of the air in the firſt queſtion, and the whole velocity will be $V + nf$. It will be the ſame in the others. The problem is alſo freed from the conſideration of the time of efflux. For this depends now on the velocity of the piſton. It is ſtill, however, a very intricate problem to aſcertain the relation between the time and the denſity, even though the piſton is moving uniformly, for at the beginning of the motion the air is of common denſity. As the piſton deſcends, it both expels and compreſſes the air, and the denſity of the air in the veſſel varies in a very intricate manner, as alſo its reſiſtance or reaction on the piſton. For this reaſon, a piſton which moves uniformly by means of an external force will never make an uniform blaſt by ſucceſſive ſtrokes; it will always be weaker at the beginning of the ſtroke. The beſt way for ſecuring an uniform blaſt is to employ the external force only for lifting up the piſton, and then to let the piſton deſcend by its own weight. In this way it will quickly ſink down, compreſſing the air, till its denſity and correſponding elaſticity exactly balance the weight of the piſton. After this the piſton will deſcend equably, and the blaſt will be uniform. We ſhall have occaſion to conſider this more particularly under the head of PNEUMATICAL *Machines*. Theſe obſervations and theorems will ſerve to determine the initial velocity of the air in all important caſes of its expulſion. The philoſopher will learn the rate of its efflux out of one veſſel into another; the chemiſt will be able to calculate the quantities of the different gaſes which are employed in the curious experiments of the ingenious but unfortunate Lavoiſier on Combuſtion, and will find them extremely different from what he ſuppoſed; the engineer will learn how to proportion the motive force of his machine to the quantity of aerial matter which his bellows muſt ſupply. But it is not enough, for this purpoſe, that the air *begin* to iſſue in the proper quantity; we muſt ſee whether it be not affected by the circumſtances of its ſubſequent paſſage.

All the modifications of motion which are obſerved in water-conduits take place alſo in the paſſage of air through pipes and holes of all kinds. There is the ſame diminution of quantity paſſing through a hole in a thin plate that is obſerved in water. We know that (abating the ſmall effect of friction) water iſſues with the velocity acquired by falling from the ſurface; and yet, if we calculate by this velocity and by the area of the orifice, we ſhall find the quantity of water deficient nearly in the proportion of 63 to 100. This is owing to the water preſſing towards the orifice from all ſides, which occaſions a contraction of the jet. The ſame thing happens in the efflux of air. Alſo the motion of water is greatly impeded by all contractions of its paſſage. Theſe oblige it to accelerate its velocity, and therefore require an increaſe of preſſure to force it through them, and this in proportion to the ſquares of the velocities. Thus, if a machine working a pump cauſes it to give a certain number of ſtrokes in a minute, it will deliver a determined quantity of water in that time. Should it happen that the paſſage of the water is contracted to one half in any part of the machine (a thing which frequently happens at the valves), the water muſt move through this contraction with twice the velocity that it has in the reſt of the paſſage. This will require four times the force to be exerted on the piſton. Nay (which will appear very odd, and is never ſuſpected by engineers), if no part of the paſſage is narrower than the barrel of the pump, but on the contrary a part much wider, and if the conduit be again contracted to the width of the barrel, an additional force muſt be applied to the piſton to drive the water through this paſſage, which would not have been neceſſary if the paſſage had not been widened in any part. It will require a force equal to the weight of a column of water of the height neceſſary for communicating a velocity the ſquare of which is equal to the difference of the ſquares of the velocities of the water in the wide and the narrow part of the conduit.

The ſame thing takes place in the motion of air, and therefore all contractions and dilatations muſt be carefully avoided, when we want to preſerve the velocity unimpaired.

Air alſo ſuffers the ſame retardation in its motion along pipes. By not knowing, or not attending to that, engineers of the firſt reputation have been prodigiouſly diſappointed in their expectations of the quantity of air which will be delivered by long pipes. Its extreme mobility and lightneſs hindered them from ſuſpecting that it would ſuffer any ſenſible retardation. Dr. Papin, a moſt ingenious man, propoſed this as the moſt effectual method of transferring the action of a moving power to a great diſtance. Suppoſe, for inſtance, that it was required to raiſe water out of a mine by a water-machine, and that there was no fall of water nearer than a mile's diſtance. He employed this water to drive a piſton, which ſhould compreſs the air in a cylinder communicating, by a long pipe, with another cylinder at the mouth of the mine. This ſecond cylinder had a piſton in it, whoſe rod was to give motion to the pumps at the mine. He expected, that as ſoon as the piſton at the water-machine had compreſſed the air ſufficiently, it would cauſe the air in the cylinder at the mine to force up its piſton, and thus work the pumps. Doctor Hooke made many objections to the method, when laid before the Royal Society, and it was much debated there. But dynamics was at this time an infant ſcience, and very little underſtood. Newton had not then taken any part in the buſineſs of the ſociety, otherwiſe the true objections would not have eſcaped his ſagacious mind. Notwithſtanding Papin's great reputation as an engineer and mechanic, he could not bring his ſcheme into uſe in England; but afterwards, in France and in Germany, where he ſettled, he got ſome perſons of great fortunes to employ him in this project; and he erected great machines in Auvergne and Weſtphalia for draining mines. But, ſo far from being effective machines, they would not even begin to move. He attributed the failure to the quantity of air in the pipe of communication, which muſt be condenſed before it can condenſe the air in the remote cylinder. This indeed is true, and he ſhould have thought of this earlier. He therefore diminiſhed the ſize of this pipe, and made his water-machine exhauſt inſtead of condenſing, and had no doubt but that the immenſe velocity with which air ruſhes into a void would make a rapid and effectual communication of power. But he was equally diſappointed here, and the machine at the mine ſtood ſtill as before.

Near a century after this, a very intelligent engineer attempted a much more feaſible thing of this kind at an ironfoundery in Wales. He erected a machine at a powerful fall of water, which worked a ſet of cylinder bellows, the blowpipe of which was conducted to the diſtance of a mile and a half, where it was applied to a blaſt furnace. But notwithſtanding every care to make the conducting pipe very air-tight, of great ſize, and as ſmooth as poſſible, it would hardly blow out a candle. The failure was aſcribed to the impoſſibility of making the pipe air-tight. But, what was ſurpriſing, above ten minutes elapſed after the action of the piſtons in the bellows before the leaſt wind could be perceived at the end of the pipe; whereas the engineer expected an interval of ſix ſeconds only.

No very diſtinct theory can be delivered on this ſubject; but we may derive conſiderable aſſiſtance in underſtanding the cauſes of the obſtruction to the motion of water in long pipes, by conſidering what happens to air. The elaſticity of the air, and its great compreſſibility, have given us the diſtincteſt notions of fluidity in general, ſhowing us, in a way that can hardly be controverted, that the particles of a fluid are kept at a diſtance from each other, and from other bodies, by the corpuſcular forces. We ſhall therefore take this opportunity to give a view of the ſubject, which did not occur to us when treating of the motion of water in pipes, reſerving a further diſcuſſion to the articles RIVER, WATER-*Works*, &c.

The writers on hydrodynamics have always conſidered the obſtruction to the motion of fluids along canals of any kind as owing to ſomething like the friction by which the motion of ſolid bodies on each other is obſtructed; but we cannot form to ourſelves any diſtinct notion of reſemblance, or even analogy, between them. The fact is, however, that a fluid running along a canal has its motion obſtructed; and that this obſtruction is greateſt in the immediate vicinity of the ſolid canal, and gradually diminiſhes to the middle of the ſtream. It appears, therefore, that the parts of fluids can no more move among each other than among ſolid bodies, without ſuffering a diminution of their motion. The parts in phyſical contact with the ſides and bottom are retarded by theſe immoveable bodies. The particles of the next ſtratum of fluid cannot preſerve their initial velocities without overpaſſing the particles of the firſt ſtratum; and it appears from the fact that they are by this means retarded. They retard in the ſame manner the particles of the third ſtratum, and ſo on to the middle ſtratum or thread of fluid. It appears from the fact, therefore, that this ſort of friction is not a conſequence of rigidity alone, but that it is equally competent to fluids. Nay, ſince it is a matter of fact in air, and is even more remarkable there than in any other fluid, as we ſhall ſee by the experiments which have been made on the ſubject; and as our experiments on the compreſſion of air ſhow us the particles of air ten times nearer to each other in ſome caſes than in others (viz. when we ſee air a thouſand times denſer in theſe caſes), and therefore force us to acknowledge that they are not in contact: it is plain that this obſtruction has no analogy to friction, which ſuppoſes roughneſs or inequality of ſurface. No ſuch inequality can be ſuppoſed in the ſurface of an aerial particle; nor would it be of any ſervice in explaining the obſtruction, ſince the particles do not rub on each other, but paſs each other at ſome ſmall and imperceptible diſtance.

We muſt therefore have recourſe to ſome other mode of explication. We ſhall apply this to air only in this place; and ſince it is proved, by the incontrovertible experiments of Canton, Zimmerman, and others, that water, mercury, oil, &c. are alſo compreſſible and perfectly elaſtic, the argument from this principle, which is concluſive in air, muſt equally explain the ſimilar phenomenon in hydraulics.

The moſt highly poliſhed body which we know muſt be conceived as having an uneven ſurface when we compare it with the ſmall ſpaces in which the corpuſcular forces are exerted; and a quantity of air moving in a poliſhed pipe may be compared to a quantity of ſmall ſhot ſliding down a channel with undulated ſides and bottom. The row of particles immediately contiguous to the ſides will therefore have an undulated motion: but this undulation of the contiguous particles of air will not be ſo great as that of the ſurface along which they glide; for not only every motion requires force to produce it, but alſo every change of motion. The particles of air reſiſt this change from a rectilineal to an undulating motion; and, being elaſtic, that is, repelling each other and other bodies, they keep a little nearer to the ſurface as they are paſſing over an eminence, and their path is leſs incurvated than the ſurface. The difference between the motion of the particles of air and the particles of a fluid quite unelaſtic is, in this reſpect, ſomewhat like the difference between the motion of a ſpring-carriage and that of a common carriage. When the common carriage paſſes along a road not perfectly ſmooth, the line deſcribed by the centre of gravity of the carriage keeps perfectly parallel to that deſcribed by the axis of the wheels, riſing and falling along with it. Now let a ſpring body be put on the ſame wheels and paſs along the ſame road. When the axis riſes over an eminence perhaps half an inch, ſinks down again into the next hollow, and then riſes a ſecond time, and ſo on, the centre of gravity of the body deſcribes a much ſtraighter line; for, upon the riſing of the wheels, the body reſiſts the motion, and compreſſes the ſprings, and thus remains lower than it would have been had the ſprings not been interpoſed. In like manner, it does not ſink ſo low as the axle does when the wheels go into a hollow. And thus the motion of ſpring-carriages becomes leſs violently undulated than the road along which they paſs. This illuſtration will, we hope, enable the reader to conceive how the deviation of the particles next to the ſides and bottom of the canal from a rectilineal motion is leſs than that of the canal itſelf.

It is evident that the ſame reaſoning will prove that the undulation of the next row of particles will be leſs than that of the firſt, that the undulation of the third row will be leſs than that of the ſecond, and ſo on, as is repreſented in fig. A. pl. 13. And thus it appears, that while the maſs of air has a progreſſive motion along the pipe or canal, each particle is deſcribing a waving line, of which a line parallel to the direction of the canal is the axis, cutting all theſe undulations. This axis of each undulated path will be ſtraight or curved as the canal is, and the excurſions of the path on each ſide of its axis will be leſs and leſs as the axis of the path is nearer to the axis of the canal.

Let us now ſee what *ſenſible* effect this will have; for all the motion which we here ſpeak of is imperceptible. It is demonſtrated in mechanics, that if a body moving with any velocity be deflected from its rectilineal path by a curved and perfectly ſmooth channel, to which the rectilineal path is a tangent, it will proceed along this channel with undiminiſhed velocity. Now the path, in the preſent caſe, may be conſidered as perfectly ſmooth, ſince the particles do not touch it. It is one of the undulations which we are conſidering, and we may at preſent conceive this as without any ſubordinate inequalities. There ſhould not, therefore, be any diminution of the velocity. Let us grant this of the abſolute velocity of the particle; but what we obſerve is the velocity of the maſs, and we judge of it perhaps by the motion of a feather carried along by it. Let us ſuppoſe a ſingle atom to be a ſenſible object, and let us attend to two ſuch particles, one at the ſide, and the other in the middle: although we cannot perceive the undulations of theſe particles during their progreſſive motions, we ſee the progreſſive motions themſelves. Let us ſuppoſe then that the middle particle has moved without any undulation whatever, and that it has advanced ten feet. The lateral particle will alſo have moved ten feet; but this has not been in a ſtraight line. It will not be ſo far advanced, therefore, in the direction of the canal; it will be left behind, and will appear to us to have been retarded in its motion: and in like manner each thread of particles will be more and more retarded (apparently only) as it recedes further from the axis of the canal, or what is uſually called the thread of the ſtream.

And thus the obſerved fact is ſhown to be a neceſſary conſequence of what we know to be the nature of a compreſſible or elaſtic fluid; and that without ſuppoſing any diminution in the real velocity of each particle, there will be a diminution of the velocity of the ſenſible threads of the general ſtream, and a diminution of the whole quantity of air which paſſes along it during a given time.

Let us now ſuppoſe a parcel of air impelled along a pipe, which is *perfectly* ſmooth, out of a larger veſſel, and iſſuing from this pipe with a certain velocity. It requires a certain force to change its velocity in the veſſel to the greater velocity which it has in the pipe. This is abundantly demonſtrated. How long ſoever we ſuppoſe this pipe, there will be no change in the velocity, or in the force to keep it up. But let us ſuppoſe that about the middle of this pipe there is a part of it which has ſuddenly got an undulated ſurface, however imperceptible. Let us further ſuppoſe that the final velocity of the middle thread is the ſame as before. In this caſe it is evident that the ſum total of the motions of all the particles is greater than before, becauſe the abſolute motions of the lateral particles is greater than that of the central particle, which we ſuppoſe the ſame as before. This abſolute increaſe of motion cannot be without an increaſe of propelling force: the force acting now, therefore, muſt be greater than the force acting formerly. Therefore, if only the former force had continued to act, the ſame motion of the central particle could not have been preſerved, or the progreſſive motion of the whole ſtream muſt be diminiſhed.

And thus we ſee that this internal inſenſible undulatory motion becomes a real obſtruction to the ſenſible motion which we obſerve, and occaſions an expanſe of power.

Let us ſee what will be the conſequence of extending this obſtructing ſurface further along the canal. It muſt evidently be accompanied by an augmentation of the motion produced, if the central velocity be ſtill kept up; for the particles which are now in contact with the ſides do not continue to occupy that ſituation: the middle particles moving faſter *forward* get over them, and in their turn come next the ſide; and as they are really moving equally faſt, but not in the direction into which they are now to be forced, force is neceſſary for changing the direction alſo; and this is in addition to the force neceſſary for producing the undulations ſo minutely treated of. The conſequence of this muſt be, that an additional force will be neceſſary for preſerving a given progreſſive motion in a longer *obſtructing* pipe, and that the motion produced in a pipe of greater length by a given force will be leſs than in a ſhorter one, and the efflux will be diminiſhed.

There is another conſideration which muſt have an influence here. Nothing is more irrefragably demonſtrated than the neceſſity of an additional force for producing an efflux through any contraction, even though it ſhould be ſucceeded by a dilatation of the paſſage. Now, both the inequalities of the ſides and the undulations of the motions of each particle are equivalent to a ſucceſſion of contractions and dilatations; although each of theſe is next to infinitely ſmall; their number is alſo next to infinitely great, and therefore the total effect may be ſenſible.

We have hitherto ſuppoſed that the abſolute velocity of the particles was not diminiſhed: this we did, having aſſumed that the interval of each undulation of the ſides was without inequalities. But this was gratuitous: it was alſo gratuitous that the ſides were only undulated. We have no reaſon for excluding angular aſperities. Theſe will produce, and moſt certainly often produce, real diminutions in the velocity of the contiguous particles; and this muſt extend to the very axis of the canal, and produce a diminution of the ſum total of motion: and in order to preſerve the ſame ſenſible progreſſive motion, a greater force muſt be employed. This is all that can be meant by ſaying that there is a reſiſtance to the motion of air through long pipes.

There remains another cauſe of diminution, viz. the want of perfect fluidity, whether ariſing from the diſſemination of ſolid particles in a real fluid, or from the viſcidity of the fluid. We ſhall not inſiſt on this at preſent, becauſe it cannot be ſhown to obtain in air, at leaſt in any caſe which deſerves conſideration. It ſeems of no importance to determine the motion of air hurrying along with it ſoot or duſt. The effect of fogs on a particular modification of the motion of air will be conſidered under the article Sound. What has been ſaid on this ſubject is ſufficient for our purpoſe, as explaining the prodigious and unexpected obſtruction to the paſſage of air through long and narrow pipes. We are able to collect an important maxim from it, viz. that all pipes of communication ſhould be made as wide as circumſtances will permit; for it is plain that the obſtruction depends on the internal ſurface, and the force to overcome it muſt be in proportion to the maſs of matter which is in motion. The firſt increaſes as the diameter of the pipe, and the laſt as the ſquare. The obſtruction muſt therefore bear a greater proportion to the whole motion in a ſmall pipe than in a large one.

It were very deſirable to know the law by which the retardation extends from the axis to the ſides of the canal, and the proportion which ſubſiſts between the lengths of canal and the forces neceſſary for overcoming the obſtructions when the velocity is given; as alſo whether the proportion of the obſtruction to the whole motion varies with the velocity: but all this is unknown. It does not, however, ſeem a deſperate caſe in air: we know pretty diſtinctly the law of action among its particles, viz. that their mutual repulſions are inverſely as their diſtances. This promiſes to enable us to trace the progreſs of undulation from the ſides of the canal to the axis.

We can ſee that the retardations will not increaſe ſo faſt as the ſquare of the velocity. Were the fluid incompreſſible, ſo that the undulatory path of a particle were invariable, the deflecting forces by which each individual particle is made to deſcribe its undulating path would be preciſely ſuch as ariſe from the path itſelf and the motion in it; for each particle would be in the ſituation of a body moving along a fixed path. But in a very compreſſible fluid, ſuch as air, each particle may be conſidered as a ſolitary body, actuated by a projectile and a tranſverſe force, ariſing from the action of the adjoining particles. Its motion muſt depend on the adjuſtment of theſe forces, in the ſame manner as the elliptical motion of a planet depends on the adjuſtment of the force of projection, with a gravitation inverſely proportional to the ſquare of the diſtance from the focus. The tranſverſe force in the preſent caſe has its origin in the preſſure on the air which is propelling it along the pipe: this, by ſqueezing the particles together, brings their mutual repulſion into action. Now it is the property of a perfect fluid, that a preſſure exerted on any part of it is propagated equally through the whole fluid; therefore the tranſverſe forces which are excited by this preſſure are proportional to the preſſure itſelf: and we know that the preſſures exerted on the ſurface of a fluid, ſo as to expel it through any orifice, or along any canal, are proportional to the ſquares of the velocities which they produce. Therefore, in every point of the undulatory motion of any particle, the tranſverſe force by which it is deflected into a curve is proportional to the ſquare of its velocity. When this is the caſe, a body would continue to deſcribe the ſame curve as before; but, by the very compreſſion, the curvatures are increaſed, ſuppoſing them to remain ſimilar. This would require an increaſe of the tranſverſe forces; but this is not to be found: therefore the particle will not deſcribe a ſimilar curve, but one which is leſs incurvated in all its parts; conſequently the progreſſive velocity of the whole, which is the only thing perceivable by us, will not be ſo much diminiſhed; that is, the obſtructions will not increaſe ſo faſt as they would otherwiſe do, or as the ſquares of the velocities.

This reaſoning is equally applicable to all fluids, and is abundantly confirmed by experiments in hydraulics, as we ſhall ſee when conſidering the motion of rivers. We have taken this opportunity of delivering our notions on this ſubject; becauſe, as we have often ſaid, it is in the avowed diſcreet conſtitution of air that we ſee moſt diſtinctly the operation of thoſe natural powers which conſtitute fluidity in general.

We would beg leave to mention a form of experiment for diſcovering the law of retardation with conſiderable accuracy. Experiments have been made on pipes and canals. Mr. Boſſut, in his *Hydrodynamique*, has given a very beautiful ſet made on pipes of an inch and two inches diameter, and 200 feet long: but although theſe experiments are very inſtructive, they do not give us any rule by which we can extend the reſult to pipes of greater length and different diameters.

Let a ſmooth cylinder be ſet upright in a very large veſſel or pond, and be moveable round its axis: let it be turned round by means of a wheel and pulley with an uniform motion and determined velocity. It will exert the ſame force on the contiguous water which would be exerted on it by water turning round it with the ſame velocity: and as this water would have its motion gradually retarded by the fixed cylinder, ſo the moving cylinder will gradually communicate motion to the ſurrounding water. We ſhould obſerve the water gradually dragged round by it; and the vortex would extend further and further from it as the motion is continued, and the velocities of the parts of the vortex will be leſs and leſs as we recede from the axis. Now, we apprehend, that when a point of the ſurface of the cylinder has moved over 200 feet, the *motion* of the water at different diſtances from it will be ſimilar and proportional to, if not preciſely the ſame with, the *retardations* of water flowing 200 feet at the ſame diſtance from the ſide of a canal: at any rate, the two are ſuſceptible of an accurate compariſon, and the law of retardation may be accurately deduced from obſervations made on the motions of this vortex.

Air in motion is a very familiar object of obſervation; and it is intereſting. In all languages it has got a name; we call it wind: and it is only upon reflection that we conſider air as wind in a quieſcent ſtate. Many perſons hardly know what is meant when air is mentioned; but they cannot refuſe that the blaſt from a bellows is the expulſion of what they contained; and thus they learn that wind is air in motion.

It is of conſequence to know the velocity of wind; but no good and unexceptionable method has been contrived for this purpoſe. The beſt ſeems to be by meaſuring the ſpace paſſed over by the ſhadow of a cloud; but this is extremely fallacious. In the firſt place, it is certain, that although we ſuppoſe that the cloud has the velocity of the air in which it is carried along, this is not an exact meaſure of the current on the ſurface of the earth; we may be almoſt certain that it is greater: for air, like all other fluids, is retarded by the ſides and bottom of the channel in which it moves. But, in the next place, it is very gratuitous to ſuppoſe, that the velocity of the cloud is the velocity of the ſtratum of air between the cloud and the earth; we are almoſt certain that it is not. It is abundantly proved by Dr. Hutton, that clouds are always formed when two parcels of air of different temperatures mix together, each containing a proper quantity of vapour in the ſtate of chemical ſolution. We know that different ſtrata of air will frequently flow in different directions for a long time. In 1781 while a great fleet rendezvouſed in Leith Roads during the Dutch war, there was a briſk eaſterly wind for about five weeks; and, during the laſt fortnight of this period, there was a briſk weſterly current at the height of about three-fourths of a mile. This was diſtinctly indicated by frequent fleecy clouds at a great diſtance above a lower ſtratum of theſe clouds, which were driving all this time from the eaſtward. A gentleman who was at the ſiege of Quebec in 1759 informed us, that one day while there blew a gale from the weſt, ſo hard that the ſhips at anchor in the river were obliged to ſtrike their topmaſts, and it was with the utmoſt difficulty that ſome well manned boats could row againſt it, carrying ſome artillery ſtores to a poſt above the town, ſeveral ſhells were thrown from the town to deſtroy the boats: one of the ſhells burſt in the air near the top of its flight, which was about half a mile high. The ſmoke of this bomb remained in the ſame ſpot for above a quarter of an hour, like a great round ball, and gradually diſſipated by diffuſion, without removing many yards from its place. When, therefore, two ſtrata of air come from different quarters, and one of them flows over the other, it will be only in the contiguous ſurfaces that a precipitation of vapour will be made. This will form a thin fleecy cloud; and it will have a velocity and direction which neither belongs to the upper nor to the lower ſtratum of air which produced it. Should one of theſe ſtrata come from the eaſt and the other from the weſt with equal velocities, the cloud formed between them will have no motion at all; ſhould one come from the eaſt and the other from the north, the cloud will move from the north-eaſt with a greater velocity than either of the ſtrata. So uncertain then is the information given by the clouds either of the velocity or the direction of the wind. A thick ſmoke from a furnace will give us a much leſs equivocal meaſure: and this, combined with the effects of the wind in impelling bodies, or deflecting a loaded plane from the perpendicular. or other effects of this kind, may give us meaſures of the different currents of wind with a preciſion ſufficient for all practical uſes.

The celebrated engineer Mr. John Smeaton has given, in the 51ſt volume of the Philoſophical Tranſactions, the velocities of wind correſponding to the uſual denominations in our language. Theſe are founded on a great number of obſervations made by himſelf in the courſe of his practice in erecting wind-mills. They are contained in the following table.

Miles per hour.	Feet per ſecond.	Names.
1	1,47	
2	2,93	Light airs.
3	4,40	
4	5,87	Breeze.
5	7,33	
10	14,67	Briſk gale.
15	22,	
20	29,34	Freſh gale.
25	36,67	
30	44,01	Strong gale.
35	51,34	
40	58,68	Hard gale.
45	66,01	
50	73,35	Storm.
60	88,02	
80	117,36	Hurricane, turning up trees, overturning buildings, &c.
100	146,70	

See alſo ſome valuable experiments by him on this ſubject, Philoſophical Tranſactions 1760 and 1761.

One of the moſt ingenious and convenient methods for meaſuring the velocity of the wind is to employ its preſſure in ſupporting a column of water, in the ſame way as Mr. Pitot meaſures the velocity of a current of water. We believe that it was firſt propoſed by Dr. James Lynd of Windſor, a gentleman eminent for his great knowledge in all the branches of natural ſcience, and for his ingenuity in every matter of experiment or practical application.

His anemometer (as theſe inſtruments are called) conſiſts of a glaſs tube of the form ABCD (pl. 11. fig. 65.) open at both ends, and having the branch AB at right angles to the branch CD. This tube contains a few inches of water or any fluid (the lighter the better); it is held with the part CD upright, and AB horizontal and in the direction of the wind; that is, with the mouth A fronting the wind. The wind acts in the way of preſſure on the air in AB, compreſſes it, and cauſes it to preſs on the ſurface of the liquor; forcing it down to F, while it riſes to E in the other leg. The velocity of the wind is concluded from the difference E*f* between the heights of the liquor in the legs. As the wind does not generally blow with uniform velocity, the liquor is apt to dance in the tube, and render the obſervation difficult and uncertain: to remedy this, it is proper to contract very much the communication at C between the two legs. If the tube have half an inch of diameter (and it ſhould not have leſs), a hole of $\frac{1}{10}$ of an inch is large enough; indeed the hole can hardly be too ſmall, nor the tubes too large.

This inſtrument is extremely ingenious, and will undoubtedly give the proportions of the velocities of different currents with the greateſt preciſion; for, in whatever way the preſſure of wind is produced by its motion, we are certain that the different preſſures are as the ſquares of the velocities: if, therefore, we can obtain one certain meaſure of the velocity of the wind, and obſerve the degree to which the preſſure produced by it raiſes the liquor, we can at all other times obſerve the preſſures and compute the velocities from them, making proper allowances for the temperature and the height of the mercury in the barometer; becauſe the velocity will be in the ſubduplicate ratio of the denſity of the air inverſely when the preſſure is the ſame.

It is uſually concluded, that the velocity of the wind is that which would be acquired by falling from a height which is to E*f* as the weight of water is to that of an equal bulk of air. Thus, ſuppoſing air to be 840 times lighter than water, and that E*f* is $\frac{1}{10}$ of an inch, the velocity will be about 63 feet *per* ſecond, which is that of a very hard gale, approaching to a ſtorm. Hence we ſee by the by, that the ſcale of this inſtrument is extremely ſhort, and that it would be a great improvement of it to make the leg CD not perpendicular, but very much ſloping; or perhaps the following form of the inſtrument will give it all the perfection of which it is capable. Let the horizontal branch AB (pl. 12. fig. 67.) be contracted at B, and continued horizontally for ſeveral inches BG of a much ſmaller bore, and then turned down for two or three inches GC, and then upwards with a wide bore. To uſe the inſtrument, hold it with the part DC perpendicular; and (having ſheltered the mouth A from the wind) pour in water at D till it advances along GB to the point B, which is made the beginning of the ſcale; the water in the upright branch ſtanding at *f* in the ſame horizontal line with BG. Now, turn the mouth A to the wind; the air in AB will be compreſſed and will force the water along BG to F, and cauſe it to riſe from *f* to E; and the range *f*E will be to the range BF on the ſcale as the ſection of the tube BG to that of CD. Thus, if the width of DC be one-half of an inch, and that of BG one-tenth, we ſhall have 25 inches in the ſcale for one inch of real preſſure E*f*.

But it has not been demonſtrated in a very ſatisfactory manner, that the velocity of the wind is that acquired by falling through the height of a column of air whoſe weight is equal to that of the column of water E*f*. Experiments made with Pitot's tube in currents of water ſhow that ſeveral corrections are neceſſary for concluding the velocity of the current from the elevation in the tube: theſe corrections may however be made, and ſafely applied to the preſent caſe; and then the inſtrument will enable us to conclude the velocity of the wind immediately, without any fundamental compariſon of the elevation, with a velocity actually determined upon other principles. The chief uſe which we have for this information is in our employment of wind as an impelling power, by which we can actuate machinery or navigate ſhips. Theſe are very important applications of pneumatical doctrines, and merit a particular conſideration; and this naturally brings us to the laſt part of our ſubject, viz. the conſideration of the impulſe of air on bodies expoſed to its action, and the reſiſtance which it oppoſes to the paſſage of bodies through it.

This is a ſubject of the greateſt importance; being the foundation of that art which has done the greateſt honour to the ingenuity of man, and the greateſt ſervice to human ſociety, by connecting together the moſt diſtant inhabitants of this globe, and making a communication of benefits which would otherwiſe have been impoſſible; we mean the art of navigation or ſeamanſhip. Of all the machines which human art has conſtructed, a ſhip is not only the greateſt and moſt magnificent, but alſo the moſt ingenious and intricate; and the clever ſeaman poſſeſſes a knowledge founded on the moſt difficult and abſtruſe doctrines of mechanics. The ſeaman probably cannot give any account of his own ſcience; and he poſſeſſes it rather by a kind of intuition than by any proceſs of reaſoning: but the ſucceſs and efficacy of all the mechaniſm of this complicated engine, and the propriety of all the manœuvres which the ſeaman practiſes, depend on the invariable laws of mechanics; and a thorough knowledge of theſe would enable an intelligent perſon not only to underſtand the machine and the manner of working it, but to improve both.

Unfortunately this is a ſubject of very great difficulty; and although it has employed the genius of Newton, and he has conſidered it with great care, and his followers have added more to his labours on this ſubject than on any other, it ſtill remains in a very imperfect ſtate.

A minute diſcuſſion of this ſubject cannot therefore be expected in a work like this: we muſt content ourſelves with ſuch a general ſtatement of the moſt approved doctrine on the ſubject as ſhall enable our readers to conceive it diſtinctly, and judge with intelligence and confidence of the practical deductions which may be made from it.

It is evidently a branch of the general theory of the impulſe and reſiſtance of fluids, which ſhould have been treated of under the article HYDRAULICS, but was then deferred till the mechanical properties of compreſſible fluids ſhould alſo be conſidered. It was thought very reaſonable to ſuppoſe that the circumſtances of elaſticity would introduce the ſame changes in the impulſe and reſiſtance of fluids that it does in ſolid bodies. It would greatly divert the attention from the diſtinctive properties of air, if we ſhould in this place enter on this ſubject, which is both extenſive and difficult. We reckon it better therefore to take the whole together: this we ſhall do under the article RESISTANCE *of Fluids*, and confine ourſelves at preſent to what relates to the impulſe and reſiſtance of air alone; anticipating a few of the general propoſitions of that theory, but without demonſtration, in order to underſtand the applications which may be made of it.

Suppoſe then a plane ſurface, of which *a*C (pl. 12. fig. 68.) is the ſection, expoſed to the action of a ſtream of wind blowing in the direction QC, perpendicular to *a*C. The motion of the wind will be obſtructed, and the ſurface *a*C preſſed forward. And as all impulſe or preſſure is exerted in a direction perpendicular to the ſurface, and is reſiſted in the oppoſite direction, the ſurface will be impelled in the direction CD, the continuation of QC. And as the mutual actions of bodies depend on their relative motions, the force acting on the ſurface *a*C will be the ſame, if we ſhall ſuppoſe the air at reſt, and the ſurface moving equally ſwift in the oppoſite direction. The reſiſtance of the air to the motion of the body will be equal to the impulſe of the air in the former caſe. Thus reſiſtance and impulſe are equal and contrary.

If the air be moving twice as faſt, its particles will give a double impulſe; but in this caſe a double number of particles will exert their impulſe in the ſame time: the impulſe will therefore be fourfold; and in general it will be as the ſquare of the velocity: or, if the air and body be both in motion, the impulſe and reſiſtance will be proportional to the ſquare of the relative velocity.

This is the firſt propoſition on the ſubject, and it appears very conſonant to reaſon. There will therefore be ſome analogy between the force of the air's impulſe or the reſiſtance of a body, and the weight of a column of air incumbent on the ſurface: for it is a principle in the action of fluids, that the heights of the columns of fluid are as the ſquares of the velocities which their preſſures produce. Accordingly the ſecond propoſition is, that the abſolute impulſe of a ſtream of air, blowing perpendicularly on any ſurface, is equal to the weight of a column of air which has that ſurface for its baſe, and for its height the ſpace through which a body muſt fall in order to acquire the velocity of the air.

Thirdly, Suppoſe the ſurface AC, equal to aC, no longer to be perpendicular to the ſtream of air, but inclined to it in the angle ACD, which we ſhall call the *angle of incidence*; then, by the reſolution of forces, it follows, that the action of each particle is diminiſhed in the proportion of radius to the ſine of the angle of incidence, or of AC to AL, AL being perpendicular to CD.

Again: Draw AK parallel to CD. It is plain that no air lying further from CD than KA is will ſtrike the plane. The quantity of impulſe therefore is diminiſhed ſtill further in the proportion of aC to KC, or of AC to AL. Therefore, on the whole, the abſolute impulſe is diminiſhed in the proportion of AC^2 to AL^2: hence the propoſition, that the impulſe and reſiſtance of a given ſurface are in the proportion of the ſquare of the ſine of the angle of incidence.

Fourthly, This impulſe is in the direction PL, perpendicular to the impelled ſurface, and the ſurface tends to move in this direction: but ſuppoſe it moveable only in ſome other direction PO, or that it is in the direction PO that we wiſh to employ this impulſe, its action is therefore oblique; and if we wiſh to know the intenſity of the impulſe in this direction, it muſt be diminiſhed ſtill further in the proportion of radius to the coſine of the angle LPO or ſine of CPO. Hence the general propoſition: The *effective impulſe is as the ſurface, as the ſquare of the velocity of the wind, as the ſquare of the ſine of the angle of incidence, and as the ſine of the obliquity jointly*, which we may expreſs by the ſymbol $R=S\cdot V^2.\ \textit{ſin.}^2\, I\cdot \textit{ſin.}\, O$; and as the impulſe depends on the denſity of the impelling fluid, we may take in every circumſtance by the equation $R=S\cdot D\cdot V^2.\ \textit{ſin.}^2\, I\cdot \textit{ſin.}\, O$. If the impulſe be eſtimated in the direction of the ſtream, the angle of obliquity ACD is the ſame with the angle of incidence, and the impulſe in this direction is as the ſurface, as the ſquare of the velocity, and as the cube of the angle of incidence jointly.

It evidently follows from theſe premiſes, that if ACA′ be a wedge, of which the baſe AA′ is perpendicular to the wind, and the angle ACA′ biſected by its direction, the direct or perpendicular impulſe on the baſe is to the oblique impulſe on the ſides as radius to the ſquare of the ſine of half the angle ACA′.

The ſame muſt be affirmed of a pyramid or cone ACA′, of which the axis is in the direction of the wind.

If ACA′ (fig. 69.) repreſent the ſection of a ſolid produced by the revolution of a curve line APC round the axis CD, which lies in the direction of the wind, the impulſe on this body may be compared with the direct impulſe on its baſe; or the reſiſtance to the motion of this body through the air may be compared with the direct reſiſtance of its baſe, by reſolving its ſurface into elementary planes Pp, which are coincident with a tangent plane PR, and comparing the impulſe on Pp with the direct impulſe on the correſponding part Kk of the baſe.

In this way it follows that the impulſe on a ſphere is one half of the impulſe on its great circle, or on the baſe of a cylinder of equal diameter.

We ſhall conclude this ſketch of the doctrine with a very important propoſition to determine the moſt advantageous poſition of a plane ſurface, when required to move in one direction while it is impelled by the wind blowing in a different direction. Thus,

Let AB (fig. 70.) be the ſail of a ſhip, CA the direction in which the wind blows, and AD the line of the ſhip's courſe. It is required to place the yard AC in ſuch a poſition that the impulſe of the wind upon the ſail may have the greateſt effect poſſible in impelling the ſhip along AD.

Let AB, Ab, be two poſitions of the ſail very near the beſt poſition, but on oppoſite ſides of it. Draw BE, be, perpendicular to CA, and BF, bf, perpendicular to AD, calling AB radius; it is evident that BE, BF, are the ſines of impulſe and obliquity, and that the effective impulſe is $BE^2 + BF$, or $be^2 + bf$. This muſt be a maximum.

Let the points B, b, continually approach and ultimately coincide; the chord bB will ultimately coincide with a ſtraight line CBD touching the circle in B; the triangles CBE, cbe are ſimilar, as alſo the triangles DBF, Dbf: therefore $BE^2 : be^2 = BC^2 : bc^2$, and $BF : bf = BD : bD$; and $BE^2 \times BF : be^2 \times bf = CB^1 \times BD : cb^2 \times bD$. Therefore when AB is in the beſt poſition, ſo that $BE^2 \times BF$ is greater than $be^2 \times bf$, we ſhall have $CB \times BD$ greater than $Cb^2 \times bD$, or $cB^2 \times BD$ is alſo a maximum. This we know to be the caſe when $CB = 2BD$: therefore the ſail muſt be ſo placed that the tangent of the angle of incidence ſhall be double of the tangent of the angle of the ſail and keel.

In a common windmill the angle CAD is neceſſarily a right angle; for the ſail moves in a circle to which the wind is perpendicular: therefore the beſt angle of the ſail and axle will be 54°. 44 nearly.

Such is the theory of the reſiſtance and impulſe of the air. It is extremely ſimple and of eaſy application. In all phyſical theories there are aſſumptions which depend on other principles, and thoſe on the judgment of the naturaliſt; ſo that it is always proper to confront the theory with experiment. There are even circumſtances in the preſent caſe which have not been attended to in the theory. When a ſtream of air is obſtructed by a ſolid body, or when a ſolid body moves along in air, the air is condenſed before it and rarefied behind. There is therefore a preſſure on the anterior parts ariſing from this want of equilibrium in the elaſticity of the air. This muſt be ſuperadded to the force ariſing from the impetus or inertia of the air. We cannot tell with preciſion what may be the amount of this condenſation; it depends on the velocity with which any condenſation diffuſes itſelf.

Alſo, if the motion be ſo rapid that the preſſure of the atmoſphere cannot make the air immediately occupy the place quitted by the body, it will ſuſtain this preſſure on its forepart to be added to the other forces.

Experiments on this ſubject are by no means numerous; at leaſt ſuch experiments as can be depended on for the foundation of any practical application. The firſt that have this character are thoſe publiſhed by Mr. Robins in 1742 in his treatiſe on Gunnery. They were repeated with ſome additions by the Chevalier Borda, and ſome account of them publiſhed in the Memoirs of the Academy of Sciences in 1763. In the Philoſophical Tranſactions of the Royal Society of London, vol. lxxiii. there are ſome experiments of the ſame kind on a larger ſcale by Mr. Edgeworth. Theſe were all made in the way deſcribed in our account of Mr. Robins's improvements in gunnery. Bodies were made to move with determined velocities, and the reſiſtances were meaſured by weights.

In all theſe experiments the reſiſtances were found very exactly in the proportion of the ſquares of the velocities; but they were found conſiderably greater than the weight of the column of air whoſe height would produce the velocity in a falling body. Mr. Robins's experiments on a ſquare of 16 inches, deſcribing 25,2 feet per ſecond, indicate the reſiſtance to be to this weight nearly as 4 to 3. Borda's experiments upon the ſame ſurface ſtate the diſproportion ſtill to be greater.

The reſiſtances are found not to be in the proportion of the ſurfaces, but increaſe conſiderably faſter. Surfaces of 9, 16, 36 and 81 inches, moving with one velocity, had reſiſtances in the proportion of 9, $17\frac{1}{2}$, $42\frac{3}{4}$, and $104\frac{3}{4}$.

Now as this deviation from the proportion of the ſurfaces increaſes with great regularity, it is moſt probable that it continues to increaſe in ſurfaces of ſtill greater extent; and theſe are the moſt generally to be met with in practice in the action of wind on ſhips and mills.

Borda's experiments on 81 inches ſhow that the impulſe of wind moving one foot per ſecond is about $\frac{1}{500}$ of a pound on a ſquare foot. Therefore to find the impulſe on a foot correſponding to any velocity, divide the ſquare of the velocity by 500, and we obtain the impulſe in pounds. Mr. Rouſe of Leiceſterſhire made many experiments, which are mentioned with great approbation by Mr. Smeaton. His great ſagacity and experience in the erection of windmills oblige us to pay a conſiderable deference to his judgment. Theſe experiments confirm our opinion, that the impulſes increaſe faſter than the ſurfaces. The following table was calculated from Mr. Rouſe's obſervations, and may be conſidered as pretty near the truth.

Velocity in Feet.	Impulſe on a Foot in Pounds.
0	0,000
10	0,129
20	0,915
30	2,059
40	3,660
50	5,718
60	8,234
70	11,207
80	14,638
90	18,526
100	22,872
110	27,675
120	32,926
130	38,654
140	44,830
150	51,462

If we multiply the ſquare of the velocity in feet by 16, the product will be the impulſe or reſiſtance on a ſquare foot in grains, according to Mr. Rouſe's numbers.

The greateſt deviation from the theory occurs in the oblique impulſes. Mr. Robins compared the reſiſtance of a wedge, whoſe angle was 90°, with the reſiſtance of its baſe; and inſtead of finding it leſs in the proportion of $\sqrt{2}$ to 1, as determined by the theory, he found it greater in the proportion of 55 to 68 nearly; and when he formed the body into a pyramid, of which the ſides had the ſame ſurface and the ſame inclination as the ſides of the wedge, the reſiſtance of the baſe and face were now as 55 to 39 nearly: ſo that here the ſame ſurface with the ſame inclination had its reſiſtance reduced from 68 to 39 by being put into this form. Similar deviations occur in the experiments of the Chevalier Borda; and it may be collected from both, that the reſiſtances diminiſh more nearly in the proportion of the ſines of incidence than in the proportion of the ſquares of thoſe ſines.

The irregularity in the reſiſtance of curved ſurfaces is as great as in plane ſurfaces. In general, the theory gives the oblique impulſes on plane ſurfaces much too ſmall, and the impulſes on curved ſurfaces too great. The reſiſtance of a ſphere does not exceed the fourth part of the reſiſtance of its great circle, inſtead of being its half; but the anomaly is ſuch as to leave hardly any room for calculation. It would be very deſirable to have the experiments on this ſubject repeated in a greater variety of caſes, and on larger ſurfaces, ſo that the errors of the experiments may be of leſs conſequence. Till this matter be reduced to ſome rule, the art of working ſhips muſt remain very imperfect, as muſt alſo the conſtruction of windmills.

The caſe in which we are moſt intereſted in the knowledge of the reſiſtance of the air is the motion of bullets and ſhells. Writers on artillery have long been ſenſible of the great effect of the air's reſiſtance. It ſeems to have been this conſideration that chiefly engaged Sir Iſaac Newton to conſider the motions of bodies in a reſiſting medium. A propoſition or two would have ſufficed for ſhowing the incompatibility of the planetary motions with the ſuppoſition that the celeſtial ſpaces were filled with a fluid matter; but he has with great ſolicitude conſidered the motion of a body projected on the ſurface of the earth, and its deviation from the parabolic track aſſigned by Galileo. He has beſtowed more pains on this problem than any other in his whole work; and his inveſtigation has pointed out almoſt all the improvements which have been made in the application of mathematical knowledge to the ſtudy of nature. Nowhere does his ſagacity and fertility of reſource appear in ſo ſtrong a light as in the ſecond book of the *Principia*, which is almoſt wholly occupied by this problem. The celebrated mathematician John Bernouilli engaged in it as the fineſt opportunity of diſplaying his ſuperiority. A miſtake committed by Newton in his attempt to a ſolution was matter of triumph to him; and the whole of his performance, though a piece of elegant and elaborate geometry, is greatly hurt by his continually bringing this miſtake (which is a mere trifle) into view. The difficulty of the ſubject is ſo great, that ſubſequent mathematicians ſeem to have kept aloof from it; and it has been entirely overlooked by the many voluminous writers who have treated profeſſedly on military projectiles. They have ſpoken indeed of the reſiſtance of the air as affecting the flight of ſhot, but have ſaved themſelves from the taſk of inveſtigating this effect (a taſk to which they were unequal), by ſuppoſing that it was not ſo great as to render their theories and practical deductions very erroneous. Mr. Robins was the firſt who ſeriouſly examined the ſubject. He ſhowed, that even the Newtonian theory (which had been corrected, but not in the ſmalleſt degree improved or extended in its principles) was ſufficient to ſhow that the path of a cannon ball could not reſemble a parabola. Even this theory ſhowed that the reſiſtance was more than eight times the weight of the ball, and ſhould produce a greater deviation from the parabola than the parabola deviated from a ſtraight line.

This ſimple but ſingular obſervation was a ſtrong proof how faulty the profeſſed writers on artillery had been, in rather amuſing themſelves with elegant but uſeleſs applications of eaſy geometry, than in endeavouring to give their readers any uſeful information. He added, that the difference between the ranges by the Newtonian theory and by experiment were ſo great, that the reſiſtance of the air muſt be vaſtly ſuperior to what that theory ſuppoſed. It was this which ſuggeſted to him the neceſſity of experiments to aſcertain this point. We have ſeen the reſult of theſe experiments in moderate velocities; and that they were ſufficient for calling the whole theory in queſtion, or at leaſt for rendering it uſeleſs. It became neceſſary, therefore, to ſettle every point by means of a direct experiment. Here was a great difficulty. How ſhall we meaſure either theſe great velocities which are obſerved in the motions of cannon ſhot, or the reſiſtances which theſe enormous velocities occaſion? Mr. Robins had the ingenuity to do both. The method which he took for meaſuring the velocity of a muſket-ball was quite original; and it was ſuſceptible of great accuracy. We have already given an account of it under the article GUNNERY. Having gained this point, the other was not difficult. In the moderate velocities he had determined the reſiſtances by the forces which balanced them, the weights which kept the reſiſted body in a ſtate of uniform motion. In the great velocities, he propoſed to determine the reſiſtances by their immediate effects, by the retardations which they occaſioned. This was to be done by firſt aſcertaining the velocity of the ball, and then meaſuring its velocity after it had paſſed through a certain quantity of air. The difference of theſe velocities is the retardation, and the proper meaſure of the reſiſtance; for, by the initial and final velocities of the ball, we learn the time which was employed in paſſing through this air with the medium velocity. In this time the air's reſiſtance diminiſhed the velocity by a certain quantity. Compare this with the velocity which a body projected directly upwards would loſe in the ſame time by the reſiſtance of gravity. The two forces muſt be in the proportion of their effects. Thus we learn the proportion of the reſiſtance of the air to the weight of the ball. It is indeed true, that the time of paſſing through this ſpace is not accurately had by taking the arithmetical medium of the initial and final velocities, nor does the reſiſtance deduced from this calculation accurately correſpond to this mean velocity; but both may be accurately found by the experiment by a very troubleſome computation, as is ſhown in the 5th and 6th propoſitions of the ſecond book of Newton's *Principia*. The difference between the quantities thus found and thoſe deduced from the ſimple proceſs is quite trifling, and far within the limits of accuracy attainable in experiments of this kind; it may therefore be ſafely neglected.

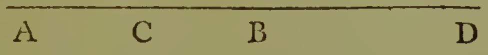
Mr. Robins made many experiments on this ſubject; but unfortunately he has publiſhed only a very few, ſuch as were ſufficient for aſcertaining the point he had in view. He intended a regular work on the ſubject, in which the gradual variations of reſiſtance correſponding to different velocities ſhould all be determined by experiment: but he was then newly engaged in an important and laborious employment, as chief engineer to the Eaſt India Company, in whoſe ſervice he went out to India, where he died in leſs than two years. It is to be regretted that no perſon has proſecuted theſe experiments. It would be neither laborious nor difficult, and would add more to the improvement of artillery than any thing that has been done ſince Mr. Robins's death, if we except the proſecution of his experiments on the initial velocities of cannon-ſhot by Dr. Charles Hutton, royal profeſſor at the Woolwich Academy. It is to be hoped that this gentleman, after having with ſuch effect and ſucceſs extended Mr. Robins's experiments on the initial velocities of muſket-ſhot to cannon, will take up this other ſubject, and thus give the art of artillery all the ſcientific foundation which it can receive in the preſent ſtate of our mathematical knowledge. Till then we muſt content ourſelves with the practical rules which Robins has deduced from his own experiments. As he has not given us the mode of deduction, we muſt compare the reſults with experiment. He has indeed given a very extenſive compariſon with the numerous experiments made both in Britain and on the continent; and the agreement is very great. His learned commentator Euler has been at no pains to inveſtigate theſe rules, and has employed himſelf chiefly in detecting errors, moſt of which are ſuppoſed, becauſe he takes for a finiſhed work what Mr. Robins only gives to the public as a haſty but uſeful ſketch of a new and very difficult branch of ſcience.

The general reſult of Robins's experiments on the retardation of muſket-ſhot is, that although in moderate velocities the reſiſtance is ſo nearly in the duplicate proportion of the velocities that we cannot obſerve any deviation, yet in velocities exceeding 200 feet per ſecond the retardations increaſe faſter, and the deviation from this rate increaſes rapidly with the velocity. He aſcribes this to the cauſes already mentioned, viz. the condenſation of the air before the ball and to the rarefaction behind, in conſequence of the air not immediately occupying the ſpace left by the bullet. This increaſe is ſo great, that if the reſiſtance to a ball moving with the velocity of 1700 feet in a ſecond be computed on the ſuppoſition that the reſiſtance obſerved in moderate velocities is increaſed in the duplicate ratio of the velocity, it will be found hardly one-third part of its real quantity. He found, for inſtance, that a ball moving through 1670 feet in a ſecond loſt about about 125 feet per ſecond of its velocity in paſſing through 50 feet of air. This it muſt have done in the $\frac{1}{32}$ of a ſecond, in which time it would have loſt one foot if projected directly upwards; from which it appears that the reſiſtance was about 125 times its weight, and more than three times greater than if it had increaſed from the reſiſtance in ſmall velocities in the duplicate ratio of the velocities. He relates other experiments which ſhow ſimilar reſults.

But he alſo mentions a ſingular circumſtance, that till the velocities exceed 1100 feet per ſecond, the reſiſtances increaſe pretty regularly, in a ratio exceeding the duplicate ratio of the velocities; but that in greater velocities the reſiſtances become ſuddenly triple of what they would have been, even according to this law of increaſe. He thinks this explicable by the vacuum which is then left behind the ball, it being well known that air ruſhes into a vacuum with the velocity of 1132 feet per ſecond nearly. Mr. Euler controverts this concluſion, as inconſiſtent with that gradation which is obſerved in all the operations of nature; and ſays, that although the vacuum is not produced in ſmaller velocities than this, the air behind the ball muſt be ſo rare (the ſpace being but imperfectly filled), that the preſſure on the anterior part of the ball muſt gradually approximate to that preſſure which an abſolute vacuum would produce; but this is like his other criticiſms. Robins does nowhere aſſert that this ſudden change of reſiſtance happens in the tranſition of the velocity from 1132 feet to that of 1131 feet 11 inches or the like, but only that it is very ſudden and very great. It may be ſtrictly demonſtrated, that ſuch a change muſt happen in a narrow enough limit of velocities to juſtify the appellation of ſudden: a ſimilar fact may be obſerved in the motion of a ſolid through water. If it be gradually accelerated, the water will be found nearly to fill up its place, till the velocity arrives at a certain magnitude, correſponding to the immerſion of the body in the water; and then the ſmalleſt augmentation of its motion immediately produces a void behind it, into which the water ruſhes in a violent manner, and is daſhed into froth. A gentleman, who has had many opportunities for ſuch obſervations, aſſures us, that when ſtanding near the line of direction of a cannon diſcharging a ball with a large allotment of powder, ſo that the initial velocity certainly exceeded 1100 feet per ſecond, he always obſerved a very ſudden diminution of the noiſe which the bullet made during its paſſage. Although the ball was coming towards him, and therefore its noiſe, if equable, would be continually increaſing, he obſerved that it was loudeſt at firſt. That this continued for a ſecond or two, and ſuddenly diminiſhed, changing to a ſound which was not only weaker, but differed in kind, and gradually increaſed as the bullet approached him. He ſaid, that the firſt noiſe was like the hiſſing of red-hot iron in water, and that the ſubſequent noiſe rather reſembled a hazy whiſtling. Such a change of ſound is a neceſſary conſequence of the different agitation of the air in the two caſes. We know alſo, that air ruſhing into a void, as when we break an exhauſted bottle, makes a report like a muſket.

Mr. Robins's aſſertion, therefore, has every argument for its truth that the nature of the thing will admit. But we are not left to this vague reaſoning: his experiments ſhow us this diminution of reſiſtance. It clearly appears from them, that in a velocity of 1700 feet the reſiſtance is more than three times the reſiſtance determined by the theory which he ſuppoſes the common one. When the velocity was 1065 feet, the actual reſiſtance was $\frac{11}{7}$ of the theoretical; and when the velocity was 400 feet, the actual reſiſtance was about $\frac{4}{3}$ of the theoretical. That he aſſumed a theory of reſiſtance which gave them all too ſmall, is of no conſequence in the preſent argument.

Mr. Robins, in ſumming up the reſults of his obſervations on this ſubject, gives a rule very eaſily remembered for computing the reſiſtances to thoſe very rapid motions. It has been already mentioned, but we repeat it here, in order to accommodate it to the quantities which have been determined in ſome degree by experiment.



Let AB repreſent the velocity of 1700 feet per ſecond, and AC any other velocity. Make BD to AD as the reſiſtance given by the ordinary theory to the reſiſtance actually obſerved in the velocity 1700: then will CD be to AD as the reſiſtance aſſigned by the ordinary theory to the velocity AC is to that which really correſponds to it.

To accommodate this to experiment, recollect that a ſphere of the ſize of a 12 pound iron ſhot, moving 25 feet in a ſecond, had a reſiſtance of $\frac{1}{22}$ of a pound. Augment this in the ratio of 25^2 to 1700^2, and we obtain 210 nearly for the theoretical reſiſtance to this velocity; but by comparing its diameter of $4\frac{1}{2}$ inches with $\frac{3}{4}$, the diameter of the leaden ball, which had a reſiſtance of at leaſt 11 pounds with this velocity, we conclude that the 12 pound ſhot would have had a reſiſtance of 396 pounds: therefore BD : AD = 210 : 396, and AB : AD = 186 : 396; and AB being 1700, AD will be 3613.

Let AD $= a$, AC $= x$, and let R be the reſiſtance to a 12 pound iron ſhot moving one foot per ſecond, and r the reſiſtance (in pounds) wanted for the velocity x; we have $r = \mathrm{R}\frac{a x^2}{a - x}$

Mr. Robins's experiments give $\mathrm{R} = \frac{1}{13750}$ very nearly. This gives $\mathrm{R}a = 0{,}263235$, which is nearly one-fourth. Thus our formula becomes $r = \frac{0{,}263235\, x^2}{3613 - x}$, or very nearly $\frac{x^2}{4(3613 - x)}$, falling ſhort of the truth about $\frac{1}{23}$th part. The ſimplicity of the formula recommends it to our uſe, and when we increaſe its reſult $\frac{1}{27}$, it is incomparably nearer to the true reſult of the theory as corrected by Mr. Robins than we can hope that the theory is to the actual reſiſtance. We can eaſily ſee that Mr. Robins's correction is only a ſagacious approximation. If we ſuppoſe the velocity 3613 feet, a very poſſible thing, the reſiſtance by this formula is infinite, which cannot be. We may even ſuppoſe that the reſiſtance given by the formula is near the truth only in ſuch velocities as do not greatly exceed 1700 feet per ſecond. No military projectile exceeds 2200, and it is great folly to make it ſo great, becauſe it is reduced 1700 almoſt in an inſtant, by the enormous reſiſtance.

The reſiſtance to other balls will be made by taking them in the duplicate ratio of the diameters.

It has been already obſerved, that the firſt mathematicians of Europe have lately employed themſelves in improving this theory of the motion of bodies in a reſiſting medium; but their diſcuſſions are ſuch as few artilleriſts can underſtand. The problem can only be ſolved by approximation, and this by the quadrature of very complicated curves. They have not been able therefore to deduce from them any practical rules of eaſy application, and have been obliged to compute tables ſuited to different caſes. Of theſe performances, that of the Chevalier Borda, in the Memoirs of the Academy of Sciences in 1769, ſeems the beſt adapted to military readers, and the tables are undoubtedly of conſiderable uſe; but it is not too much to ſay, that the ſimple rules of Mr. Robins are of as much ſervice, and are more eaſily remembered: beſides, it muſt be obſerved, that the nature of military ſervice does not give room for the application of any very preciſe rule. The only advantage that we can derive from a perfect theory would be an improvement in the conſtruction of pieces of ordnance, and a more judicious appropriation of certain velocities to certain purpoſes. The ſervice of a gun or mortar muſt always be regulated by the eye.

There is another motion of which air and other elaſtic fluids are ſuſceptible, viz. an internal vibration of their particles, or undulation, by which any extended portion of air is diſtributed into alternate parcels of condenſed and rarefied air, which are continually changing their condition without changing their places. By this change the condenſation which is produced in one part of the air is gradually transferred along the maſs of air to the greateſt diſtances in all directions. It is of importance to have ſome diſtinct conception of this motion. It is found to be by this means that diſtant bodies produce in us the ſenſation of ſound. See Sound, and Acoustics. Sir Iſaac Newton treated this ſubject with his accuſtomed ingenuity, and has given us a theory of it in the end of the ſecond book of his *Principia*. This theory has been objected to with reſpect to the conduct of the argument, and other explanations have been given by the moſt eminent mathematicians. Though they appear to differ from Newton's, their reſults are preciſely the ſame; but, on a cloſe examination, they differ no more than John Bernouilli's theorem of centripetal forces differs from Newton's, viz. the one being expreſſed by geometry and the other by literal analyſis. The celebrated De la Grange reduces Newton's inveſtigation to a tautological propoſition or identical equation; but Mr. Young of Trinity College, Dublin, has, by a different turn of expreſſion, freed Newton's method from this objection. We ſhall not repeat it here, but refer our mathematical readers to the article Acoustics, it not being our buſineſs at preſent to conſider its connection with ſound.

But ſince Newton publiſhed this theory of aerial undulations, and of their propagation along the air, and ſince the theory has been ſo corrected and improved as to be received by the moſt accurate philoſophers as a branch of natural philoſophy ſuſceptible of rigid demonſtration, it has been freely reſorted to by many writers on other parts of natural ſcience, who did not profeſs to be mathematicians, but made uſe of it for explaining phenomena in their own line on the authority of the mathematicians themſelves. Learning from them that this vibration, and the *quaquaverſum* propagation of the pulſes, were the neceſſary properties of an elaſtic fluid, and that the rapidity of this propagation had a certain aſſignable proportion to the elaſticity and denſity of the fluid, they freely made uſe of theſe conceſſions, and have introduced elaſtic vibrating fluids into many facts, where others would ſuſpect no ſuch thing, and have attempted to explain by their means many abſtruſe phenomena of nature. Æthers are everywhere introduced, endued with great elaſticity and tenuity. Vibrations and pulſes are ſuppoſed in this æther, and theſe are offered as explanations. The doctrines of animal ſpirits and nervous fluids, and the whole mechanical ſyſtem of Hartley, by which the operations of the ſoul are ſaid to be explained, have their foundation in this theory of aerial undulations. If theſe fancied fluids, and their internal vibrations, really operate in the phenomena aſcribed to them, any explanation that can be given of the phenomena from this principle muſt be nothing elſe than ſhowing that the legitimate conſequences of theſe undulations are ſimilar to the phenomena; or, if we are no more able to ſee this laſt ſtep than in the caſe of ſound (which we know to be *one* conſequence of the aerial undulations, although we cannot tell how), we muſt be able to point out, as in the caſe of ſound, certain conſtant relations between the general laws of theſe undulations and the general laws of the phenomena. It is only in this way that we think ourſelves intitled to ſay that the aerial undulations are cauſes, though not the only cauſes, of ſound; and it is becauſe there is no ſuch relation, but, on the contrary, a total diſſimilarity, to be obſerved between the laws of elaſtic undulations and the laws of the propagation of light, that we aſſert with confidence that æthereal undulations are not the cauſes of viſion.

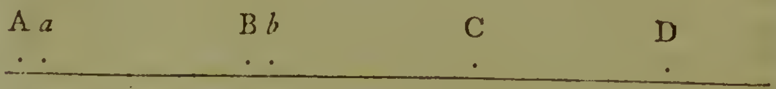
Explanations of this kind ſuppoſe, therefore, in the firſt place, that the philoſopher who propoſes them underſtands preciſely the nature of theſe undulations; in the next place, that he makes his reader ſenſible of thoſe circumſtances of them which are concerned in the effect to be explained; and, in the third place, that he makes the reader underſtand how this circumſtance of the vibrating fluid is connected with the phenomenon, either by ſhowing it to be its mechanical cauſe, as when the philoſopher explains the reſounding of a muſical chord to a flute or pipe which gave the ſame tone; or by ſhowing that this circumſtance of the undulation always accompanies the phenomenon, as when the philoſopher ſhows that 233 vibrations of air in a ſecond, in whatever manner or by whatever cauſe they are produced, always are followed by the ſenſation of the tone C in the middle of the harpſichord.

But here we muſt obſerve, that, with the exception of Euler's unſucceſsful attempt to explain the optical phenomena by the undulations of æther, we have met with no explanation of natural phenomena, by means of elaſtic and vibrating fluids, where the author has ſo much as attempted any one of theſe three things, ſo indiſpenſably requiſite in a logical explanation. They have talked of vibrations without deſcribing them, or giving the reader the leaſt notion of what kind they are; and in no inſtance that we can recollect have they ſhowed how ſuch vibrations could have any influence in the phenomenon. Indeed, by not deſcribing with preciſion the undulations, they were freed from the taſk of ſhowing them to be mechanical cauſes of the phenomenon; and when any of them ſhow any analogy between the general laws of elaſtic undulations and the general laws of the phenomenon, the analogy is ſo vague, indiſtinct, or partial, that no perſon of common prudence would receive it as argument in any caſe in which he was much intereſted.

We think it our duty to remonſtrate againſt this ſlovenly way of writing: we would even hold it up to reprobation. It has been chiefly on this faithleſs foundation that the blind vanity of men has raiſed that degrading ſyſtem of opinions called MATERIALISM, by which the affections and faculties of the ſoul of man have been reſolved into vibrations and pulſes of æther.

We alſo think it our duty to give ſome account of this motion of elaſtic fluids. It muſt be ſuch an account as ſhall be underſtood by thoſe who are not mathematicians, becauſe thoſe only are in danger of being miſled by the improper application of them. Mathematical diſcuſſion is, however, unavoidable in a ſubject purely mathematical; but we ſhall introduce nothing that may not be eaſily underſtood or confided in; and we truſt that mathematical readers will excuſe us for a mode of reaſoning which appears to them lax and inelegant.

The firſt thing incumbent on us is to ſhow how elaſtic fluids differ from the unelaſtic in the propagation of any agitation of their parts. When a long tube is filled with water, and any one part of it puſhed out of its place, the whole is inſtantly moved like a ſolid maſs. But this is not the caſe with air. If a door be ſuddenly ſhut, the window at the further end of a long and cloſe room will rattle; but ſome time will elapſe between the ſhutting of the door and the motion of the window. If ſome light duſt be lying on a braced drum, and another be violently beat at a little diſtance from it, an attentive obſerver will ſee the duſt dance up from the parchment; but this will be at the inſtant he hears the ſound of the ſtroke on the other drum, and a ſenſible time after the ſtroke. Many ſuch familiar facts ſhow that the agitation is gradually communicated along the air; and therefore that when one particle is agitated by any ſenſible motion, a finite time, however ſmall, muſt elapſe before the adjoining particle is agitated in the ſame manner. This would not be the caſe in water if water be perfectly incompreſſible. We think that this may be made intelligible with very little trouble.



Let A, B, C, D, &c. be a row of aerial particles, at ſuch diſtances that their elaſticity juſt balances the preſſure of the atmoſphere; and let us ſuppoſe (as is deducible from the obſerved denſity of air being proportional to the compreſſing force) that the elaſticity of the particles, by which they keep each other at a diſtance, is as their diſtances inverſely. Let us further ſuppoſe that the particle A has been carried, with an uniform motion, to *a* by ſome external force. It is evident that B cannot remain in its preſent ſtate; for being now nearer to *a* than to C, it is propelled towards C by the exceſs of the elaſticity of A above the natural elaſticity of C. Let E be the natural elaſticity of the particles, or the force correſponding to the diſtance BC or BA, and let F be the force which impels B towards C, and let f be the force exerted by A when at *a*. We have

$$E : f = Ba : BC, = Ba : BA;$$
$$\text{and } E : f - E = Ba : BA - Ba = Ba : Aa;$$
$$\text{or } E : F = Ba : Aa.$$

Now in pl. 12. fig. 71. let ABC be the line joining three particles, to which draw FG, PH parallel, and IAF, HBG perpendicular. Take IF or HG to repreſent the elaſticity correſponding to the diſtance AB. Let the particle A be ſuppoſed to have been carried with an uniform motion to *a* by ſome external force, and draw R *a* M perpendicular to RG, and make FI : RM = B*a* : BA. We ſhall then have FI : PM = B*a* : A*a*; and PM will repreſent the force with which the particle B is urged towards C. Suppoſe this conſtruction to be made for every point of the line AB, and that a point M is thus determined for each of them, mathematicians know that all theſe points M lie in the curve of a hyperbola, of which FG and GH are the aſymptotes. It is alſo known by the elements of mechanics, that ſince the motion of A along AB is uniform, A *a* or IP may be taken to repreſent the time of deſcribing A*a*; and that the area IPM repreſents the whole velocity which B has acquired in its motion towards C when A has come to *a*, the force urging B being always as the portion PM of the ordinate.

Take GX of any length in HG produced, and let GX repreſent the velocity which the uniform action of the natural elaſticity IF could communicate to the particle B during the time that A would uniformly deſcribe AB. Make GX to GY as the rectangle IFGH to the hyperbolic ſpace IFRM, and draw YS cutting MR produced in S, and draw FX cutting MR in T. It is known to the mathematicians that the point S is in a curve line FS*s* called the *logarithmic curve*; of which the leading property is, that any line RS parallel to GX is to GX as the rectangle IFGH is to the hyperbolic ſpace IFRM, and that FX touches the curve in F.

This being the caſe, it is plain, that becauſe RT increaſes in the ſame proportion with FR, or with the rectangle IFRP, and RS increaſes in the proportion of the ſpace IFRM, TS increaſes in the proportion of the ſpace IPM. Therefore TS is proportional to the velocity of B when A has reached *a*, and RT is proportional to the velocity which the uniform action of the natural elaſticity would communicate to B in the ſame time.

Then ſince FT is as the time, and TS is as the velocity, the area FTS will be as the ſpace deſcribed by B (urged by the variable force PM); while A urged by the external force, deſcribes A a; and the triangle FRT will repreſent the ſpace which the uniform action of the natural elaſticity would cauſe B to deſcribe in the ſame time.

And thus it is plain that theſe three motions can be compared together: the uniform motion of the agitated particle A, the uniformly accelerated motion which the natural elaſticity would communicate to B by its conſtant action, and the motion produced in B by the agitation of A. But this compariſon, requiring the quadrature of the hyperbola and logarithmic curve, would lead us into the moſt intricate and tedious computations. Of theſe we need only give the reſult, and make ſome other compariſons which are palpable.

Let A a be ſuppoſed indefinitely ſmall in compariſon of AB. The ſpace deſcribed by A is therefore indefinitely ſmall; but in this caſe we know that the ratio of the ſpace FRT to the rectangle IFRP is indefinitely ſmall. There is therefore no compariſon between the agitation of A by the external force, and the agitation which natural elaſticity would produce on a ſingle particle in the ſame time, the laſt being incomparably ſmaller than the firſt. And this ſpace FRT is incomparably greater than FTS; and therefore the ſpace which B would deſcribe by the uniform action of the natural elaſticity is incomparably greater than what it would deſcribe in conſequence of the agitation of A.

From this reaſoning we ſee evidently that A muſt be ſenſibly moved, or a finite or meaſurable time muſt elapſe before B acquires a meaſurable motion. In like manner B muſt move during a meaſurable time before C acquires a meaſurable motion, &c. and therefore the agitation of A is communicated to the diſtant particles in gradual ſucceſſion.

By a further compariſon of theſe ſpaces we learn the time in which each ſucceeding particle acquires the very agitation of A. If the particles B and C only be conſidered, and the motion of C neglected, it will be found that B has acquired the motion of A a little before it has deſcribed $\frac{1}{3}$ of the ſpace deſcribed by A; but if the motion of C be conſidered, the acceleration of B muſt be increaſed by the retreat of C, and B muſt deſcribe a greater ſpace in proportion to that deſcribed by A. By computation it appears, that when both B and C have acquired the velocity of A, B has deſcribed nearly $\frac{1}{2}$ of A's motion, and C more nearly $\frac{1}{2}$. Extending this to D, we ſhall find that D has deſcribed ſtill more nearly $\frac{1}{2}$ of A's motion. And from the nature of the computation it appears that this approximation goes on rapidly: therefore, ſuppoſing it accurate from the very firſt particle, it follows from the equable motion of A, that each ſucceeding particle moves through an equal ſpace in acquiring the motion of A.

The concluſion which we muſt draw from all this is, that when the agitation of A has been fully communicated to a particle at a *ſenſible* diſtance, the intervening particles, all moving forward with a common velocity, are equally compreſſed as to ſenſe, except a very few of the firſt particles; and that this communication, or this propagation of the original agitation, goes on with an uniform velocity.

Theſe computations need not be attended to by ſuch as do not wiſh for an accurate knowledge of the preciſe agitation of each particle. It is enough for ſuch readers to ſee clearly that time *muſt* eſcape between the agitation of A and that of a diſtant particle; and this is abundantly manifeſt from the incomparability (excuſe the term) of the naſcent rectangle IFRP with the naſcent triangle FRT, and the incomparability of FRT with FTS.

What has now been ſhown of the communication of any ſenſible motion A a muſt hold equally with reſpect to any change of this motion. Therefore if a tremulous motion of a body, ſuch as a ſpring or bell, ſhould agitate the adjoining particle A by puſhing it forward in the direction AB, and then allowing it to come back again in the direction BA, an agitation ſimilar to this will take place in all the particles of the row one after the other. Now if this body vibrate according to the law of motion of a pendulum vibrating in a cycloid, the neighbouring particle of air *will of neceſſity* vibrate in the ſame manner; and then Newton's demonſtration needs no apology. Its only deficiency was, that it *ſeemed* to prove that this *would be* the way in which every particle would of neceſſity vibrate; which is not true, for the ſucceſſive parcels of air will be differently agitated according to the original agitation. Newton only wants to prove the uniform propagation of the agitations, and he ſelects that form which renders the proof eaſieſt. He proves, in the moſt unexceptionable manner, that if the particles of a pulſe of air be really moving like a cycloidal pendulum, the forces acting on each particle, in conſequence of the compreſſion and dilatation of the different parts of the pulſe, are preciſely ſuch as are neceſſary for continuing this motion, and therefore no other forces are required. Then, ſince each particle is in a certain part of its path, is moving in a certain direction and with a certain velocity, and is urged by a determined force, it *muſt* move in that very manner. The objection ſtarted by John Bernouilli againſt Newton's demonſtration (in a ſingle line) of the elliptical motion of a body urged by a force in the inverſe duplicate ratio of the diſtance from the focus, is preciſely the ſame with the objection againſt Newton's demonſtration of the progreſs of aerial undulations, and is equally futile.

It muſt, however, be obſerved, that Newton's demonſtration proceeds on the ſuppoſition that the lineal agitations of a particle are incomparably ſmaller than the extent of an undulation. This is not ſtrictly the caſe in any inſtance, and in many it is far from being true. In a pretty ſtrong twang of a harpſichord wire, the agitation of a particle may be near the 50th part of the extent of the undulation. This muſt diſturb the regularity of the motion, and cauſe the agitations in the remote undulations to differ from thoſe in the firſt pulſe. In the exploſion of a cannon, the breaking of an exhauſted bottle, and many inſtances which may be given, the agitations are ſtill greater. The commentators on Newton's *Principia*, Le Sueur and Jacquier, have ſhown, and Euler more clearly, that when the original agitations are very violent, the particles of air will acquire a ſubordinate vibration compounded with the regular cycloidal vibration, and the progreſs of the pulſes will be ſomewhat more rapid; but the intricacy of the calculus is ſo great, that they have not been able to determine with any tolerable preciſion what the change of velocity will be.

All this, however, is fully confirmed by experiment on ſounds. The ſound of a cannon at 10 or 20 miles diſtance does not in the leaſt reſemble its ſound when near. In this caſe it is a loud inſtantaneous crack, to which we can aſſign no muſical pitch: at a diſtance, it is a grave ſound, of which we can tell the note; and it begins ſoftly, ſwells to its greateſt loudneſs, and then dies away growling. The ſame may be ſaid of a clap of thunder, which we know to be a loud ſnap of ſtill leſs duration. It is highly probable that the appreciable tone which thoſe diſtant ſounds afford are produced by the continuance of theſe ſubordinate vibrations which are added together and fortified in the ſucceſſive pulſes, though not perceptible in the firſt, in a way ſomewhat reſembling the reſonance of a muſical chord. Newton's explanation gathers evidence therefore from this circumſtance. And we muſt further obſerve, that all elaſtic bodies tremble or vibrate almoſt preciſely as a pendulum ſwinging in a cycloid, unleſs their vibrations are uncommonly violent; in which caſe they are quickly reduced to a moderate quantity by the reſiſtance of the air. The only very loud ſounds which we can produce in this way are from great bells; and in theſe the utmoſt extent of the vibration is very ſmall in compariſon with the breadth of the pulſe. The velocity of theſe ſounds has not been compared with that of cannon, or perhaps it would be found leſs, and an objection againſt Newton's determination removed. He gives 969 feet per ſecond, Experiment 1142.

But it is alſo very probable, that in the propagation through the air, the agitation gradually and rapidly approaches to this regular cycloidal form in the ſucceſſive pulſes, in the ſame way as we obſerve that whatever is the form of agitation in the middle of a ſmooth pond of water, the ſpreading circles are always of one gentle form without aſperities. In like manner, into whatever form we throw a ſtretched cord by the twang which we give it, it almoſt immediately makes ſmooth undulations, keeping itſelf in the ſhape of an elongated trochoid. Of this laſt we can demonſtrate the neceſſity, becauſe the caſe is ſimple. In the wave, the inveſtigation is next to impoſſible; but we ſee the fact. We may therefore preſume it in air. And accordingly we know that any noiſe, however abrupt and jarring near at hand, is ſmooth at a diſtance. Nothing is more rough and harſh than the ſcream of a heron; but at half a mile's diſtance it is ſoft. The ruffle of a drum is alſo ſmooth at a diſtance.

Fig. 72. ſhows the ſucceſſive ſituations of the particles of a row. Each line of the figure ſhows the ſame particles marked with the ſame letters; the firſt particle *a* being ſuppoſed to be removed ſucceſſively from its quieſcent ſituation and back to it again. The mark × is put on that part of each line where the agitated particles are at their natural diſtances, and the air is of the natural denſity. The mark 1 is put where the air is moſt of all compreſſed, and where it is moſt of all dilated; the curve line drawn through the loweſt line of the figure is intended to repreſent the denſity in every point, by drawing ordinates to it from the ſtraight line: the ordinates below the line indicate a rarity, and thoſe above the line a denſity, greater than common.

It appears that when *a* has come back to its natural ſituation, the part of greateſt denſity is between the particles *i* and *k*, and the greateſt rarity between *c* and *d*.

We have only to add, that the velocity of this propagation depends on the elaſticity and denſity of the fluid. If theſe vary in the ſame proportion, that is, if the fluid have its elaſticity proportional to its denſity, the velocity will remain the ſame. If the elaſticity or denſity alone be changed, the velocity of the undulations will change in the direct ſubduplicate ratio of the elaſticity and the inverſe ſubduplicate ratio of the denſity; for ſhould the elaſticity be quadrupled, the quantity of motion produced by it in any given time will be quadrupled. This will be the caſe if the velocity be doubled; for there would then be double the number of particles doubly agitated. Should the denſity be quadrupled, the elaſticity remaining the ſame, the quantity of motion muſt remain the ſame. This will be the caſe if the velocity be reduced to one half; for this will propagate half the agitation to half the diſtance, which will communicate it to twice the number of particles, and the quantity of motion will remain the ſame. The ſame may be ſaid of other proportions, and therefore $V = \frac{\sqrt{E}}{\sqrt{D}}$. Therefore a change in the barometer will not affect the velocity of the undulations in air, but they will be accelerated by heat, which diminiſhes its denſity, or increaſes its elaſticity. The velocity of the pulſes in inflammable air muſt be at leaſt thrice as great, becauſe its denſity is but one-tenth of that of air when the elaſticity of both is the ſame.

Let us now attend a little to the propagation of aerial pulſes as they really happen; for this hypotheſis of a ſingle row of particles is nowhere to be obſerved.

Suppoſe a ſphere A, fig. 73. filled with condenſed air, and that the veſſel which contains it is ſuddenly annihilated. The air muſt expand to its natural dimenſions, ſuppoſe BCD. But it cannot do this without preſſing aſide the ſurrounding air. We have ſeen that in any ſingle row of particles this cannot be at once diffuſed to a diſtance, but muſt produce a condenſation in the air adjoining; which will be gradually propagated to a diſtance. Therefore this ſphere BCD of the common denſity will form round it a ſhell, bounded by EFG, of condenſed air. Suppoſe that at this inſtant the inner air BCD becomes ſolid. The ſhell of condenſed air can expand only outwards. Let it expand till it be of the common denſity, occupying the ſhell HIK. This expanſion, in like manner, muſt produce a ſhell of condenſed air without it: at this inſtant let HIK become ſolid. The ſurrounding ſhell of condenſed air can expand only outward, condenſing another ſhell without it. It is plain that this muſt go on continually, and the central agitation will be gradually propagated to a diſtance in all directions. But, in this proceſs, it is not that the ſame numerical particles go to a diſtance. Thoſe of the original ſphere go no further than BCD, thoſe of the next ſhell go no further than HIK, &c. Further, the expanſion outwards of any particle will be more moderate as the diffuſion advances; for the whole motion of each ſhell cannot exceed the original quantity of motion; and the number of particles in each ſucceſſive ſhell increaſes as the ſurface, that is, as the ſquare of the diſtance from the centre: therefore the agitation of the particles will decreaſe in the ſame ratio, or will be in the inverſe duplicate ratio of the diſtance from the centre. Each ſucceſſive ſhell, therefore, contains the ſame quantity of motion, and the ſucceſſive agitations of the particles of any row out from the centre will not be equal to the original agitation, as happens in the ſolitary row. But this does not affect the velocity of the propagation, becauſe all agitations are propagated equally faſt.

We ſuppoſed the air A to become ſolid as ſoon as it acquired the common denſity; but this was to facilitate the conception of the diffuſion. It does not ſtop at this bulk; for while it was denſer it had a tendency to expand. Therefore each particle has attained this diſtance with an accelerated motion. It will, therefore, continue this motion like a pendulum that has paſſed the perpendicular, till it be brought to reſt by the air without it; and it is now rarer than common air, and collapſes again by the greater elaſticity of the air without it. This outward air, therefore, in regaining its natural denſity, muſt expand both ways. It expands towards the centre, following the collapſing of the air within it; and it expands outwards, condenſing the air beyond it. By expanding inwards, it will again condenſe the air within it, and this will again expand; a ſimilar motion happens in all the outward ſhells; and thus there is propagated a ſucceſſion of condenſed and rarefied ſhells of air, which gradually ſwell to the greateſt diſtance.

It may be demonſtrated, that, when the central air has for the ſecond time acquired the natural denſity, it will be at reſt, and be diſturbed no more; and that this will happen to all the ſhells in ſucceſſion. But the demonſtration is much too intricate for this place; we muſt be contented with pointing out a fact perfectly analogous. When we drop a ſmall pebble into water, we ſee it produce a ſeries of circular waves, which go along the ſurface of ſmooth water to a great diſtance, becoming more and more gentle as they recede from the centre; and the middle, where the agitation was firſt produced, remains perfectly ſmooth, and this ſmoothneſs extends continually; that is, each wave when brought to a level remains at reſt. Now theſe waves are produced and propagated by the depreſſion and elevation made at the centre. The elevation tends to diffuſe itſelf; and the force with which each particle of water is actuated is a force acting directly up and down, and is proportional to the elevation or depreſſion of the particle. This hydroſtatical preſſure operates preciſely in the ſame way as the condenſation and rarefaction of the air; and the mathematical inveſtigation of the propagation of the circular undulations on ſmooth water is ſimilar in every ſtep to that of the propagation of the ſpherical waves in ſtill air. For this we appeal to Newton's *Principia*, or to Euler's *Opuſcula*, where he gives a very beautiful inveſtigation of the velocity of the aerial pulſes; and to ſome memoirs of de la Grange in the collections of the academies of Berlin and Turin. Theſe two laſt authors have made the inveſtigation as ſimple as ſeems poſſible, and have freed it from every objection which can be ſtated againſt the geometrical one of their great teacher Newton.

Having ſaid thus much on the ſimilarity between the waves on water and the aerial undulations, we ſhall have recourſe to them, as affording us a very ſenſible object to repreſent many affections of the other which it would be extremely difficult to explain. We neither ſee nor feel the aerial undulations; and they behoved, therefore, to be deſcribed very abſtractedly and imperfectly. In the watery wave there is no permanent progreſſive motion of the water from the centre. Throw a ſmall bit of cork on the ſurface, and it will be obſerved to popple up and down without the leaſt motion outwards. In like manner, the particles of air are only agitated a very little outwards and inwards; which motion is communicated to the particles beyond them, while they themſelves come to reſt, unleſs agitated afreſh; and this agitation of the particles is inconceivably ſmall. Even the exploſion of a cannon at no great diſtance will but gently agitate a feather, giving it a ſingle impulſe outwards, and immediately after another inwards or towards the cannon. When a harpſichord wire is forcibly twanged at a few feet diſtance, the agitation of the air is next to inſenſible. It is not, however, nothing; and it differs from that in a watery wave by being *really* outwards and inwards. In conſequence of this, when the condenſed ſhell reaches an elaſtic body, it impels it ſlightly. If its elaſticity be ſuch as to make it acquire the oppoſite ſhape at the inſtant that the next agitation and condenſed ſhell of air touches it, its agitation will be doubled, and a third agitation will increaſe it, and ſo on, till it acquire the agitation competent to that of the ſhell of air which reaches it, and it is thrown into *ſenſible* vibration, and gives a ſound extremely faint indeed, becauſe the agitation which it acquires is that correſponding to a ſhell of air conſiderably removed from the original ſtring. Hence it happens that a muſical chord, pipe, or bell, will cauſe another to reſound, whoſe vibrations are iſochronous with its own; or if the vibrations of the one coincide with every ſecond, or third, or fourth, &c. of the other; juſt as we can put a very heavy pendulum into ſenſible motion by giving it a gentle puff with the breath at every vibration, or at every ſecond, third, or fourth, &c. A drum ſtruck in the neighbourhood of another drum will agitate it *very ſenſibly*; for here the ſtroke depreſſes a very conſiderable ſurface, and produces an agitation of a conſiderable maſs of air: it will even agitate the ſurface of ſtagnant water. The exploſion of a cannon will even break a neighbouring window. The ſhell of condenſed air which comes againſt the glaſs has a great ſurface and a great agitation: the beſt ſecurity in this caſe is to throw up the ſaſh; this admits the condenſed air into the room, which acts on the inſide of the window, balancing part of the external impulſe.

It is demonſtrated in every elementary treatiſe of natural philoſophy, that when a wave on water meets any plane obſtacle, it is reflected by it from a centre equally removed behind the obſtacle: that waves radiating from the focus of a parabola are reflected in waves perpendicular to its axis; that waves radiating from one focus of an ellipſe are made to converge to the other focus, &c. &c. All this may be affirmed of the aerial undulations; that when part of a wave gets through a hole in the obſtacle, it becomes the centre of a new ſeries of waves; that waves bend round the extremities of an obſtacle; all this happens in the aerial undulations. And laſtly, that when the ſurface of water is thrown into regular undulations by one agitation, another agitation in another place will produce other regular waves, which will croſs the former without diſturbing them in the ſmalleſt degree. The ſame thing happens in air; and experiments may be made on water which will illuſtrate in the moſt perfect manner many other affections of the aerial pulſes, which we ſhould otherwiſe conceive very imperfectly. We would recommend to our curious readers to make ſome of theſe experiments in a large veſſel of milk. Take a long and narrow plate of lead, which, when ſet on the bottom of the veſſel, will reach above the ſurface of the milk; bend this plate into a parabola, elliptical or other curve. Make the undulations by dropping milk on the focus from a ſmall pipe, which will cauſe the agitations to ſucceed with rapidity, and then all that we have ſaid will be moſt diſtinctly ſeen, and the experiment be very amuſing and inſtructive, eſpecially to the muſical reader.

We would now requeſt all who make or read explanations of natural phenomena by means of vibrations of æthers, animal ſpirits, nervous fluids, &c. to fix their attention on the nature of the agitation in one of theſe undulations. Let him conſider whether this can produce the phenomenon, acting as any matter muſt act, by impulſe or by preſſure. If he ſee that it can produce the phenomenon, he will be able to point out the very motion it will produce, both in quantity and direction, in the ſame manner as Sir Iſaac Newton has pointed out all the irregularities of the moon's motion produced by the diſturbing force of the ſun. If he cannot do this, he fails in giving the firſt evidence of a mechanical explanation by the action of an elaſtic vibrating fluid. Let him then try to point out ſome palpable connection between the general phenomenon of elaſtic undulations and the phenomenon in queſtion; this would ſhow an accompaniment to have at leaſt ſome probability. It is thus only we learn that the undulations of air produce ſound: we cannot tell how they affect the mechaniſm of the ear; but we ſee that the phenomena of ſound always accompany them, and that certain modifications of the one are regularly accompanied by certain modifications of the other. If we cannot do this neither, we have derived neither explanation nor illuſtration from the elaſtic fluid. And laſtly, let him remember that even if he ſhould be able to ſhow the competency of this fluid to the production of the phenomenon, the whole is ſtill a hypotheſis, becauſe we do not know that ſuch a fluid exiſts.

We will venture to ſay that whoever will proceed in this prudent manner will ſoon ſee the futility of moſt of the explanations of this kind which have been given. They are unfit for any but conſummate mathematicians; for they alone really underſtand the mechaniſm of aerial undulations, and even they ſpeak of them with heſitation as a thing but imperfectly underſtood. But even the unlearned in this ſcience can ſee the incompatibility of the hypotheſis with many things which they are brought to explain. To take an inſtance of the conveyance of ſenſation along the nerves; an elaſtic fluid is ſuppoſed to occupy them, and the undulations of this fluid are thought to be propagated along the nerves. Let us juſt think a little how the undulations would be conveyed along the ſurface of a canal which was completely filled up with reeds and bulruſhes, or let us make the experiment on ſuch a canal: we may reſt aſſured that the undulations in the one caſe will reſemble thoſe in the other; and we may ſee that in the canal there will be no regular or ſenſible propagation of the waves.

Let theſe obſervations have their influence, along with others which we have made on other occaſions, to wean our readers from this faſhionable proneneſs to introduce inviſible fluids and unknown vibrations into our phyſical diſcuſſions. They have done immenſe, and we fear irreparable, miſchief in ſcience; and there is but one phenomenon that has ever received any explanation by their means.

This may ſuffice for a looſe and popular account of aerial undulations; and with it we conclude our account of the motion, impulſe, and reſiſtance of air.

We ſhall now explain a number of natural appearances, depending on its preſſure and elaſticity; appearances not ſufficiently general, or too complicated, for the purpoſes of argument, while we were employed in the inveſtigation of theſe properties, but too important to be paſſed over in ſilence.

It is owing to the preſſure of the atmoſphere that two ſurfaces which accurately fit each other cohere with ſuch force. This is a fact familiary known to the glaſs-grinders, poliſhers of marble, &c. A large lens or ſpeculum, ground on its tool till it becomes very ſmooth, requires more than any man's ſtrength to ſeparate it directly from the tool. If the ſurface be only a ſquare inch, it will require 15 pounds to ſeparate them perpendicularly, though a very moderate force will make them ſlide along each other. But this coheſion is not obſerved unleſs the ſurfaces be wetted or ſmeared with oil or greaſe; otherwiſe the air gets between them, and they ſeparate without any trouble. That this coheſion is owing to the atmoſpheric preſſure, is evident from the caſe with which the plates may be ſeparated in an exhauſted receiver.

To the ſame cauſe we muſt aſcribe the very ſtrong adheſion of ſnails, periwinkles, limpets, and other univalve ſhells, to the rocks. The animal forms the rim of its ſhell, ſo as to fit the ſhape of the rock to which it intends to cling. It then fills its ſhell (if not already filled by its own body) with water. In this condition it is evident that we muſt act with a force equal to 15 pounds for every ſquare inch of touching ſurface before we can detach it. This may be illuſtrated thus: fill a drinking glaſs to the brim with water; and, having covered it with a piece of thin wet leather, whelm it on a table, and then try to pull it ſtraight up; it will require a conſiderable force. But if we expoſe a ſnail adhering to a ſtone in the exhauſted receiver, we ſhall ſee it drop off by its own weight. In the ſame manner do the remora, the polypus, the lamprey, and many other animals, adhere with ſuch firmneſs. Boys frequently amuſe themſelves by pulling out large ſtones from the pavement by means of a circle of ſtiff wetted leather faſtened to a ſtring. It is owing to the ſame cauſe that the bivalve ſhell-fiſhes keep themſelves ſo firmly ſhut. We think the muſcular force of an oyſter prodigious, becauſe it requires ſuch force to open it; but if we grind off a bit of the convex ſhell, ſo as to make a hole in it, though without hurting the fiſh in the ſmalleſt degree, it opens with great eaſe, as it does alſo *in vacuo*.

The preſſure of the air operating in this way contributes much to the coheſion of bodies, where we do not ſuſpect its influence. The tenacity of our mortars and cements would frequently be ineffectual without this aſſiſtance.

It is owing to the preſſure of the atmoſphere that a caſk will not run by the cock unleſs a hole be opened in ſome other part of the caſk. If the caſk be not quite full, ſome liquor indeed will run out, but it will ſtop as ſoon as the diminiſhed elaſticity of the air above the liquor is in equilibrio (together with the liquor) with the atmoſpheric preſſure. In like manner, a tea-pot muſt have a ſmall hole in its lid to enſure its pouring out the tea. If indeed the hole in the caſk be of large dimenſions, it will run without any other hole, becauſe air will get in at the upper ſide of the hole while the liquor runs out by the lower part of it.

On the ſame principle depends the performance of an inſtrument uſed by the ſpirit dealers for taking out a ſample of their ſpirits. It conſiſts of a long tin plate tube AB (pl. 11. fig. 57.), open at top at A, and ending in a ſmall hole at B. The end B is dipped into the ſpirit, which riſes into the tube; then the thumb is clapt on the mouth A, and the whole is lifted out of the caſk. The ſpirit remains in it till the thumb be taken off; it is then allowed to run into a glaſs for examination.

It ſeems principally owing to the preſſure of the air that froſts immediately occaſion a ſcantineſs of water in our fountains and wells. This is erroneouſly accounted for, by ſuppoſing that the water freezes in the bowels of the earth. But this is a great miſtake: the moſt intenſe froſt of a Siberian winter would not freeze the ground two feet deep; but a very moderate froſt will conſolidate the whole ſurface of a country, and make it impervious to the air; eſpecially if the froſt has been preceded by rain, which has ſoaked the ſurface. When this happens, the water which was filtering through the ground is all arreſted and kept ſuſpended in its capillary tubes by the preſſure of the air, in the very ſame manner as the ſpirits are kept ſuſpended in the inſtrument juſt now deſcribed by the thumb's ſhutting the hole A. A thaw melts the ſuperficial ice, and allows the water to run in the ſame manner as the ſpirits run when the thumb is removed.

Common air is neceſſary for ſupporting the lives of moſt animals. If a ſmall animal, ſuch as a mouſe or bird, be put under the receiver of an air-pump, and the air be exhauſted, the animal will quickly be thrown into convulſions and fall down dead; if the air be immediately readmitted, the animal will ſometimes revive, eſpecially if the rarefaction has been briſkly made, and has not been very great. We do not know that any breathing animal can bear the air to be reduced to one-fourth of its ordinary denſity, nor even one-third; nor have we good evidence that an animal will ever recover if the rarefaction be puſhed very far, although continued for a very ſhort time.

But the mere preſence of the air is by no means ſufficient for preſerving the life of the animal; for it is found, that an animal ſhut up in a veſſel of air cannot live in it for any length of time. If a man be ſhut up in a box, containing a wine hogſhead of air, he cannot live in it much above an hour, and long before this he will find his breathing very unſatisfactory and uneaſy. A gallon of air will ſupport him about a minute. A box EF (fig. 58.) may be made, having a pipe AB inſerted into its top, and fitted with a very light valve at B, opening upwards. This pipe ſends off a lateral branch *d*D*d*C, which enters the box at the bottom, and is alſo fitted with a light valve at C opening upwards. If a perſon breathe through the pipe, keeping his noſtrils ſhut, it is evident that the air which he expires will not enter the box by the hole B, nor return through the pipe CD *d*; and by this contrivance he will gradually employ the whole air of the box. With this apparatus experiments can be made without any riſk or inconveniency, and the quantity of air neceſſary for a given time of eaſy breathing may be accurately aſcertained.

How the air of our atmoſphere produces this effect, is a queſtion which does not belong to mechanical philoſophy to inveſtigate or determine. We can, however, affirm, that it is neither the preſſure nor the elaſticity of the air which is immediately concerned in maintaining the animal functions. We know that we can live and breathe with perfect freedom on the tops of the higheſt mountains. The valley of Quito in Peru, and the country round Gondar in Abyſſinia, are ſo far elevated above the ſurface of the ocean, that the preſſure and the elaſticity of the air are one-third leſs than in the low countries; yet theſe are populous and healthy places. And, on the other hand, we know, that when an animal has breathed in any quantity of air for a certain time without renewal, it will not only be ſuffocated, but another animal put into this air will die immediately; and we do not find either the preſſure or elaſticity of the air remarkably diminiſhed: it is indeed diminiſhed, but by a very ſmall quantity. Reſtoring the former preſſure and elaſticity has not the ſmalleſt tendency to prevent the death of the animal: for an animal will live no longer under a receiver that has its mouth inverted on water, than in one ſet upon the pump-plate covered with leather. Now when the receiver is ſet on water, the preſſure of the atmoſphere acts completely on the included air, and preſerves it in the ſame ſtate of elaſticity.

In ſhort, it is known that the air which has already ſerved to maintain the animal functions has its chemical and alimentary properties completely changed, and is no longer fit for this purpoſe. So much of any maſs of air as has really been thus employed is changed into what is called *fixed air* by Dr. Black, or *carbonic acid* by the chemiſts of the Lavoiſierian ſchool. Any perſon may be convinced of this by breathing or blowing through a pipe immerſed in lime water. Every expiration will produce white clouds on the water, till all the lime which it contains be precipitated in the form of pure chalk. In this caſe we know that the lime has combined with the fixed air.

The celebrated Dr. Stephen Hales made many experiments, with a view to clear the air from the noxious vapour which he ſuppoſed to be emitted from the lungs.

He made uſe of the apparatus which we have been juſt now mentioning; and he put ſeveral diaphragms *ff*, *ff*, &c. of thin woollen ſtuff into the box, and moiſtened them with various liquids. He found nothing ſo efficacious as a ſolution of potaſh. We now underſtand this perfectly. If the ſolution be not already ſaturated with fixed air, it will take it up as faſt as it is produced, and thus will purify the air: a ſolution of cauſtic alkali therefore will have this effect till it be rendered quite mild.

Theſe experiments have been repeated, and varied in many circumſtances, in order to aſcertain whether this fixed air was really emitted by the lungs, or whether the inſpired air was in part changed into fixed air by its combination with ſome other ſubſtance. This is a queſtion which comes properly in our way, and which the doctrines of pneumatics enable us to anſwer. If the fixed air be emitted in ſubſtance from the lungs, it does not appear how a renewal of the air into which it is emitted is neceſſary: for this does not hinder the ſubſequent emiſſion; and the bulk of the air would be increaſed by breathing in it, viz. by the bulk of all the fixed air emitted; but, on the contrary, it is a little diminiſhed. We muſt therefore adopt the other opinion; and the diſcoveries in modern chemiſtry enable us to give a pretty accurate account of the whole proceſs. Fixed air is acknowledged to be a compound, of which one ingredient is found to conſtitute about $\frac{3}{8}$ of the whole atmoſpheric fluid: we mean vital air or the oxygen of Lavoiſier. When this is combined with phlogiſton, according to the doctrine of Stahl, or with charcoal, according to Lavoiſier, the reſult is fixed air or carbonic acid. The change therefore which breathing makes on the air is the ſolution of this matter by vital air; and the uſe of air in breathing is the carrying off this noxious principle in the way of ſolution. When therefore the air is already ſo far ſaturated as not to diſſolve this ſubſtance as faſt as it is ſecreted, or muſt be ſecreted in the lungs, the animal ſuffers the pain of ſuffocation, or is otherwiſe mortally affected. Suffocation is not the only conſequence; for we can remain for a number of ſeconds without breathing, and then we begin to feel the true pain of ſuffocation: but thoſe who have been inſtantaneouſly ſtruck down by an inſpiration of fixed air, and afterwards recovered to life, complained of no ſuch pain, and ſeemed to have ſuffered chiefly by a nervous affection. It is ſaid (but we will not vouch for the truth of it), that a perſon may ſafely take a full inſpiration of fixed air, if the paſſages of the noſe be ſhut; and that unleſs theſe nerves be ſtimulated by the fixed air, it is not inſtantaneouſly mortal. But theſe are queſtions out of our preſent line of inquiry. They are queſtions of phyſiology, and are treated of in other places of this work. See ANATOMY and PHYSIOLOGY; ſee alſo LUNGS and RESPIRATION. Our buſineſs is to explain in what manner the preſſure and elaſticity of the air, combined with the ſtructure and mechaniſm of the body, operate in producing this neceſſary ſecretion and removal of the matter diſcharged from the lungs in the act of breathing.

It is well aſcertained, that the ſecretion is made from the maſs of blood during its paſſage through the lungs. The blood delivered into the lungs is of a dark blackiſh colour, and it is there changed into a florid red. In the lungs it is expoſed to the action of the air in a prodigiouſly extended ſurface: for the lungs conſiſt of an inconceivable number of ſmall veſſels or bladders, communicating with each other and with the windpipe. Theſe are filled with air in every inſpiration. Theſe veſſels are everywhere in contact with minute blood-veſſels. The blood does not *in toto* come into immediate contact with the air; and it would ſeem that it is only the thin ſerous part of it which is acted on by the air at the mouths of the veſſels or pores, where it ſtands by capillary attraction. Dr. Prieſtley found, that venous blood incloſed in thin bladders and other membranes was rendered florid by keeping the bladders in contact with abundance of pure vital air. We know alſo, that breath is moiſt or damp, and *muſt* have acquired this moiſture in the lungs. It is immaterial whether this ſecretion of water or lymph (as the anatomiſts call it) be furniſhed by mere exudation through ſimple pores, or by a vaſcular and organic ſecretion; in either caſe, ſome ingredient of the blood comes in contact with air in the lungs, and there unites with it. This is further confirmed, by obſerving that all breathing animals are warmer than the ſurrounding medium, and that by every proceſs in which fixed air is formed from vital air heat is produced. Hence this ſolution in air of ſomething from the blood has been aſſigned by many as the ſource of animal heat. We touch on theſe things in a very tranſitory way in this place, only in order to prove that, for the ſupport of animal life, there muſt be a very extenſive application of air to the blood, and that this is made in the lungs.

The queſtion before us in this place is, How is this brought about by the weight and elaſticity of the air? This is done in two ways; by the action of the muſcles of the ribs, and by the action of the diaphragm and other muſcles of the abdomen. The thorax or cheſt is a great cavity completely filled by the lungs. The ſides of this cavity are formed by the ribs. Theſe are crooked or arched, and each is moveable round its two ends, one of them being inſerted into the vertebræ of the back, and the other into the ſternum or breaſt-bone. The rib turns in a manner reſembling the handle of a drawer. The inſpection of fig. 59. pl. 11. will illuſtrate this matter a little. Suppoſe the curves *a c c*, *b k f*, *c l g*, &c. to repreſent the ribs moveable round the extremities. Each ſucceeding rib is more bent than the one above it, and this curvature is both in the vertical and horizontal direction. Suppoſe each ſo broad as to project a little over its inferior like the tiles of a roof. It is evident, that if we take the lower one by its middle, and draw it out a little, moving it round the line *n p*, it will bring out the next *d m b* along with it. Alſo, becauſe the diſtance of the middle point *o* from the axis of motion *n p* is greater than the diſtance of *m* from the axis *d b*, and becauſe *o* will therefore deſcribe a portion of a larger circle than *m* does, the rib *n o p* will ſlide up a little under the rib *d m b*, or the rib *d m b* will overlap *n o p* a little more than before; the diſtance *o m* will therefore be diminiſhed. The ſame muſt happen to all the ſuperior ribs;

but the change of diſtance will be leſs and leſs as we go upwards. Now, inſtead of this great breadth of the ribs overlapping each other, ſuppoſe each inferior rib connected with the one above it by threads or fibres ſuſceptible of contraction at the will of man. The articulations *e*, *a*, of the firſt or upper rib with the ſpine and ſternum are ſo broad and firm, that this rib can have little or no motion round the line *a e*; this rib therefore is as a fixture for the ends of all the contracting fibres: therefore, whenever the fibres which connect the ſecond rib with the firſt rib contract, the ſecond muſt riſe a little, and alſo go outward, and will carry the lower ribs along with it; the third rib will riſe ſtill further by the contraction of the muſcles which connect it with the ſecond, and ſo on: and thus the whole ribs are raiſed and thrown outward (and a little forward, becauſe the articulation of each with the ſpine is conſiderably higher than that with the ſternum), and the capacity of the thorax is enlarged by the contraction of its muſcular covering. The direction of the muſcular fibres is very oblique to the direction of the circular motion which it produces; from which circumſtance it follows, that a very minute contraction of the muſcles produces all the motion which is neceſſary. This indeed is not great; the whole motion of the loweſt ribs is leſs than an inch in the moſt violent inſpiration, and the whole contraction of the muſcles of the 12 ribs does not exceed the eighth part of an inch, even ſuppoſing the intercoſtal muſcles at right angles to the ribs; and being oblique, the contraction is ſtill leſs. It would ſeem, that the intenſity of the contractive power of a muſcular fibre is eaſily obtained, but that the ſpace through which it can be exerted is very limited; for in moſt caſes nature places the muſcles in ſituations of great mechanical diſadvantage in this reſpect, in order to procure other conveniences.

But this is not the whole effect of the contraction of the intercoſtal muſcles: ſince the compound action of the two ſets of muſcles, which croſs each other from rib to rib like the letter X, is nearly at right angles to the rib, but is oblique to its plane, it tends to puſh the ribs cloſer on their articulations, and thus to preſs out the two pillars on which they are articulated. Thus, ſuppoſing *a f* (fig. 60.) to repreſent the ſection of one of the vertebræ of the ſpine, and *c d* a ſection of the ſternum, and *a b c*, *f e d*, two oppoſite ribs, with a lax thread *c e* connecting them. If this thread be pulled upwards by the middle *g* till it be tight, it will tend to pull the points *b* and *e* nearer to each other, and to preſs the vertebra *a f* and the ſternum *c d* outwards. The ſpine being the chief pillar of the body, may be conſidered as immoveable in the preſent inſtance. The ſternum is ſufficiently ſuſceptible of motion for the preſent purpoſe. It remains almoſt fixed at top at its articulation with the firſt rib, but it gradually yields below; and thus the capacity of the thorax is enlarged in this direction alſo. The whole enlargement of the diameters of the thorax during inſpiration is very ſmall, not exceeding the fiftieth part of an inch in ordinary caſes. This is eaſily calculated. Its quieſcent capacity is about two cubic feet, and we never draw in more than 15 inches. Two ſpheres, one of which holds 2 cubic feet and the other 2 feet and 15 inches, will not differ in diameter above the fiftieth part of an inch.

The other method of enlarging the capacity of the thorax is very different. It is ſeparated from the abdomen by a ſtrong muſcular partition called the *diaphragm*, which is attached to firm parts all around. In its quieſcent or relaxed ſtate it is conſiderably convex upwards, that is, towards the thorax, riſing up into its cavity like the bottom of an ordinary quart bottle, only not ſo regular in its ſhape. Many of its fibres tend from its middle to the circumference, where they are inſerted into firm parts of the body. Now ſuppoſe theſe fibres to contract. This muſt draw down its middle, or make it flatter than before, and thus enlarge the capacity of the thorax.

Phyſiologiſts are not well agreed as to the ſhare which each of theſe actions has in the operation of enlarging the thorax. Many refuſe all ſhare of it to the intercoſtal muſcles, and ſay that it is performed by the diaphragm alone. But the fact is, that the ribs are really obſerved to riſe even while the perſon is aſleep; and this cannot poſſibly be produced by the diaphragm, as theſe anatomiſts aſſert. Such an opinion ſhows either ignorance or neglect of the laws of pneumatics. If the capacity of the thorax were enlarged only by drawing down the diaphragm, the preſſure of the air would compreſs the ribs, and make them deſcend. And the ſimple laws of mechanics make it as evident as any propoſition in geometry, that the contraction of the intercoſtal muſcles *muſt* produce an elevation of the ribs and enlargement of the thorax; and it is one of the moſt beautiful contrivances of nature. It depends much on the will of the animal what ſhare each of theſe actions ſhall have. In general, the greateſt part is done by the diaphragm; and any perſon can breathe in ſuch a manner that his ribs ſhall remain motionleſs; and, on the contrary, he can breathe almoſt entirely by raiſing his cheſt. In the firſt method of breathing the belly riſes during inſpiration, becauſe the contraction of the diaphragm compreſſes the upper part of the bowels, and therefore ſqueezes them outwards; ſo that an ignorant perſon would be apt to think that the breathing was performed by the belly, and that the belly is inflated with the air. The ſtrait lacing of the women impedes the motion of the ribs, and changes the natural habit of breathing, or brings on an unnatural habit. When the mind is depreſſed, it is obſerved that the breathing is more performed by the muſcles of the thorax; and a deep ſigh is always made in this way.

Theſe obſervations on the manner in which the capacity of the cheſt can be enlarged, were neceſſary, before we can acquire a juſt notion of the way in which the mechanical properties of air operate in applying it to the maſs of blood during its paſſage through the lungs. Suppoſe the thorax quite empty, and communicating with the external air by means of the trachea or wind-pipe, it would then reſemble a pair of bellows. Raiſing the boards correſponds to the raiſing of the ribs; and we might imitate the action of the diaphragm by forcibly pulling outwards the folded leather which unites them. Thus their capacity is enlarged, and the air ruſhes in at the nozzle by its weight in the ſame manner as water would do. The thorax differs from bellows only in this reſpect, that it is filled by the lungs, which is a vaſt collection of little bladders, like the holes in a piece of fermented bread, all communicating with the trachea, and many of them with each other. When the cheſt is enlarged, the air ruſhes into them all in the ſame manner as into the ſingle cavity of an empty thorax. It cannot be ſaid with propriety that they are inflated: all that is done is the *allowing* the air to come in. At the ſame time, as their membraneous covering muſt have ſome thickneſs, however ſmall, and ſome elaſticity, it is not unlikely that, when compreſſed by expiration, they tend a little to recover their former ſhape, and thus aid the voluntary action of the muſcles. It is in this manner that a ſmall bladder of caoutchouc ſwells again after compreſſion, and fills itſelf with air or water. But this cannot happen except in the moſt minute veſicles: thoſe of ſenſible bulk have not elaſticity enough for this purpoſe. The lungs of birds, however, have ſome very large bladders, which have a very conſiderable elaſticity, and recover their ſhape and ſize with great force after compreſſion, and thus fill themſelves with air. The reſpiration of theſe animals is conſiderably different from that of land animals, and their muſcles act chiefly in expiration. This will be explained by and by as a curious variety in the pneumatic inſtrument.

This account of the manner in which the lungs are filled with air does not ſeem agreeable to the notions we entertain of it.

We ſeem to ſuck in the air; but although it be true that we act, and exert force, in order to get air into our lungs, it is not by our action, but by external preſſure, that it does come in. If we apply our mouth to the top of a bottle filled with water, we find that no draught, as we call it, of our cheſt will ſuck in any of the water; but if we ſuck in the very ſame manner at the end of a pipe immerſed in water, it follows immediately. Our intereſt in the thing makes us connect in imagination our own action with the effect, without thinking on the many ſteps which may intervene in the train of natural operations; and we conſider the action as the immediate cauſe of the air's reception into the lungs. It is as if we opened the door, and took in by the hand a perſon who was really puſhed in by the crowd without. If an inciſion be made into the ſide of the thorax, ſo that the air can get in by that way, when the animal acts in the uſual manner, the air will really come in by this hole, and fill the ſpace between the lungs and thorax; but no air is ſucked into the lungs by this proceſs, and the animal is as completely ſuffocated, as if the wind-pipe were ſhut up. And, on the other hand, if a hole be made into the lungs without communicating with the thorax, the animal will breathe through this hole, though the windpipe be ſtopped. This is ſucceſsfully performed in caſes of patients whoſe trachea is ſhut up by accident or by inflammation; only it is neceſſary that this perforation be made into a part of the lungs where it may meet with ſome of the great pulmonary paſſages; for if made into ſome remote part of a lobe, the air cannot find its way into the reſt of the lungs through ſuch narrow paſſages, obſtructed too by blood, &c.

We have now explained, on pneumatical principles, the proceſs of inſpiration. The expiration is chiefly performed by the natural tone of the parts. In the act of inſpiration the ribs were raiſed and drawn outwards in oppoſition to the elaſticity of the ſolids themſelves; for although the ribs are articulated at their extremities, the articulations are by no means ſuch as to give a free and eaſy motion like the joints of the limbs. This is particularly the caſe in the articulations with the ſternum, which are by no means fitted for motion. It would ſeem that the motion really produced here is chiefly by the yielding of the cartilaginous parts and the bending of the rib; when therefore, the muſcles which produced this effect are allowed to relax, the ribs again collapſe. Perhaps this is aſſiſted a little by the action of the long muſcles which come down acroſs the ribs without being inſerted into them. Theſe may draw them together a little, as we compreſs a looſe bundle by a ſtring.

In like manner, when the diaphragm was drawn down, it compreſſed the abdomen in oppoſition to the elaſticity of all the viſcera contained in it, and to the elaſticity and tone of the teguments and muſcles which ſurround it. When therefore the diaphragm is relaxed, theſe parts puſh it up again into its natural ſituation, and in doing this expel the air from the lungs.

If this be a juſt account of the matter, expiration ſhould be performed without any effort. This accordingly is the caſe. We feel that, after having made an ordinary eaſy inſpiration, it requires the continuance of the effort to keep the thorax in this enlarged ſtate, and that all that is neceſſary for expiration is to ceaſe to act. No perſon feels any difficulty in emptying the lungs; but weak people often feel a difficulty of inſpiration, and compare it to the feeling of a weight on their breaſt; and expiration is the laſt motion of the thorax in a dying perſon.

But nature has alſo given us a mechaniſm by which we can expire, namely, the abdominal muſcles; and when we have finiſhed an ordinary and eaſy expiration, we can ſtill expel a conſiderable bulk of air (nearly half of the contents of the lungs) by contracting the abdominal muſcles. Theſe, by compreſſing the body, force up its moveable contents againſt the diaphragm, and cauſe it to riſe further into the thorax, acting in the ſame manner as when we expel the fæces *per anum*. When a perſon breaths out as much air as he can in this manner, he may obſerve that his ribs do not collapſe during the whole operation.

There ſeems then to be a certain natural unconſtrained ſtate of the veſicles of the lungs, and a certain quantity of air neceſſary for keeping them of this ſize. It is probable that this ſtate of the lungs gives the freeſt motion to the blood. Were they more compreſſed, the blood-veſſels would be compreſſed by the adjoining veſicles; were they more lax, the veſſels would be more crooked, and by this means obſtructed. The frequent inſpirations gradually change this air by mixing freſh air with it, and at every expiration carrying off ſome of it. In catarrhs and inflammations, eſpecially when attended with ſuppuration, the ſmall paſſages into the remote veſſels are obſtructed, and thus the renewal of air in them will be prevented. The painful feeling which this occaſions cauſes us to expel the air with violence, ſhutting the windpipe, till we have exerted ſtrongly with the abdominal muſcles, and made a ſtrong compreſſion on the lower part of the thorax. We then open the paſſage ſuddenly, and expel the air and obſtructing matter by violent coughing.

We have ſaid, that birds exhibit a curious variety in the proceſs of breathing. The muſcles of their wings being ſo very great, required a very extenſive inſertion, and this is one uſe of the great breaſt bone. Another uſe of it is, to form a firm partition to hinder the action of theſe muſcles from compreſſing the thorax in the act of flying: therefore the form of their cheſt does not admit of alternate enlargement and contraction to that degree as in land animals. Moreover, the muſcles of their abdomen are alſo very ſmall; and it would ſeem that they are not ſufficient for producing the compreſſion on the bowels which is neceſſary for carrying on the proceſs of concoction and digeſtion. Inſtead of aiding the lungs they receive help from them.

In an oſtrich, the lungs conſiſt of a fleſhy part A, A (pl. 11. fig. 61.), compoſed of veſicles like thoſe of land-animals, and, like theirs, ſerving to expoſe the blood to the action of the air. Beſides theſe, they have on each ſide four large bags B, C, D, E, each of which has an orifice G communicating with the trachea; but the ſecond, C, has alſo an orifice H, by which it communicates with another bag F ſituated below the reſt in the abdomen. Now, when the lungs are compreſſed by the action of the diaphragm, the air in C is partly expelled by the trachea through the orifice G, and partly driven through the orifice H into the bag F, which is then allowed to receive it; becauſe the ſame action which compreſſes the lungs enlarges the abdomen. When the thorax is enlarged, the bag C is partly ſupplied with freſh air through the trachea, and partly from the bag F. As the lungs of other animals reſemble a common bellows, the lungs of birds reſemble the ſmith's bellows with a partition; and anatomiſts have diſcovered paſſages from this part of the lungs into their hollow bones and quills. We do not know all the uſes of this contrivance; and only can obſerve, that this alternate action muſt aſſiſt the muſcles of the abdomen in promoting the motion of the food along the alimentary canal, &c. We can diſtinctly obſerve in birds that their belly dilates when the cheſt collapſes, and *vice verſa*, contrary to what we ſee in the land animals. Another uſe of this double paſſage may be to produce a circulation of air in the lungs, by which a compenſation is made for the ſmaller ſurface of action on the blood: for the number of ſmall veſicles, of equal capacity with theſe large bags, gives a much more extenſive ſurface.

If we try to raiſe mercury in a pipe by the action of the cheſt alone, we cannot raiſe it above two or three inches; and the attempt is both painful and hazardous. It is painful chiefly in the breaſt, and it provokes coughing. Probably the fluids ooze through the pores of the veſicles by the preſſure of the ſurrounding parts.

On the other hand we can by expiration ſupport mercury about five or ſix inches high: but this alſo is very painful, and apt to produce extravaſation of blood. This ſeems to be done entirely by the abdominal muſcles.

The operation properly termed SUCKING is totally different from breathing, and reſembles exceedingly the action of a common pump. Suppoſe a pipe held in the mouth, and its lower end immerſed in water. We fill the mouth with the tongue, bringing it forward, and applying it cloſely to the teeth and to the palate; we then draw it back, or bend it downwards (behind) from the palate, thus leaving a void. The preſſure of the air on the cheeks immediately depreſſes them, and applies them cloſe to the gums and teeth; and its preſſure on the water in the veſſel cauſes it to riſe through the pipe into the empty part of the mouth, which it quickly fills. We then puſh forward the tip of the tongue, below the water, to the teeth, and apply it to them all round, the water being above the tongue, which is kept much depreſſed. We then apply the tongue to the palate beginning at the tip, and gradually going backward in this application. By this means the water is gradually forced backward by an operation ſimilar to that of the gullet in ſwallowing. This is done by contracting the gullet above and relaxing it below, juſt as we would empty a gut of its contents by drawing our cloſed hand along it. By this operation the mouth is again completely occupied by the tongue, and we are ready for repeating the operation. Thus the mouth and tongue reſemble the barrel and piſton of a pump; and the application of the tip of the tongue to the teeth performs the office of the valve at the bottom of the barrel, preventing the return of the water into the pipe. Although uſual, it is not abſolutely neceſſary, to withdraw the tip of the tongue, making a void before the tongue. Sucking may be performed by merely ſeparating the tongue gradually from the palate, beginning at the root. If we withdraw the tip of the tongue a very minute quantity, the water gets in and flows back above the tongue.

The action of the tongue in this operation is very powerful; ſome perſons can raiſe mercury 25 inches: but this ſtrong exertion is very fatiguing, and the ſoft parts are prodigiouſly ſwelled by it. It cauſes the blood to ooze plentifully through the pores of the tongue, fauces, and palate, in the ſame manner as if a cupping-glaſs and ſyringe were applied to them; and, when the inſide of the mouth is excoriated or tender, as is frequent with infants, even a very moderate exertion of this kind is accompanied with extravaſation of blood. When children ſuck the nurſes breaſt, the milk follows their exertion by the preſſure of the air on the breaſt; and a weak child, or one that withholds its exertions on account of pain from the above-mentioned cauſe, may be aſſiſted by a gentle preſſure of the hand on the breaſt: the infant pupil of nature, without any knowledge of pneumatics, frequently helps itſelf by preſſing its face to the yielding breaſt.

In the whole of this operation the breathing is performed through the noſtrils; and it is a prodigious diſtreſs to an infant when this paſſage is obſtructed by mucus. We beg to be forgiven for obſerving by the way, that this obſtruction may be almoſt certainly removed for a little while, by rubbing the child's noſe with any liquid of quick evaporation, or even with water.

The operation in drinking is not very different from that in ſucking: we have indeed little occaſion here to ſuck, but we muſt do it a little. Dogs and ſome other animals cannot drink, but only lap the water into their mouths with their tongue, and then ſwallow it. The gallinaceous birds ſeem to drink very imperfectly; they ſeem merely to dip their head into the water up to their eyes till their mouth is filled with water, and then holding up the head, it gets into the gullet by its weight, and is then ſwallowed. The elephant drinks in a very complicated manner; he dips his trunk into the water, and fills it by making a void in his mouth: this he does in the contrary way to man. After having depreſſed his tongue, he begins the application of it to the palate at the root, and by extending the application forward, he expels the air by the mouth which came into it from the trunk. The proceſs here is not very unlike that of the condenſing ſyringe without a piſton valve, deſcribed in n° 58, in which the external air (correſponding here to the air in the trunk) enters by the hole F in the ſide, and is expelled through the hole in the end of the barrel; by this operation the trunk is filled with water: then he lifts his trunk out of the water, and bringing it to his mouth, pours the contents into it, and ſwallows it. On conſidering this operation, it appears that, by the ſame proceſs by which the air of the trunk is taken into the mouth, the water could alſo be taken in, to be afterwards ſwallowed: but we do not find, upon inquiry, that this is done by the elephant; we have always obſerved him to drink in the manner now deſcribed. In either way it is a double operation, and cannot be carried on any way but by alternately ſucking and ſwallowing, and while one operation is going on the other is interrupted; whereas man can do both at the ſame time. Nature ſeems to delight in exhibiting to rational obſervers her inexhauſtible variety of reſource; for many inſects, which drink with a trunk, drink without interruption: yet we do not call in queſtion the truth of the aphoriſm, *Natura maxime ſimplex et ſemper ſibi conſona*, nor doubt but that, if the *whole* of her purpoſe were ſeen, we ſhould find that her proceſs is the ſimpleſt poſſible: for Nature, or Nature's God, is wiſe above our wiſeſt thoughts, and ſimplicity is certainly the choice of wiſdom: but alas! it is generally but a ſmall and the moſt obvious part of her purpoſe that we can obſerve or appreciate. We ſeldom ſee this ſimplicity of nature ſtated to us, except by ſome ſyſtem-maker, who has found a principle which ſomehow tallies with a conſiderable variety of phenomena, and then cries out, *Fruſtra fit per plura quod, fieri poteſt per pauciora.*

There is an operation ſimilar to that of the elephant, which many find a great difficulty in acquiring, viz. keeping up a continued blaſt with a blow-pipe. We would deſire our chemical reader to attend minutely to the gradual action of his tongue in ſucking, and he will find it ſuch as we have deſcribed. Let him attend particularly to the way in which the tip of the tongue performs the office of a valve, preventing the return of the water into the pipe: the ſame poſition of the tongue would hinder air from coming into the mouth. Next let him obſerve, that in ſwallowing what water he has now got lodged above his tongue, he continues the tip of the tongue applied to the teeth; now let him ſhut his mouth, keeping his lips firm together, the tip of the tongue at the teeth, and the whole tongue forcibly kept at a diſtance from the palate; bring up the tongue to the palate, and allow the tip to ſeparate a little from the teeth; this will expel the air into the ſpace between the fauces and cheeks, and will blow up the cheeks a little; then acting with the tip of the tongue as a valve, hinder this air from getting back, and depreſſing the tongue again, more air (from the noſtrils) will get into the mouth, which may be expelled into the ſpace without the teeth as before, and the cheeks will be more inflated: continue this operation, and the lips will no longer be able to retain it, and it will ooze through as long as the operation is continued. When this has become familiar and eaſy, take the blow-pipe, and there will be no difficulty in maintaining a blaſt as uniform as a ſmith's bellows, breathing all the while through the noſtrils. The only difficulty is the holding the pipe: this fatigues the lips; but it may be removed by giving the pipe a convenient ſhape, a pretty flat oval, and wrapping it round with leather or thread.

Another phenomenon depending on the principles already eſtabliſhed, is the land and ſea-breeze in the warm countries.

We have ſeen that air expands exceedingly by heat ; therefore heated air, being lighter than an equal bulk of cold air, muſt riſe in it. If we lay a hot ſtone in the ſunſhine in a room, we ſhall obſerve the ſhadow of the ſtone ſurrounded with a fluttering ſhadow of different degrees of brightneſs, and that this flutter riſes rapidly in a column above the ſtone. If we hold an extinguiſhed candle near the ſtone, we ſhall ſee the ſmoke move towards the ſtone, and then aſcend up from it. Now, ſuppoſe an iſland receiving the firſt rays of the ſun in a perfectly calm morning ; the ground will ſoon be warmed, and will warm the contiguous air. If the iſland be mountainous, this effect will be more remarkable ; becauſe the inclined ſides of the hills will receive the light more directly ; the midland air will therefore be moſt warmed : the heated air will riſe, and that in the middle will riſe faſteſt ; and thus a current of air upwards will begin, which muſt be ſupplied by air coming in from all ſides, to be heated and to riſe in its turn ; and thus the morning *ſea-breeze* is produced, and continues all day. This current will frequently be reverſed during the night, by the air cooling and gliding down the ſides of the hills, and we ſhall have the *land breeze*.

It is owing to the ſame cauſe that we have a circulation of air in mines which have the mouths of their ſhafts of unequal heights. The temperature underground is pretty conſtant through the whole year, while that of the atmoſphere is extremely variable. Now, ſuppoſe a mine having a long horizontal drift, communicating between two pits or ſhafts, and that one of theſe ſhafts terminates in a valley, while the other opens on the brow of a hill perhaps 100 feet higher. Let us further ſuppoſe it ſummer, and the air heated to 65°, while the temperature of the earth is but 45° ; this laſt will be alſo the temperature of the air in the ſhafts and the drift. Now, ſince air expands nearly 24 parts in 10000 by one degree of heat, we ſhall have an odds of preſſure at the bottom of the two ſhafts equal to nearly the 20th part of the weight of a column of air 100 feet high (100 feet being ſuppoſed the difference of the heights of the ſhafts). This will be about ſix ounces on every ſquare foot of the ſection of the ſhaft. If this preſſure could be continued, it would produce a prodigious current of air down the long ſhaft, along the drift, and up the ſhort ſhaft. The weight of the air acting through 100 feet would communicate to it the velocity of 80 feet *per* ſecond : divide this by $\sqrt{20}$, that is, by 4, 5, and we ſhall have 18 feet *per* ſecond for the velocity : this is the velocity of what is called a briſk gale. This preſſure *would* be continued, if the warm air which enters the long ſhaft were cooled and condenſed as faſt as it comes in ; but this is not the caſe. *It is however cooled* and condenſed, and a current is produced ſufficient to make an abundant circulation of air along the whole paſſage ; and care is taken to diſpoſe the ſhafts and conduct the paſſages in ſuch a manner that no part of the mine is out of the circle. When any new lateral drift is made, the renewal of air at its extremity becomes more imperfect as it advances ; and when it is carried a certain length, the air ſtagnates and becomes ſuffocating, till either a communication can be made with the reſt of the mine, or a ſhaft be made at the end of this drift.

As this current depends entirely on the difference of temperature between the air below and that above, it muſt ceaſe when that difference ceaſes. Accordingly, in the ſpring and autumn, the miners complain much of ſtagnation ; but in ſummer they never want a current from the deep pits to the ſhallow, nor in the winter a current from the ſhallow pits to the deep ones. It frequently happens alſo, that in mineral countries the chemical changes which are going on in different parts of the earth make differences of temperature ſufficient to produce a ſenſible current.

It is eaſy to ſee that the ſame cauſes muſt produce a current down our chimneys in ſummer. The chimney is colder than the ſummer air, and muſt therefore condenſe it, and it will come down and run out at the doors and windows.

And this naturally leads us to conſider a very important effect of the expanſion and conſequent aſcent of air by heat, namely the drawing (as it is called) of chimneys. The air which has contributed to the burning of fuel muſt be intenſely heated, and will riſe in the atmoſphere. This will alſo be the caſe with much of the ſurrounding air which has come very near the fire, although not in contact with it. If this heated air be made to riſe in a pipe, it will be kept together, and therefore will not ſoon cool and collapſe : thus we ſhall obtain a long column of light air, which will riſe with a force ſo much the greater as the column is longer or more heated. Therefore the taller we make the chimney, or the hotter we make the fire, the more rapid will be the current, or the draught or ſuction, as it is injudiciouſly called, will be ſo much the greater. The aſcenſional force is the difference between the weight of the column of heated air in the funnel and a column of the ſurrounding atmoſphere of equal height. We increaſe the draught, therefore, by increaſing the perpendicular height of the chimney. Its length in a horizontal direction gives no increaſe, but, on the contrary, diminiſhes the draught by cooling the air before it gets into the effective part of the funnel. We increaſe the draught alſo by obliging all the air which enters the chimney to come very near the fuel ; therefore a low mantle-piece will produce this effect alſo filling up all the ſpaces on each ſide of the the grate. When much air gets in above the fire, by having a lofty mantle-piece, the general maſs of air in the chimney cannot be much heated. Hence it muſt happen that the greateſt draught will be produced by bringing down the mantle-piece to the very fuel ; but this converts a fire-place into a furnace, and by thus ſending the whole air through the fuel, cauſes it to burn with great rapidity, producing a prodigious heat ; and this producing an increaſe of aſcenſional force, the current becomes furiouſly rapid, and the heat and conſumption of fuel immenſe. If the fire-place be a cube of a foot and a half, and the front cloſed by a door, ſo that all the air muſt enter through the bottom of the grate, a chimney 15 or 20 feet high, and ſufficiently wide to give paſſage to all the expanded air which can paſs through the fire, will produce a current which will roar like thunder, and a heat ſufficient to run the whole inſide into a lump of glaſs.

All that is neceſſary, however, in a chamber fire-place, is a current ſufficiently great for carrying up the ſmoke and vitiated air of the fuel. And as we want alſo the enlivening flutter and light of the fire, we give the chimney-piece both a much greater height and width than what is merely neceſſary for carrying up the ſmoke, only wiſhing to have the current ſufficiently determinate and ſteady for counteracting any occaſional tendency which it may ſometimes have to come into the room. By allowing a greater quantity of air to get into the chimney, heated only to a moderate degree, we produce a more rapid renewal of the air of the room : did we oblige it to come ſo much nearer the fire as to produce the ſame renewal of the air in conſequence of a more rapid current, we ſhould produce an inconvenient heat. But in this country, where pit-coal is in general ſo very cheap, we carry this indulgence to an extreme ; or rather we have not ſtudied how to get all the deſired advantages with economy. A much ſmaller renewal of air than we commonly produce is abundantly wholeſome and pleaſant, and we may have all the pleaſure of the light and flame of the fuel at much leſs expenſe, by contracting greatly the paſſage into the vent. The beſt way of doing this is by contracting the brick-work on each ſide behind the mantle-piece, and reducing it to a narrow parallelogram, having the back of the vent for one of its long ſides. Make an iron-plate to fit this hole, of the ſame length, but broader, ſo that it may lie ſloping, its lower edge being in contact with the foreſide of the hole, and its upper edge leaning on the back of the vent. In this poſition it ſhuts the hole entirely. Now let the plate have a hinge along the front or lower edge, and fold up like the lid of a cheſt. We ſhall thus be able to enlarge the paſſage at pleaſure. In a fire-place fit for a room of 24 feet by 18, if this plate may be about 18 inches long from ſide to ſide, and folded back within an inch or an inch and a half of the wall, this will allow paſſage for as much air as will keep up a very cheerful fire; and by raiſing or lowering this REGISTER, the fire may be made to burn more or leſs rapidly. A free paſſage of half an inch will be ſufficient in weather that is not immoderately cold. The principle on which this conſtruction produces its effect is, that the air which is in the front of the fire, and much warmed by it, is not allowed to get into the chimney, where it would be immediately hurried up the vent, but riſes up to the ceiling and is diffuſed over the whole room. This double motion of the air may be diſtinctly obſerved by opening a little of the door and holding a candle in the way. If the candle be held near the floor, the flame will be blown into the room; but if held near the top of the door, the flame will be blown outward.

But the moſt perfect method of warming an apartment in theſe temperate climates, where we can indulge in the cheerfulneſs and ſweet air produced by an open fire, is what we call a ſtove-grate, and our neighbours on the continent call a chapelle, from its reſemblance to the chapels or oratories in the great churches.

In the great chimney-piece, which, in this caſe, may be made even larger than ordinary, is ſet a ſmaller one fitted up in the ſame ſtile of ornament, but of a ſize no greater than is ſufficient for holding the fuel. The ſides and back of it are made of iron (caſt iron is preferable to hammered iron, becauſe it does not ſo readily calcine), and are kept at a ſmall diſtance from the ſides and back of the main chimney-piece, and are continued down to the earth, ſo that the aſh-pit is alſo ſeparated. The pipe or chimney of the ſtove-grate is carried up behind the ornaments of the mantle-piece till it riſes above the mantle-piece of the main chimney-piece, and is fitted with a regiſter or damper-plate turning round a tranſverſe axis. The beſt form of this regiſter is that which we have recommended for an ordinary fire-place, having its axis or joint cloſe at the front; ſo that when it is opened or turned up, the burnt air and ſmoke ſtriking it obliquely, are directed with certainty into the vent, without any riſk of reverberating and coming out into the room. All the reſt of the vent is ſhut up by iron plates or brick-work out of ſight.

The effect of this conſtruction is very obvious. The fuel, being in immediate contact with the back and ſides of the grate, heat them to a great degree, and they heat the air contiguous to them. This heated air cannot get up the vent, becauſe the paſſages above theſe ſpaces are ſhut up. It therefore comes out into the room; ſome of it goes into the real fire-place and it is carried up the vent, and the reſt riſes to the ceiling and is diffuſed over the room.

It is ſurpriſing to a perſon who does not conſider it with ſkill how powerfully this grate warms a room. Leſs than one fourth of the fuel conſumed in an ordinary fire-place is ſufficient; and this with the ſame cheerful blazing hearth and ſalutary renewal of air. It even requires attention to keep the room cool enough. The heat communicated to thoſe parts in contact with the fuel is needleſsly great; and it will be a conſiderable improvement to line this part with very thick plates of caſt iron, or with tiles made of fire-clay which will not crack with the heat. Theſe, being very bad conductors, will make the heat, ultimately communicated to the air, very moderate. If, with all theſe precautions, the heat ſhould be found too great, it may be brought under perfect management by opening paſſages into the vent from the lateral ſpaces. Theſe may be valves or trap-doors moved by rods concealed behind the ornaments.

Thus we have a fire-place under the moſt complete regulation, where we can always have a cheerful fire without being for a quarter of an hour incommoded by the heat; and we can as quickly raiſe our fire, when too low, by hanging a plate of iron on the front, which ſhall reach as low as the grate. This in five minutes will blow up the fire into a glow; and the plate may be ſent out of the room, or ſet behind the ſtove-grate out of ſight.

The propriety of incloſing the aſh-pit is not ſo obvious; but if this be not done, the light aſhes, not finding a ready paſſage up the chimney, will come out into the room along with the heated air.

We do not conſider in this place the various extraneous circumſtances which impede the current of air in our chimneys and produce ſmoky houſes: theſe will be treated of, and the methods of removing or remedying them, under the article SMOKE. We conſider at preſent only the theory of this motion in general, and the modifications of its operation ariſing from the various purpoſes to which it may be applied.

Under this head we ſhall next give a general account and deſcription of the method of warming apartments by ſtoves. A STOVE in general is a fire-place ſhut up on all ſides, having only a paſſage for admitting the air to ſupport the fire, and a tube for carrying off the vitiated air and ſmoke; and the air of the room is warmed by coming into contact with the outſide of the ſtove and flue. The general principle of conſtruction, therefore, is very ſimple. The air muſt be made to come into as cloſe contact as poſſible with the fire, or even to paſs through it, and this in ſuch quantities as juſt to conſume a quantity of fuel ſufficient for producing the heat required; and the ſtove muſt be ſo conſtructed, that both the burning fuel and the air which has been heated by it ſhall be applied to as extenſive a ſurface as poſſible of furnace, all in contact with the air of the room; and the heated air within the ſtove muſt not be allowed to get into the funnel which is to carry it off till it is too much cooled to produce any conſiderable heat on the outſide of the ſtove.

In this temperate climate no great ingenuity is neceſſary for warming an ordinary apartment; and ſtoves are made rather to pleaſe the eye as furniture than as economical ſubſtitutes for an open fire of equal calorific power. But our neighbours on the continent, and eſpecially towards the north, where the cold of winter is intenſe and fuel very dear, have beſtowed much attention on their conſtruction, and have combined ingenious economy with every elegance of form. Nothing can be handſomer than the ſtoves of Fayencerie that are to be ſeen in French Flanders, or the Ruſſian ſtoves at St. Peterſburgh, finiſhed in ſtucco. Our readers will not, therefore, be diſpleaſed with a deſcription of them. In this place, however, we ſhall only conſider a ſtove in general as a ſubject of pneumatical diſcuſſion, and we refer our readers to the article STOVE for an account of them as articles of domeſtic accommodation.

The general form, therefore, of a ſtove, and of which all others are only modifications adapted to circumſtances of utility or taſte, is as follows:

MIKL (fig. 62.) is a quadrangular box of any ſize in the directions MI IK. The inſide width from front to back is pretty conſtant, never leſs than ten inches, and rarely extending to 20; the included ſpace is divided by a great many partitions. The loweſt chamber AB is the receptacle for the fuel, which lies on the bottom of the ſtove without any grate: this fire-place has a door AO turning on hinges, and in this door is a very ſmall wicket P: the roof of the fire-place extends to within a very few inches of the further end, leaving a narrow paſſage B for the flame. The next partition *c* C is about eight inches higher, and reaches almoſt to the other end, leaving a narrow paſſage for the flame at C. The partitions are repeated above, at the diſtance of eight inches, leaving paſſages at the ends, alternately diſpoſed as in the figure; the laſt of them H communicates with the room vent. This communication may be regulated by a plate of iron, which can be ſlid acroſs it by means of a rod or handle which comes through the ſide. The more uſual way of ſhutting up this paſſage is by a ſort of pan or bowl of earthen ware, which is whelmed over it with its brim reſting in ſand contained in a groove formed all round the hole. This damper is introduced by a door in the front, which is then ſhut. The whole is ſet on low pillars, ſo that its bottom may be a few inches from the floor of the room: it is uſually placed in a corner, and the apartments are ſo diſpoſed that their chimneys can be joined in ſtacks as with us.

Some ſtraw or wood ſhavings are firſt burnt on the hearth at its further end. This warms the air in the ſtove, and creates a determined current. The fuel is then laid on the hearth cloſe by the door, and pretty much piled up. It is now kindled; and the current being already directed to the vent, there is no danger of any ſmoke coming out into the room. Effectually to prevent this, the door is ſhut, and the wicket P opened. The air ſupplied by this, being directed to the middle or bottom of the fuel, quickly kindles it, and the operation goes on.

The aim of this conſtruction is very obvious. The flame and heated air are retained as long as poſſible within the body of the ſtove by means of the long paſſages; and the narrowneſs of theſe paſſages obliges the flame to come in contact with every particle of ſoot, ſo as to conſume it completely, and thus convert the whole combuſtible matter of the fuel into heat. For want of this, a very conſiderable portion of our fuel is waſted by our open fires, even under the very beſt management: the ſoot which ſticks to our vents is very inflammable, and a pound weight of it will give as much if not more heat than a pound of coal. And what ſticks to our vents is very inconſiderable in compariſon with what eſcapes at the chimney top. In fires of green wood, peat, and ſome kinds of pit-coal, nearly $\frac{1}{5}$ of the fuel is loſt in this way; but in theſe ſtoves there is hardly ever any mark of ſoot to be ſeen; and even this ſmall quantity is produced only after lighting the fires. The volatile inflammable matters are expelled from parts much heated indeed, but not ſo hot as to burn; and ſome of it charred or half-burnt cannot be any further conſumed, being enveloped in flame and air already vitiated and unfit for combuſtion. But when the ſtove is well heated, and the current briſk, no part of the ſoot eſcapes the action of the air.

The hot air retained in this manner in the body of the ſtove is applied to its ſides in a very extended ſurface. To increaſe this ſtill more, the ſtove is made narrower from front to back in its upper part; a certain breadth is neceſſary below, that there may be room for fuel. If this breadth were preſerved all the way up, much heat would be loſt, becauſe the heat communicated to the partitions of the ſtove does no good. By diminiſhing their breadth, the proportion of uſeful ſurface is increaſed. The whole body of the ſtove may be conſidered as a long pipe folded up, and its effect would be the greateſt poſſible if it really were ſo; that is, if each partition *c* C, *d* D, &c. were ſplit into two, and a free paſſage allowed between them for the air of the room. Something like this will be obſerved afterwards in ſome German ſtoves.

It is with the ſame view of making an extenſive application of a hot ſurface to the air, that the ſtove is not built in the wall, nor even in contact with it, nor with the floor: for by its detached ſituation, the air in contact with the back, and with the bottom (where it is hotteſt), is warmed, and contributes at leaſt one half of the whole effect; for the great heat of the bottom makes its effect on the air of the room at leaſt equal to that of the two ends. Sometimes a ſtove makes part of the wall between two ſmall rooms, and is found ſufficient.

It muſt be remarked, on the whole, that the effect of a ſtove depends much on keeping in the room the air already heated by it. This is ſo remarkably the caſe, that a ſmall open fire in the ſame room will be ſo far from increaſing its heat, that it will greatly diminiſh it: it will even draw the warm air from a ſuite of adjoining apartments. This is diſtinctly obſerved in the houſes of the Engliſh merchants in St. Peterſburgh: their habits of life in Britain make them uneaſy without an open fire in their ſitting rooms; and this obliges them to heat all their ſtoves twice a day, and their houſes are cooler than thoſe of the Ruſſians who heat them only once. In many German houſes, eſpecially of the lower claſs, the fire-place of the ſtove does not open into the room, but into the yard or a lobby, where all the fires are lighted and tended; by this means is avoided the expenſe of warm air which muſt have been carried off by the ſtove: but it is evident, that this muſt be very unpleaſant, and cannot be wholeſome. We muſt breathe the ſame quantity of ſtagnant air loaded with all the vapours and exhalations which muſt be produced in every inhabited place. Going into one of theſe houſes from the open air, is like putting one's head into a ſtew-pan or under a pie-cruſt, and quickly nauſeates us who are accuſtomed to freſh air and cleanlineſs. In theſe countries it is a matter almoſt of neceſſity to fumigate the rooms with frankincenſe and other gums burnt. The cenſer in ancient worſhip was in all probability an utenſil introduced by neceſſity for ſweetening or rendering tolerable the air of a crouded place: and it is a conſtant practice in the Ruſſian houſes for a ſervant to go round the room after dinner, waving a cenſer with ſome gums burning on bits of charcoal.

The account now given of ſtoves for heating rooms, and of the circumſtances which muſt be attended to in their conſtruction, will equally apply to hot walls in gardening, whether within or without doors. The only new circumſtance which this employment of a flue introduces, is the attention which muſt be paid to the equability of the heat, and the gradation which muſt be obſerved in different parts of the building. The heat in the flue gradually diminiſhes as it recedes from the fire-place, becauſe it is continually giving out heat to the flue. It muſt therefore be ſo conducted through the building by frequent returns, that in every part there may be a mixture of warmer and cooler branches of the flue, and the final chimney ſhould be cloſe by the fire-place. It would, however, be improper to run the flue from the end of the floor up to the ceiling, where the ſecond horizontal pipe would be placed, and then return it downward again and make the third horizontal flue adjoining to the firſt, &c. This would make the middle of the wall the coldeſt. If it be the flue of a green-houſe, this would be highly improper, becauſe the upper part of the wall can be very little employed; and in this caſe it is better to allow the flue to proceed gradually up the wall in its different returns, by which the the loweſt part would be the warmeſt, and the heated air will aſcend among the pots and plants; but in a hot wall where the trees are to receive heat by contact, ſome approximation to the above method may be uſeful.

In the hypocauſta and ſudaria of the Greeks and Romans, the flue was conducted chiefly under the floors.

Malt-kilns are a ſpecies of ſtove which merit our attention. Many attempts have been made to improve them on the principles of flue ſtoves; but they have been unſucceſsful, becauſe heat is not what is chiefly wanted in malting: it is a copious current of very dry air to carry off the moiſture. We muſt refer the examination of this ſubject alſo to the article Stove, and proceed to conſider the current of heated air in the chief varieties of furnaces.

All that is to be attended to in the different kinds of melting furnaces is, that the current of air be ſufficiently rapid, and that it be applied in as extenſive a ſurface as poſſible to the ſubſtance to be melted. The more rapid the current it is the hotter, becauſe it is conſuming more fuel; and therefore its effect increaſes in a higher proportion than its rapidity. It is doubly effectual if twice as hot; and if it then be twice as rapid, there is twice the quantity of doubly hot air applied to the ſubject; it would therefore be four times more powerful. This is procured by raiſing the chimney of the furnace to a greater height. The cloſe application of it to the ſubject can hardly be laid down in general terms, becauſe it depends on the preciſe circumſtances of each caſe.

In reverberatory furnaces, ſuch as refining furnaces for gold, ſilver, and copper, the flame is made to play over the ſurface of the melted metal. This is produced entirely by the form of the furnace, by making the arch of the furnace as low as the circumſtances of the manipulation will allow (See Furnace). Experience has pointed out in general the chief circumſtances of their conſtruction, viz. that the fuel ſhould be at one end on a grate, through which the air enters to maintain the fire; and that the metal ſhould be placed on a level floor between the fuel and the tall chimney which produces the current. But there is no kind of furnace more variable in its effect, and almoſt every place has a ſmall peculiarity of conſtruction, on which its preeminence is reſted. This has occaſioned many whimſical varieties in their form. This uncertainty ſeems to depend much on a circumſtance rather foreign to our preſent purpoſe; but as we do not obſerve it taken notice of by mineralogical writers, we beg leave to mention it here. It is not heat alone that is wanted in the refining of ſilver by lead, for inſtance: We muſt make a continual application to its ſurface of air, which has not contributed to the combuſtion of the fuel. Any quantity of the hotteſt air, already ſaturated with the fuel, may play on the ſurface of the metal for ever, and keep it in the ſtate of moſt perfect fuſion, but without refining it in the leaſt. Now, in the ordinary conſtruction of a furnace, this is much the caſe. If the whole air has come in by the grate, and paſſed through the middle of the fuel, it can hardly be otherwiſe than nearly ſaturated with it; and if air be alſo admitted by the door (which is generally done or ſomething equivalent), the pure air lies above the vitiated air, and during the paſſage along the horizontal part of the furnace, and along the ſurface of the metal, it ſtill keeps above it, at leaſt there is nothing to promote their mixture. Thus the metal does not come into contact with air fit to act on the baſe metal and calcine it, and the operation of refining goes on ſlowly. Trifling circumſtances in the form of the arch or canal may tend to promote the jumbling of the airs together, and thus render the operation more expeditious; and as theſe are but ill underſtood, or perhaps this circumſtance not attended to, no wonder that we ſee theſe conſidered as ſo many noſtrums of great importance. It were therefore worth while to try the effect of changes in the form of the roof directed to this very circumſtance. Perhaps ſome little prominence down from the arch of the reverberatory would have this effect, by ſuddenly throwing the current into confuſion. If the additional length of paſſage do not cool the air too much, we ſhould think that if there were interpoſed between the fuel and the refining floor a paſſage twiſted like a cork-ſcrew, making juſt half a turn, it would be moſt effectual: for we imagine, that the two airs, keeping each to their reſpective ſides of the paſſage, would by this means be turned upſide down, and that the pure ſtratum would now be in contact with the metal, and the vitiated air would be above it.

The glaſshouſe furnace exhibits the chief variety in the management of the current of heated air. In this it is neceſſary that the hole at which the workman dips his pipe into the pot ſhall be as hot as any part of the furnace. This could never be the caſe if the furnace had a chimney ſituated in a part above the dipping-hole; for in this caſe cold air would immediately ruſh in at the hole, play over the ſurface of the pot, and go up the chimney. To prevent this the hole itſelf is made the chimney; but as this would be too ſhort, and would produce very little current and very little heat, the whole furnace is ſet under a tall dome. Thus the heated air from the real furnace is confined in this dome, and conſtitutes a high column of very light air, which will therefore riſe with great force up the dome, and eſcape at the top. The dome is therefore the chimney, and will produce a draught or current proportioned to its height. Some are raiſed above a hundred feet. When all the doors of this houſe are ſhut, and thus no ſupply given except through the fire, the current and heat become prodigious. This, however, cannot be done, becauſe the workmen are in this chimney, and muſt have reſpirable air. But notwithſtanding this ſupply by the houſe-doors, the draught of the real furnace is vaſtly increaſed by the dome, and a heat produced ſufficient for the work, and which could not have been produced without the dome.

This has been applied with great ingenuity and effect to a furnace for melting iron from the ore, and an iron finery, both without a blaſt. The common blaſt iron furnace is well known. It is a tall cone with the apex undermoſt. The ore and fluxes are thrown into this cone mixed intimately with the fuel till it is full, and the blaſt of moſt powerful bellows is directed into the bottom of this cone through a hole in the ſide. The air is thrown in with ſuch force, that it makes its way through the maſs of matter, kindles the fuel in its paſſage, and fluxes the materials, which then drop down into a receptacle below the blaſt-hole, and thus the paſſage for the air is kept unobſtructed. It was thought impoſſible to produce or maintain this current without bellows; but Mr. Cotterel, an ingenious founder, tried the effect of a tall dome placed over the mouth of the furnace, and though it was not half the height of many glaſshouſe domes it had the deſired effect. Conſiderable difficulties, however, occurred; and he had not ſurmounted them all when he left the neighbourhood of Edinburgh, nor have we heard that he has yet brought the invention to perfection. It is extremely difficult to place the holes below, at which the air is to enter, at ſuch a preciſe height as neither to be choked by the melted matter, nor to leave ore and ſtones below them unmelted; but the invention is very ingenious, and will be of immenſe ſervice if it can be perfected; for in many places iron ore is to be found where water cannot be had for working a blaſt furnace.

The laſt application which we ſhall make of the currents produced by heating the air is to the freeing mines, ſhips, priſons, &c. from the damp and noxious vapours which frequently infeſt them.

As a drift or work is carried on in the mine, let a trunk of deal boards, about 6 or 8 inches ſquare, be laid along the bottom of the drift, communicating with a trunk carried up in the corner of one of the ſhafts. Let the top of this laſt trunk open into the aſh-pit of a ſmall furnace, having a tall chimney. Let fire be kindled in the furnace; and when it is well heated, ſhut the fire-place and aſh-pit doors. There being no other ſupply for the current produced in the chimney of this furnace, the air will flow into it from the trunk, and will bring along with it all the offenſive vapours. This is the moſt effectual method yet found out. In the ſame manner may trunks be conducted into the aſh-pit of a furnace from the cells of a priſon or the wards of an hoſpital.

In the account which we have been giving of the management of air in furnaces and common fires, we have frequently mentioned the immediate application of air to the burning fuel as neceſſary for its combuſtion. This is a general fact. In order that any inflammable body may be really inflamed, and its combuſtible matter conſumed and aſhes produced, it is not enough that the body be made hot. A piece of charcoal incloſed in a box of iron may be kept red-hot for ever, without waſting its ſubſtance in the ſmalleſt degree. It is farther neceſſary that it be in contact with a particular ſpecies of air, which conſtitutes about $\frac{4}{5}$ths of the air of the atmoſphere, viz. the vital air of Lavoiſier. It was called *empyreal air* by Scheele, who firſt obſerved its indiſpenſable uſe in maintaining fire: and it appears, that, in contributing to the combuſtion of an inflammable body, this air combines with ſome of its ingredients, and becomes fixed air, ſuffering the ſame change as by the breathing of animals. Combuſtion may therefore be conſidered as a ſolution of the inflammable body in air. This doctrine was firſt promulgated by the celebrated Dr. Hooke in his *Micrographia*, publiſhed in 1660, and afterwards improved in his treatiſe on Lamps. It is now completely eſtabliſhed, and conſidered as a new diſcovery. It is for this reaſon that in fire-places of all kinds we have directed the conſtruction, ſo as to produce a cloſe application of the air to the fuel. It is quite needleſs at this day to enter into the diſcuſſions which formerly occupied philoſophers about the manner in which the preſſure and elaſticity of the air promoted combuſtion. Many experiments were made in the laſt century by the firſt Members of the Royal Society, to diſcover the office of air in combuſtion, It was thought that the flame was extinguiſhed in rare air for want of a preſſure to keep it together; but this did not explain its extinction when the air was not renewed. Theſe experiments are ſtill retained in courſes of experimental philoſophy, as they are injudiciouſly ſtyled; but they give little or no information, nor tend to the illuſtration of any pneumatical doctrine; they are therefore omitted in this place. In ſhort, it is now fully eſtabliſhed, that it is not a mechanical but a chemical phenomenon. We can only inform the chemiſt, that a candle will conſume faſter in the low countries than in the elevated regions of Quito and Gondar, becauſe the air is nearly one-half denſer below, and will act proportionally faſter in decompoſing the candle.

We ſhall conclude this part of our ſubject with the explanation of a curious phenomenon obſerved in many places. Certain ſprings or fountains are obſerved to have periods of repletion and ſcantineſs, or ſeem to ebb and flow at regular intervals; and ſome of theſe periods are of a complicated nature. Thus a well will have ſeveral returns of high and low water, the difference of which gradually increaſes to a maximum, and then diminiſhes, juſt as we obſerve in the ocean. A very ingenious and probable explanation of this has been given in No. 424. of the Philoſophical Tranſactions, by Mr. Atwell, as follows:

Let ABCD (pl. 11. fig. 63.) repreſent a cavern, into which water is brought by the ſubterraneous paſſage OT. Let it have an outlet MNP, of a crooked form, with its higheſt part N conſiderably raiſed above the bottom of the cavern, and thence ſloping downwards into lower ground, and terminating in an open well at P. Let the dimenſions of this canal be ſuch that it will diſcharge much more water than is ſupplied by TO. All this is very natural and may be very common. The effect of this arrangement will he a remitting ſpring at P: for when the cavern is filled higher than the point N, the canal MNP will act as a ſyphon; and, by the conditions aſſumed, it will diſcharge the water faſter than TO ſupplies it; it will therefore run it dry, and then the ſpring at P will ceaſe to furniſh water. After ſome time the cavern will again be filled up to the height N, and the flow at P will recommence.

If, beſides this ſupply, the well P alſo receive water from a conſtant ſource, we ſhall have a reciprocating ſpring.

The ſituation and dimenſions of this ſyphon canal, and the ſupply of the feeder, may be ſuch, that the efflux at P will be conſtant. If the ſupply increaſe in a certain degree, a reciprocation will be produced at P with very ſhort intervals; if the ſupply diminiſhes conſiderably, we ſhall have another kind of reciprocation with great intervals and great differences of water.

If the cavern has another ſimple outlet R, new varieties will be produced in the ſpring P, and R will afford a curious ſpring. Let the mouth of R, by which the water enters it from the cavern, be lower than N, and let the ſupply of the feeding ſpring be no greater than R can diſcharge, we ſhall have a conſtant ſpring from R, and P will give no water. But ſuppoſe that the main feeder increaſes in winter or in rainy ſeaſons, but not ſo much as will ſupply both P and R, the cavern will fill till the water gets over N, and R will be running all the while; but ſoon after P has begun to flow, and the water in the cavern ſinks below R, the ſtream from R will ſtop. The cavern will be emptied by the ſyphon canal MNP, and then P will ſtop. The cavern will then begin to fill, and when near full R will give a little water, and ſoon after P will run and R ſtop as before, &c.

Deſaguliers ſhows, vol ii. p. 177, &c. in what manner a prodigious variety of periodical ebbs and flows may be produced by underground canals, which are extremely ſimple and probable.

Pneumatic Engines.

We ſhall conclude this article with the deſcriptions of ſome pneumatical machines or engines which have not been particularly noticed under their names in the former volumes of this work.

Bellows are of moſt extenſive and important uſe; and it will be of ſervice to deſcribe ſuch as are of uncommon conſtruction and great power, fit for the great operations in metallurgy.

It is not the impulſive force of the blaſt that is wanted in moſt caſes, but merely the copious ſupply of air, to produce the rapid combuſtion of inflammable matter; and the ſervice would be better performed in general if this could be done with moderate velocities, and an extended ſurface. What are called air-furnaces, where a conſiderable ſurface of inflammable matter is acted on at once by the current which the mere heat of the expended air has produced, are found more operative in proportion to the air expended than blaſt furnaces animated by bellows; and we doubt not but that the method propoſed by Mr. Cotterel (which we have already mentioned) of increaſing this current in a melting furnace by means of a dome, will in time ſuperſede the blaſt furnaces. There is indeed a great impulſive force required in ſome caſes; as for blowing off the ſcoriæ from the ſurface of ſilver or copper in refining furnaces, or for keeping a clear paſſage for the air in the great iron furnace.

In general, however, we cannot procure this abundant ſupply of air any other way than by giving it a great velocity by means of a great preſſure, ſo that the general conſtruction of bellows is pretty much the ſame in all kinds. The air is admitted into a very large cavity, and then expelled from it through a ſmall hole.

The furnaces at the mines having been greatly enlarged, it was neceſſary to enlarge the bellows alſo; and the leathern bellows becoming exceedingly expenſive, wooden ones were ſubſtituted in Germany about the beginning of laſt century, and from them became general through Europe. They conſiſt of a wooden box ABCPFE (pl. 12. fig. 74. A), which has its top and two ſides flat or ſtraight, and the end BAE *e* formed into an arched or cylindrical ſurface, of which the line FP at the other end is the axis. This box is open below, and receives within it the ſhallow box KHGNML (fig. B), which exactly fills it. The line FP of the one coincides with FP of the other, and along this line is a ſet of hinges on which the upper box turns as it riſes and ſinks. The lower box is made faſt to a frame fixed in the ground. A pipe OQ proceeds from the end of it, and terminates at the furnace, where it ends in a ſmall pipe called the *tewer* or *tuyere*. This lower box is open above, and has in its bottom two large valves V, V, opening inwards. The conducting pipe is ſometimes furniſhed with a valve opening outwards, to prevent burning coals from being ſucked into the bellows when the upper box is drawn up. The joint along PF is made tight by thin leather nailed along it. The ſides and ends of the fixed box are made to fit the ſides and curved end of the upper box, ſo that this laſt can be raiſed and lowered round the joint FP without ſenſible friction, and yet without ſuffering much air to eſcape; but as this would not be ſufficiently air-tight by reaſon of the ſhrinking and warping of the wood, a further contrivance is adopted. A ſlender lath of wood, divided into ſeveral joints, and covered on the outer edge with very ſoft leather, is laid along the upper edges of the ſides and ends of the lower box. This lath is ſo broad, that when its inner edge is even with the inſide of the box, its outer edge projects about an inch. It is kept in this poſition by a number of ſteel wires, which are driven into the bottom of the box, and ſtand up touching the ſides, as repreſented in figure D, where *a b c* are the wires, and *e* the lath, projecting over the outſide of the box. By this contrivance the laths are preſſed cloſe to the ſides and curved end of the moveable box, and the ſpring wires yield to all their inequalities. A bar of wood RS is fixed to the upper board, by which it is either raiſed by machinery, to ſink again by its own weight, having an additional load laid on it, or it is forced downward by a crank or wiper of the machinery, and afterwards raiſed.

The operation here is preciſely ſimilar to that of blowing with a chamber-bellows. When the board is lifted up, the air enters by the valves V, V, and is expelled at the pipe OQ by depreſſing the boards. There is therefore no occaſion to inſiſt on this point.

Theſe bellows are made of a very great ſize, AD being 16 feet, AB 5 feet, and the circular end AE alſo 5 feet. The riſe, however, is but about 3 or 3½ feet. They expel at each ſtroke about 90 cubic feet of air, and they make about 8 ſtrokes per minute.

Such are the bellows in general uſe on the continent. We have adopted a different form in this kingdom, which ſeems much preferable. We uſe an iron or wooden cylinder, with a piſton ſliding along it. This may be made with much greater accuracy than the wooden boxes, at leſs expenſe, if of wood, becauſe it may be of coopers' work, held together by hoops: but the great advantage of this form is its being more eaſily made air-tight. The piſton is ſurrounded with a broad ſtrap of thick and ſoft leather, and it has around its edge a deep groove, in which is lodged a quantity of wool. This is called the packing or ſtuffing, and keeps the leather very cloſely applied to the inner ſurface of the cylinder. Iron cylinders may be very neatly bored and ſmoothed, ſo that the piſton, even when very tight, will ſlide along it very ſmoothly. To promote this, a quantity of black lead is ground very fine with water, and a little of this is ſmeared on the inſide of the cylinder from time to time.

The cylinder has a large valve, or ſometimes two, in the bottom, by which the atmoſpheric air enters when the piſton is drawn up. When the piſton is thruſt down, this air is expelled along a pipe of great diameter, which terminates in the furnace with a ſmall orifice.

This is the ſimpleſt form of bellows that can be conceived. It differs in nothing but ſize from the bellows uſed by the rudeſt nations. The Chineſe ſmiths have a bellows very ſimilar, being a ſquare pipe of wood ABCDE (fig. 75.), with a ſquare board G which exactly fits it, moved by the handle FG. At the further end is the blaſt pipe HK, and on each ſide of it a valve in the end of the ſquare pipe, opening inwards. The piſton is ſufficiently tight for their purpoſes without any leathering.

The piſton of this cylinder bellows is moved by machinery. In ſome blaſt engines the piſton is ſimply raiſed by the machine, and then let go, and it deſcends by its own weight, and compreſſes the air below it to ſuch a degree, that the velocity of efflux becomes conſtant, and the piſton deſcends uniformly: for this purpoſe it muſt be loaded with a proper weight. This produces a very uniform blaſt, except at the very beginning, while the piſton falls ſuddenly and compreſſes the air: but in moſt engines the piſton rod is forced down the cylinder with a determined motion, by means of a beam, crank, or other contrivance. This gives a more unequal blaſt, becauſe the motion of the piſton is neceſſarily ſlow in the beginning and end of the ſtroke, and quicker in the middle.

But in all it is plain that the blaſt muſt be deſultory. It ceaſes while the piſton is riſing; for this reaſon it is uſual to have two cylinders, as it was formerly uſual to have two bellows which worked alternately. Sometimes three or four are uſed, as at the Carron iron-works. This makes a blaſt abundantly uniform.

But an uniform blaſt may be made with a ſingle cylinder, by making it deliver its air into another cylinder, which has a piſton exactly fitted to its bore, and loaded with a ſufficient weight. The blowing cylinder ABCD (fig. 76.) has its piſton P worked by a rod NP, connected by double chains with the arched head of the working beam NO, moving round a gudgeon at R. The other end O of this beam is connected by the rod OP with the crank PQ of a wheel machine; or it may be connected with the piſton of a ſteam-engine, &c. &c. The blowing cylinder has a valve or valves E in its bottom, opening inwards. There proceeds from it a large pipe CF, which enters the regulating cylinder GHKI, and has a valve at top to prevent the air from getting back into the blowing cylinder. It is evident that the air forced into this cylinder muſt raiſe its piſton L, and that it muſt afterwards deſcend, while the other piſton is riſing. It muſt deſcend uniformly, and make a perfectly equable blaſt.

Obſerve, that if the piſton L be at the bottom when the machine begins to work, it will be at the bottom at the end of every ſtroke, if the *tuyere* T emits as much air as the cylinder ABCD furniſhes; nay, it will lie a while at the bottom, for, while it was riſing, air was iſſuing through T. This would make an interrupted blaſt. To prevent this, the orifice T muſt be leſſened; but then there will be a ſurplus of air at the end of each ſtroke, and the piſton L will riſe continually, and at laſt get to the top, and allow air to eſcape. It is juſt poſſible to adjuſt circumſtances, ſo that neither ſhall happen. This is done eaſier by putting a ſtop in the way of the piſton, and putting a valve on the piſton, or on the conducting pipe KST, loaded with a weight a little ſuperior to the intended elaſticity of the air in the cylinder. Therefore, when the piſton is prevented by the ſtop from riſing, the ſhifting valve, as it is called, is forced open, the ſuperfluous air eſcapes, and the blaſt preſerves its uniformity.

It may be of uſe to give the dimenſions of a machine of this kind, which has worked for ſome years at a very great furnace, and given ſatisfaction.

The diameter of the blowing cylinder is 5 feet, and the length of the ſtroke is 6. Its piſton is loaded with 3½ tons.

It is worked by a ſteam-engine whoſe cylinder is 3 feet 4 inches wide, with a ſix-feet ſtroke. The regulating cylinder is 8 feet wide, and its piſton is loaded with $8\frac{1}{2}$ tons, making about 2,63 pounds on the ſquare inch: and it is very nearly in equilibrio with the load on the piſton of the blowing cylinder. The conducting pipe KST is 12-inches in diameter, and the orifice of the tuyere was $1\frac{5}{8}$ inches when the engine was erected, but it has gradually enlarged by reaſon of the intenſe heat to which it is expoſed. The ſnifting valve is loaded with 3 pounds on the ſquare inch.

When the engine worked briſkly, it made 18 ſtrokes per minute, and there was always much air diſcharged by the ſnifting valve. When the engine made 15 ſtrokes per minute, the ſnifting valve opened but ſeldom, ſo that things were nearly adjuſted to this ſupply. Each ſtroke of the blowing cylinder ſent in 118 cubic feet of common air. The ordinary preſſure of the air being ſuppoſed $14\frac{3}{4}$ pounds on an inch, the denſity of the air in the regulating cylinder muſt be $\frac{14{,}75+2.63}{14{,}75}$, = 1,1783, the natural denſity being 1.

This machine gives an opportunity of comparing the expenſe of air with the theory. It muſt (at the rate of 15 ſtrokes) expel 30 cubic feet of air in a ſecond through a hole of $1\frac{5}{8}$ inches in diameter. This gives a velocity of near 2000 feet per ſecond, and of more than 1600 feet for the condenſed air. This is vaſtly greater than the theory can give, or is indeed poſſible; for air does not ruſh into a void with ſo great velocity. It ſhows with great evidence, that a vaſt quantity of air muſt eſcape round the two piſtons. Their united circumferences amount to above 40 feet, and they move in a dry cylinder. It is impoſſible to prevent a very great loſs. Accordingly, a candle held near the edge of the piſton L has its flame very much diſturbed. This caſe, therefore, gives no hold for a calculation; and it ſuggeſts the propriety of attempting to diminiſh this great waſte.

This has been very ingeniouſly done (in part at leaſt) at ſome other furnaces. At Omoah foundery, near Glaſgow, the blowing cylinder (alſo worked by a ſteam-engine) delivers its air into a cheſt without a bottom, which is immerſed in a large ciſtern of water, and ſupported at a ſmall height from the bottom of the ciſtern, and has a pipe from its top leading to the tuyere. The water ſtands about five feet above the lower brim of the regulating air-cheſt, and by its preſſure gives the moſt perfect uniformity of blaſt, without allowing a particle of air to get off by any other paſſage beſides the tuyere. This is a very effectual regulator, and muſt produce a great ſaving of power, becauſe a ſmaller blowing cylinder will thus ſupply the blaſt. We have not learned the dimenſions and performance of this engine. We muſt obſerve, that the loſs round the piſton of the blowing cylinder remains undiminiſhed.

A blowing machine was erected many years ago at Chaſtillon in France on a principle conſiderably different, and which muſt be perfectly air-tight throughout. Two cylinders, A, B (pl. 13. fig. 77.) loaded with great weights, were ſuſpended at the ends of the lever CD, moving round the gudgeon E. From the top F, G of each there was a large flexible pipe which united in H, whence a pipe KT led to the tuyere T. There were valves at F and G, opening outwards, or into the flexible pipes; and other valves L, M, adjoining to them in the top of each cylinder, opening inwards, but kept ſhut by a ſlight ſpring. Motion was given to the lever by a machine. The operation of this blowing machine is evident. When the cylinder A was pulled down, or allowed to deſcend, the water, entering at its bottom, compreſſed the air, and forced it along the paſſage FHKT. In the mean time, the cylinder B was riſing, and the air entered by the valve M. We ſee that the blaſt will be very unequal, increaſing as the cylinder is immerſed deeper. It is needleſs to deſcribe this machine more particularly, becauſe we ſhall give an account of one which we think perfect in its kind, and which leaves hardly any thing to be deſired in a machine of this ſort. It was invented by Mr. John Laurie, land-ſurveyor in Edinburgh, about 15 years ago, and improved in ſome reſpects ſince his death by an ingenious perſon of that city.

ABCD (fig. 78.) is an iron cylinder, truly bored within, and evaſated at top like a cup. EFGH is another, truly turned both without and within, and a ſmall matter leſs than the inner diameter of the firſt cylinder. This cylinder is cloſe above, and hangs from the end of a lever moved by a machine. It is alſo loaded with weights at N. KILM is a third cylinder, whoſe outſide diameter is ſomewhat leſs than the inſide diameter of the ſecond. This inner cylinder is fixed to the ſame bottom with the outer cylinder. The middle cylinder is looſe, and can move up and down between the outer and inner cylinders without rubbing on either of them. The inner cylinder is perforated from top to bottom by three pipes OQ, SV, PR. The pipes OQ, PR have valves at their upper ends O, P, and communicate with the external air below. The pipe SV has a horizontal part VW, which again turns upwards, and has a valve at top X. This upright part WX is in the middle of a ciſtern of water *f h k g*. Into this ciſtern is fixed an air-cheſt *a* YZ *b*, open below, and having at top a pipe *c d e* terminating in the tuyere at the furnace.

When the machine is at reſt, the valves X, O, P, are ſhut by their own weights, and the air-cheſt is full of water. When things are in this ſtate, the middle cylinder EFGH is drawn up by the machinery till its lower brims F and G are equal with the top RM of the inner cylinder. Now pour in water or oil between the outer and middle cylinders: it will run down and fill the ſpace between the outer and inner cylinders. Let it come to the top of the inner cylinder.

Now let the loaded middle cylinder deſcend. It cannot do this without compreſſing the air which is between its top and the top of the inner cylinder. This air being compreſſed will cauſe the water to deſcend between the inner and middle cylinders, and riſe between the middle and outer cylinders, ſpreading into the cup; and as the middle cylinder advances downwards, the water will deſcend further within it and riſe further without it. When it has got ſo far down, and the air has been ſo much compreſſed, that the difference between the ſurface of the water on the inſide and outſide of this cylinder is greater than the depth of water between X and the ſurface of the water *f g*, air will go out by the pipe SVW, and will lodge in the air-cheſt, and will remain there if *c* be ſhut, which we ſhall ſuppoſe for the preſent. Puſhing down the middle cylinder till the partition touch the top of the inner cylinder, all the air which was formerly between them will be forced into the air-cheſt, and will drive out water from it. Draw up the middle cylinder, and the external air will open the valves O, P, and again fill the ſpace between the middle and inner cylinders; for the valve X will ſhut, and prevent the regreſs of the condenſed air. By puſhing down the middle cylinder a ſecond time, more air will be forced into the air-cheſt, and it will at laſt eſcape by getting out between its brims Y, Z and the bottom of the ciſtern; or if we open the paſſage *c*, it will paſs along the conduit *c d e* to the tuyere, and form a blaſt.

The operation of this machine is ſimilar to Mr. Haſkins's quickſilver pump deſcribed by Deſaguliers at the end of the ſecond volume of his Experimental Philoſophy. The force which condenſes the air is the load on the middle cylinder. The uſe of the water between the inner and outer cylinders is to prevent this air from eſcaping: and the inner cylinder thus performs the office of a piſton, having no friction. It is neceſſary that the length of the outer and middle cylinders be greater than the depth of the regulator-ciſtern, that there may be a ſufficient height for the water to riſe between the middle and outer cylinders, to balance the compreſſed air, and oblige it to go into the air-cheſt. A large blaſt-furnace will require the regulator-ciſtern five feet deep, and the cylinders about ſix or ſeven feet long.

It is in fact a pump without friction, and is perfectly air-tight. The quickneſs of its operation depends on the ſmall ſpace between the middle cylinder and the two others; and this is the only uſe of theſe two. Without theſe it would be ſimilar to the engine at Chaſtillon, and operate more unequally and ſlowly. Its only imperfection is, that if the cylinder begin its motion of aſcent or deſcent rapidly, as it will do when worked by a ſteam-engine, there will be ſome danger of water daſhing over the top of the inner cylinder and getting into the pipe SV; but ſhould this happen, an iſſue can eaſily be contrived for it at V, covered with a loaded valve *v*. This will never happen if the cylinder is moved by a crank.—One blowing cylinder only is repreſented here, but two may be uſed.

We do not heſitate in recommending this form of bellows as the moſt perfect of any, and fit for all uſes where ſtanding bellows are required. They will be cheaper than any other ſort for common purpoſes. For a common ſmith's forge they may be made with ſquare wooden boxes inſtead of cylinders. They are alſo eaſily repaired. They are perfectly tight; and they may be made with a blaſt almoſt perfectly uniform, by making the ciſtern in which the air-cheſt ſtands of conſiderable dimenſions. When this is the caſe, the height of water, which regulates the blaſt will vary very little.

This may ſuffice for an account of blaſt machines. The leading parts of their conſtruction have been deſcribed as far only as was neceſſary for underſtanding their operation, and enabling an engineer to erect them in the moſt commodious manner. Views of complete machines might have amuſed, but they would not have added to our readers' information.

But the account is imperfect unleſs we ſhow how their parts may be ſo proportioned that they ſhall perform what is expected from them. The engineer ſhould know what ſize of bellows, and what load on the board or piſton, and what ſize of tuyere, will give the blaſt which the ſervice requires, and what force muſt be employed to give them the neceſſary degree of motion. We ſhall accompliſh theſe purpoſes by conſidering the efflux of the compreſſed air through the tuyere. The propoſitions formerly delivered will enable us to aſcertain this.

That we may proportion every thing to the power employed, we muſt recollect, that if the piſton of a cylinder employed for expelling air be preſſed down with any force p, it muſt be conſidered as ſuperadded to the atmoſpheric preſſure P on the ſame piſton, in order that we may compare the velocity v of efflux with the known velocity V with which air ruſhes into a void. By what has been formerly delivered, it appears that this velocity $v = \mathrm{V} \times \sqrt{\frac{p}{\mathrm{P} \times p}}$, where P is the preſſure of the atmoſphere on the piſton, and p the additional load laid on it. This velocity is expreſſed in feet *per* ſecond; and, when multiplied by the area of the orifice (alſo expreſſed in ſquare feet), it will give us the cubical feet of condenſed air expelled in a ſecond: but the bellows are always to be filled again with common air, and therefore we want to know the quantity of common air which will be expelled; for it is this which determines the number of ſtrokes which muſt be made in a minute, in order that the proper ſupply may be obtained. Therefore recollect that the quantity expelled from a given orifice with a given velocity, is in the proportion of the denſity; and that when D is the denſity of common air produced by the preſſure P, the denſity d produced by the preſſure $\mathrm{P}+p$, is $\mathrm{D} \times \frac{\mathrm{P}+p}{\mathrm{P}}$; or if D be made 1, we have $d = \frac{\mathrm{P}+p}{\mathrm{P}}$.

Therefore, calling the area of the orifice expreſſed in ſquare feet O, and the quantity of common air, or the cubic feet expelled in a ſecond Q, we have $\mathrm{Q} = \mathrm{V} \times \mathrm{O} \times \sqrt{\frac{p}{\mathrm{P}+p}} \times \frac{\mathrm{P}+p}{\mathrm{P}}$.

It will be ſufficiently exact for all practical purpoſes to ſuppoſe P to be 15 pounds on every ſquare inch of the piſton; and p is then conveniently expreſſed by the pounds of additional load on every ſquare inch: we may alſo take $\mathrm{V} = 1332$ feet.

As the orifice through which the air is expelled is generally very ſmall, never exceeding three inches in diameter, it will be more convenient to expreſs it in ſquare inches; which being the $\frac{1}{144}$ of a ſquare foot, we ſhall have the cubic feet of common air expelled in a ſecond, or $\mathrm{Q} = \frac{1332}{144}\mathrm{O} \sqrt{\frac{p}{\mathrm{P}+p}} \times \frac{\mathrm{P}+p}{\mathrm{P}}$, $= \mathrm{O} \times 9{,}25 \times \sqrt{\frac{p}{\mathrm{P}+p}} \times \frac{\mathrm{P}+p}{\mathrm{P}}$; and this ſeems to be as ſimple an expreſſion as we can obtain.

This will perhaps be illuſtrated by taking an example in numbers. Let the area of the piſton be four ſquare feet, and the area of the round hole through which the air is expelled be two inches, its diameter being 1,6, and let the load on the piſton be 1728 pounds: this is three pounds on every ſquare inch. We have $\mathrm{P} = 15$, $p = 3$, $\mathrm{P}+p = 18$, and $\mathrm{O} = 2$; therefore we will have $\mathrm{Q} = 2 \times 9{,}25 \times \sqrt{\frac{3}{18}} \times \frac{18}{15}, = 9{,}053$ cubic feet of common air expelled in a ſecond. This will however be diminiſhed at leaſt one-third by the contraction of the jet; and therefore the ſupply will not exceed ſix cubic feet *per* ſecond. Suppoſing therefore that this blowing machine is a cylinder or priſm of this dimenſion in its ſection, the piſton ſo loaded would (after having compreſſed the air) deſcend about 15 inches in a ſecond. It would firſt ſink $\frac{1}{5}$ of the whole length of the cylinder pretty ſuddenly, till it had reduced the air to the denſity $\frac{18}{15}$, and would then deſcend uniformly at the above rate, expelling ſix cubic feet of common air in a ſecond.

The computation is made much in the ſame way for bellows of the common form, with this additional circumſtance, that as the loaded board moves round a hinge at one end, the preſſure of the load muſt be calculated accordingly. The computation, however, becomes a little intricate, when the form of the loaded board is not rectangular; it is almoſt uſeleſs when the bellows have flexible ſides, either like ſmith's bellows or like organ bellows, becauſe the change of figure during their motion makes continual variation on the compreſſing powers. It is therefore chiefly with reſpect to the great wooden bellows, of which the upper board ſlides down between the ſides, that the above calculation is of ſervice.

The propriety however of this piece of information is evident; we do not know preciſely the quantity of air neceſſary for animating a furnace; but this calculation tells us what force muſt be employed for expelling the air that may be thought neceſſary. If we have fixed on the ſtrength of the blaſt, and the diameter of the cylinder, we learn the weight with which the piſton muſt be loaded; the length of the cylinder determines its capacity, the above calculation tells the expence *per* ſecond; hence we have the time of the piſton's coming to the bottom. This gives us the number of ſtrokes *per* minute: the load muſt be lifted up by the machine this number of times, making the time of aſcent preciſely equal to that of deſcent; otherwiſe the machine will either catch and ſtop the deſcent of the piſton, or allow it to lie inactive for a while of each ſtroke. Theſe circumſtances determine the labour to be performed by the machine, and it muſt be conſtructed accordingly. Thus the engineer will not be affronted by its failure, nor will he expend needleſs power and coſt.

In machines which force the piſton or bellows-board with a certain determined motion, different from what ariſes from their own weight, the computation is extremely intricate. When a piſton moves by a crank, its motion at the beginning and end of each ſtroke is ſlow, and the compreſſion and efflux is continually changing: we can however approximate to a ſtatement of the force required.

Every time the piſton is drawn up, a certain ſpace of the cylinder is filled again with air of the common denſity; and this is expelled during the deſcent of the piſton. A certain number of cubic feet of common air is therefore expelled with a velocity which perhaps continually varies; but there is a medium velocity with which it might have been uniformly expelled, and a preſſure correſponding to this velocity. To find this, divide the area of the piſton by the area of the blaſt hole (or rather by this area multiplied by 0,613, in order to take in the effect of the contracted jet), and multiply the length of the ſtroke performed in a ſecond by the quotient ariſing from this diviſion; the product is the medium velocity of the air (of the natural denſity). Then find by calculation the height through which a heavy body muſt fall in order to acquire this velocity; this is the height of a column of homogeneous air which would expel it with this velocity. The weight of this column is the leaſt force that can be exerted by the engine: but this force is too ſmall to overcome the reſiſtance in the middle of the ſtroke, and it is too great even for the end of the ſtroke, and much too great for the beginning of it. But if the machine is turned by a very heavy water-wheel, this will act as a regulator, accumulating in itſelf the ſuperfluous force during the too favourable poſitions of the crank, and exerting it by its *vis inſita* during the time of greateſt effort. A force not greatly exceeding the weight of this column of air will therefore ſuffice. On the other hand, if the ſtrength of the blaſt be determined, which is the general ſtate of the problem, this determines the degree of condenſation of the air, and the load on the ſquare inch of the piſton, or the mean force which the machine muſt exert on it. A table, which will be given preſently, determines the cubic feet of common air expelled in a ſecond, correſponding to this load. This combined with the propoſed dimenſions of the cylinder, will give the deſcent of the piſton or the length of the ſtroke.

Theſe general obſervations apply to all forms of bellows; and without a knowledge of them no perſon can erect a machine for working them without total uncertainty or ſervile imitation. In order, therefore, that they may be uſeful to ſuch as are not accuſtomed to the management of even theſe ſimple formulæ, we inſert the following ſhort table of the velocity and quantity of air diſcharged from a cylinder whoſe piſton is loaded with the pounds contained in the firſt column on every ſquare inch. The ſecond column contains the velocity with which the *condenſed air* ruſhes out through any *ſmall* hole; and the third column is the cubic feet diſcharged from a hole whoſe area is a ſquare inch; column fourth contains the mean velocity of air of the common denſity; and column fifth is the cubic feet of common air diſcharged; the ſixth column is the height in inches at which the force of the blaſt would ſupport a column of water if a pipe were inſerted into the ſide of the cylinder. This is an extremely proper addition to ſuch machines, ſhowing at all times the power of the machines, and teaching us what intenſity of blaſt is employed for different purpoſes. The table is computed from the ſuppoſition that the ordinary preſſure of the air is 15 pounds on a ſquare inch. This is ſomewhat too great, and therefore the velocities are a little too ſmall; but the quantities diſcharged will be found about one-third too great (without affecting the velocities) on account of the convergency of the ſtream.

I	II	III	IV	V	VI
½	239	1,66	247	1,72	14
1	333	2,31	355	2,47	27
1½	404	2,79	437	3,05	40
2	457	3,17	518	3,60	54
2½	500	3,48	584	4,2	68
3	544	3,76	653	4,53	82
3½	582	4,03	715	4,98	95
4	611	4,24	774	5,38	109
4½	642	4,46	822	5,75	122
5	666	4,67	888	6,17	136
5½	693	4,84	950	6,49	150
6	711	5,06	997	6,92	163

This table extends far beyond the limits of ordinary uſe, very few blaſt-furnaces having a force exceeding 60 inches of water.

We ſhall conclude this account of blowing machines with a deſcription of a ſmall one for a blow-pipe. Pl. 13. fig. 79. ABCD, is a veſſel containing water, about two feet deep. EFGH is the air-box of the blower open below, and having a pipe ILK riſing up from it to a convenient height; an arm ON which graſps this pipe carries the lamp N: the blow-pipe LM comes from the top of the upright pipe. PKQ is the feeding-pipe reaching near to the bottom of the veſſel.

Water being poured into the veſſel below, and its cover being put on, which fits the upright pipe, and touches two ſtuds *a*, *a*, projecting from it, blow in a quantity of air by the feeding pipe PQ; this expels the water from the air-box, and occaſions a preſſure which produces the blaſt through the blow-pipe M.

In No. 54 of this article, we mentioned an application which has been made of Hero's fountain, at Chemnitz, in Hungary, for raiſing water from the bottom of a mine. We ſhall now give an account of this very ingenious contrivance.

In fig. 80, B repreſents the ſource of water elevated above the mouth of the pit 136 feet. From this there is led a pipe B*b*CD four inches diameter. This pipe enters the top of a copper cylinder *b c d e*, 8½ feet high, five feet diameter, and two inches thick, and it reaches to within four inches of the bottom; it has a cock at C. This cylinder has a cock at F, and a very large one at E. From the top *b c* proceeds a pipe GHI i two inches in diameter, which goes down the pit 96 feet, and is inſerted into the top of another braſs cylinder *f g h i*, which is 6½ feet high, four feet diameter, and two inches thick, containing 83 cubic feet, which is very nearly one half of the capacity of the other, viz. of 170 cubic feet. There is another pipe NI of four inches diameter, which riſes from within four inches of the bottom of this lower cylinder, is ſoldered into its top, and riſes to the trough NO, which carries off the water from the mouth of the pit. This lower cylinder communicates at the bottom with the water L which collects in the drains of the mine. A large cock K ſerves to admit or exclude this water: another cock M, at the top of this cylinder, communicates with the external air.

Now ſuppoſe the cock C ſhut, and all the reſt open; the upper cylinder will contain air, and the lower cylinder will be filled with water, becauſe it is ſunk ſo deep that its top is below the uſual ſurface of the mine-waters. Now ſhut the cocks

F, E, M, K, and open the cock C. The water of the ſource B muſt run in by the orifice D, and riſe in the upper cylinder, compreſſing the air above it and along the pipe GHH′, and thus acting on the ſurface of the water in the lower cylinder. It will therefore cauſe it to riſe gradually in the pipe IN, where it will always be of ſuch a height that its weight balances the elaſticity of the compreſſed air. Suppoſe no iſſue given to the air from the upper cylinder, it would be compreſſed into one-fifth of its bulk by the column of 136 feet high; for a column of 34 feet nearly balances the ordinary elaſticity of the air. Therefore, when there is an iſſue given to it through the pipe GHH, it will drive the compreſſed air along this pipe, and it will expel water from the lower cylinder. When the upper cylinder is full of water, there will be 34 cubic feet of water expelled from the lower cylinder. If the pipe IN had been more than 136 feet long, the water would have riſen 136 feet, being then in equilibrio with the water in the feeding pipe B*b*CD (as was ſhown in No. 52.), by the intervention of the elaſtic air; but no more water would have been expelled from the lower cylinder than what fills this pipe. But the pipe being only 96 feet high, the water will be thrown out at N with a very great velocity. If it were not for the great obſtructions which water and air muſt meet with in their paſſage along pipes, it would iſſue at N with a velocity of more than 50 feet per ſecond. It iſſues much more ſlowly, and at laſt the upper cylinder is full of water, and the water would enter the pipe GH and enter the lower cylinder, and, without diſplacing the air in it, would riſe through the diſcharging pipe IN, and run off to waſte. To prevent this there hangs in the pipe HG a cork ball or double cone, by a braſs wire which is guided by holes in two croſs pieces in the pipe HG. When the upper cylinder is filled with water, this cork plugs up the orifice G, and no water is waſted; the influx at D now ſtops. But the lower cylinder contains compreſſed air, which would balance water in a diſcharging pipe 136 feet high, whereas IN is only 96. Therefore the water will continue to flow at N till the air has ſo far expanded as to balance only 96 feet of water, that is, till it occupies one-half of its ordinary bulk, that is, one-fourth of the capacity of the upper cylinder, or $42\frac{1}{2}$ cubic feet. Therefore $42\frac{1}{2}$ cubic feet will be expelled, and the efflux at N will ceaſe; and the lower cylinder is about one-half full of water. When the attending workman obſerves this, he ſhuts the cock C. He might have done this before, had he known when the orifice G was ſtopped; but no loſs enſues from the delay. At the ſame time the attendant opens the cock E, the water iſſues with great violence, being preſſed by the condenſed air from the lower cylinder. It therefore iſſues with the ſum of its own weight and of this compreſſion. Theſe gradually decreaſe together, by the efflux of the water and the expanſion of the air; but this efflux ſtops before all the water has flowed out; for there is $42\frac{1}{2}$ feet of the lower cylinder occupied by air. This quantity of water remains, therefore, in the upper cylinder nearly: the workman knows this, becauſe the diſcharged water is received firſt of all into a veſſel containing three-fourths of the capacity of the upper cylinder. Whenever this is filled, the attendant opens the cock K by a long rod which goes down the ſhaft; this allows the water of the mine to fill the lower cylinder, allows the air to get into the upper cylinder, and this allows the remaining water to run out of it.

And thus every thing is brought into its firſt condition; and when the attendant ſees no more water come out at E, he ſhuts the cocks E and M, and opens the cock C, and the operation is repeated.

There is a very ſurpriſing appearance in the working of this engine. When the efflux at N has ſtopped, if the cock F be opened, the water and air ruſh out together with prodigious violence, and the drops of water are changed into hail or lumps of ice. It is a ſight uſually ſhown to ſtrangers, who are deſired to hold their hats to receive the blaſt of air: the ice comes out with ſuch violence as frequently to pierce the hat like a piſtol bullet. This rapid congelation is a remarkable inſtance of the general fact, that air by ſuddenly expanding, generates cold, its capacity for heat being increaſed. Thus the peaſant cools his broth by blowing over the ſpoon, even from warm lungs: a ſtream of air from a pipe is always cooling.

The above account of the procedure in working this engine ſhows that the efflux both at N and E becomes very ſlow near the end. It is found convenient therefore not to wait for the complete diſcharges, but to turn the cocks when about 30 cubic feet of water have been diſcharged at N: more work is done in this way. A gentleman of great accuracy and knowledge of theſe ſubjects took the trouble, at our deſire, of noticing particularly the performance of the machine. He obſerved that each ſtroke, as it may be called, took up about three minutes and one-eighth; and that 32 cubic feet of water were diſcharged at N, and 66 were expended at E. The expence therefore is 66 feet of water falling 136 feet, and the performance is 32 raiſed 96, and they are in the proportion of 66 × 136 to 32 × 96, or of 1 to 0,3422, or nearly as 3 to 1. This is ſuperior to the performance of the moſt perfect underſhot mill, even when all friction and irregular obſtructions are neglected; and is not much inferior to any overſhot pump mill that has yet been erected. When we reflect on the great obſtructions which water meets with in its paſſage through long pipes, we may be aſſured that, by doubling the ſize of the feeder and diſcharger, the performance of the machine will be greatly improved; we do not heſitate to ſay, that it would be increaſed one-third: it is true that it will expend more water; but this will not be nearly in the ſame proportion; for moſt of the deficiency of the machine ariſes from the needleſs velocity of the firſt efflux at N. The diſcharging pipe ought to be 110 feet high, and not give ſenſibly leſs water.

Then it muſt be conſidered how inferior in original expence this ſimple machine muſt be to a mill of any kind which would raiſe 10 cubic feet 96 feet high in a minute, and how ſmall the repairs on it need be, when compared with a mill.

And, laſtly, let it be noticed, that ſuch a machine can be uſed where no mill whatever can be put in motion. A ſmall ſtream of water, which would not move any kind of wheel, will here raiſe one-third of its own quantity to the ſame height; working as faſt as it is ſupplied.

For all theſe reaſons, we think that the Hungarian machine eminently deſerves the attention of mathematicians and engineers, to bring it to its utmoſt perfection, and into general uſe. There are ſituations where this kind of machine may be very uſeful. Thus, where the tide riſes 17 feet, it may be uſed for compreſſing air to ſeven-eighths of its bulk; and a pipe leading from a very large veſſel inverted in it, may be uſed for raiſing the water from a veſſel of one-eighth of its capacity 17 feet high; or if this veſſel has only one tenth of the capacity of the large one ſet in the tide-way, two pipes may be led from it; one into the ſmall veſſel, and the other into an equal veſſel 16 feet higher, which receives the water from the firſt. Thus one-ſixteenth of the water may be raiſed 34 feet, and a ſmaller quantity to a ſtill greater height; and this with a kind of power that can hardly be applied in any other way. Machines of this kind are deſcribed by Schottus, Sturmius, Leupold, and other old writers; and they ſhould not be forgotten, becauſe opportunites may offer of making them highly uſeful. A gentleman's houſe in the country may thus be ſupplied with water by a machine that will coſt little, and hardly go out of repair.

The laſt pneumatical engine which we ſhall ſpeak of at preſent is the common fanners, uſed for winnowing grain, and for

PNEUMATICS.

Fig. 1.

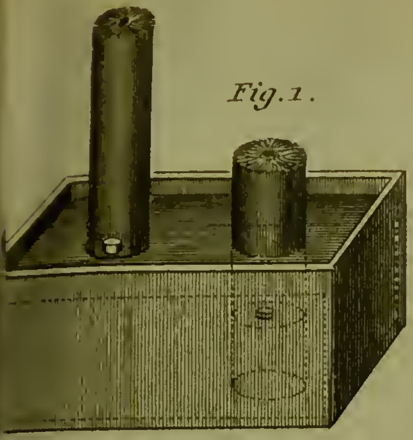
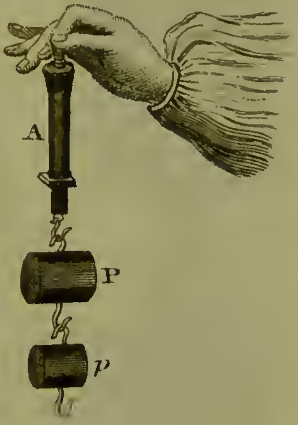


Fig. 2.



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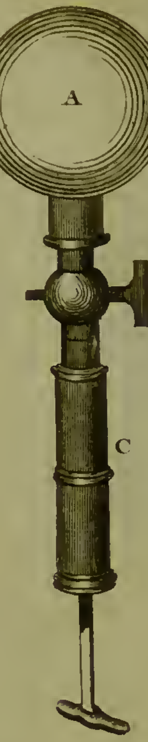

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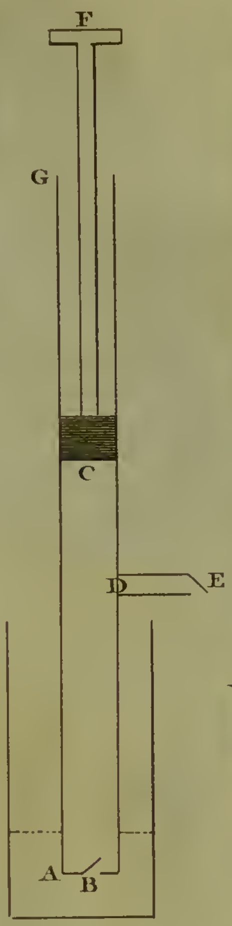

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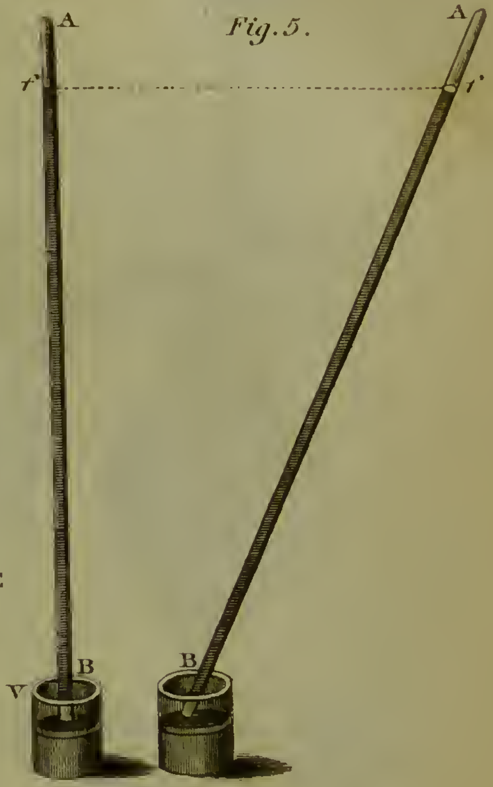

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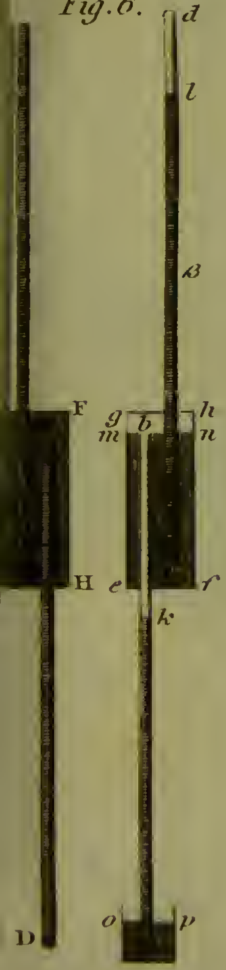

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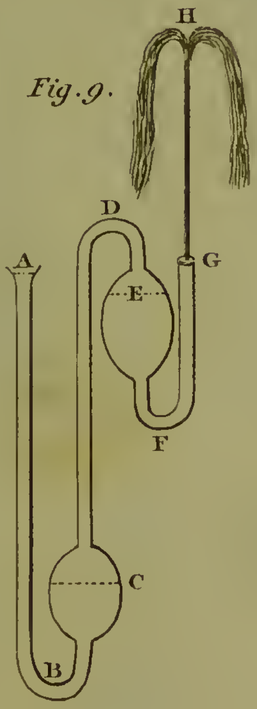

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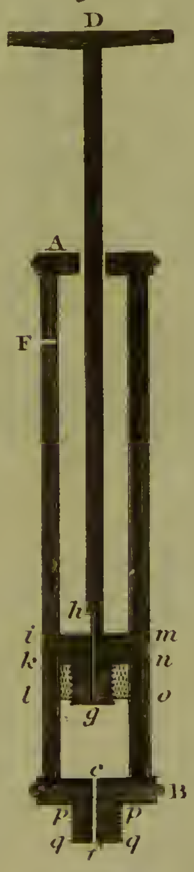

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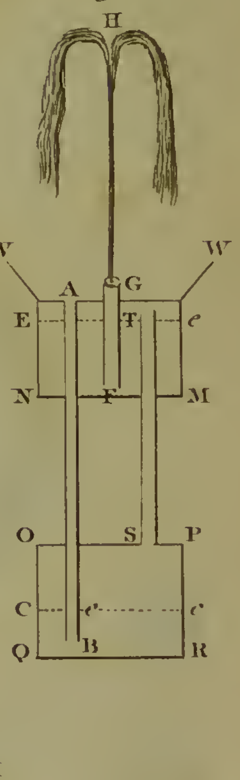

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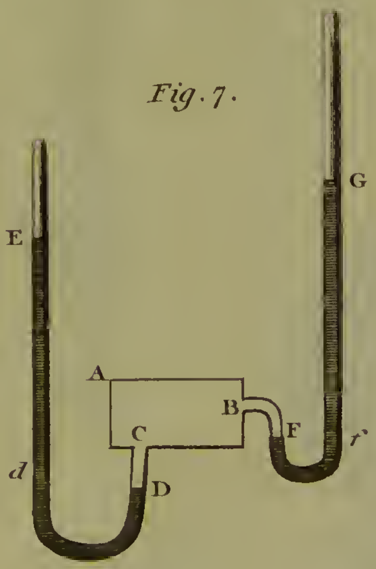

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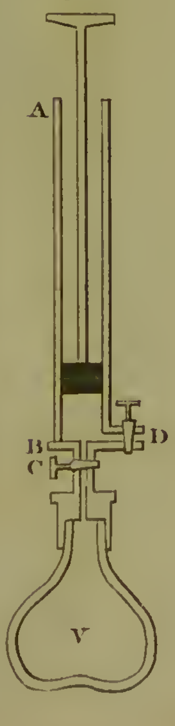

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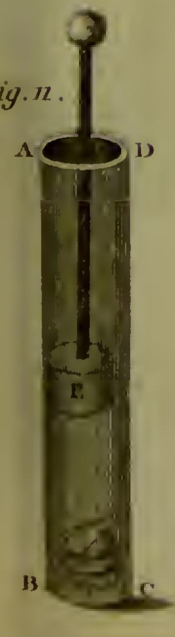

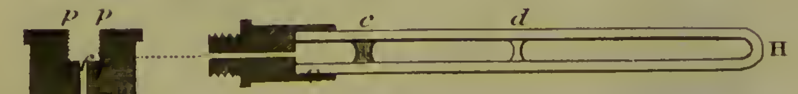
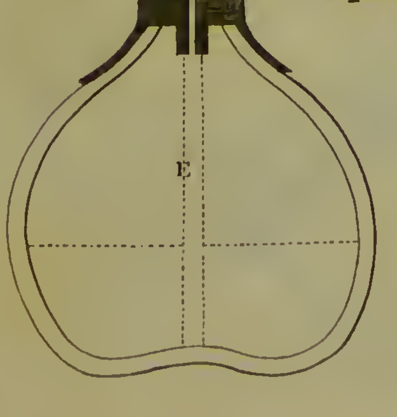

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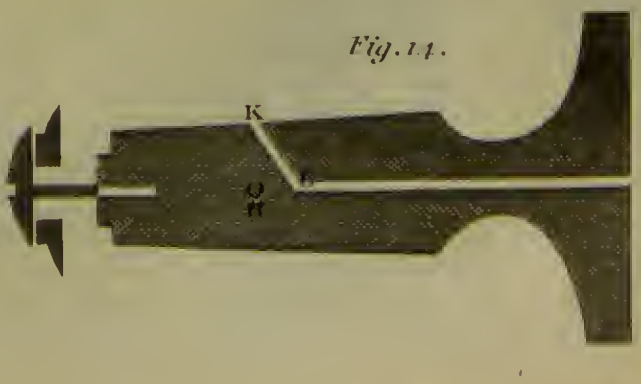
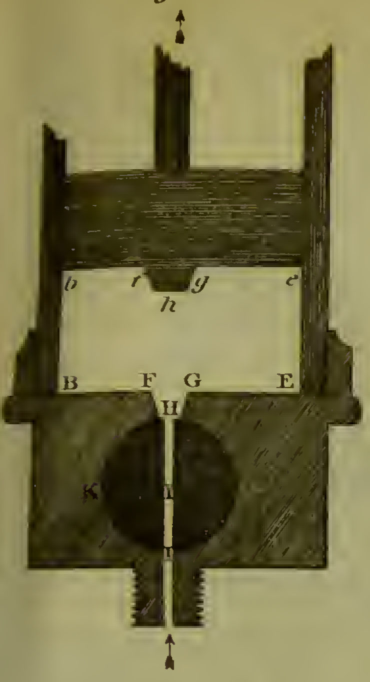


PNEUMATICS.

Fig. 13.



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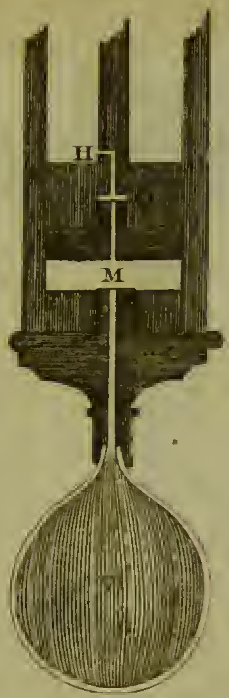

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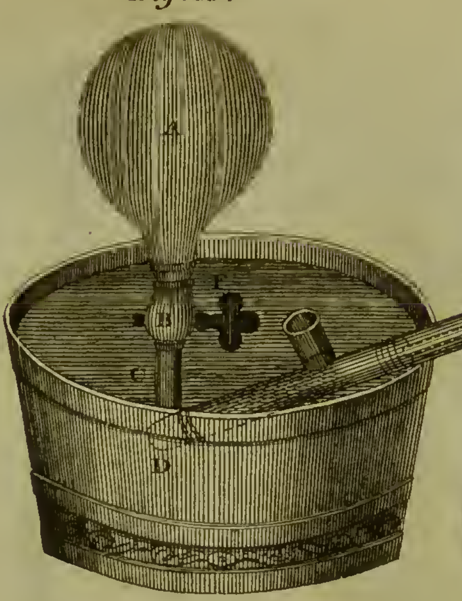

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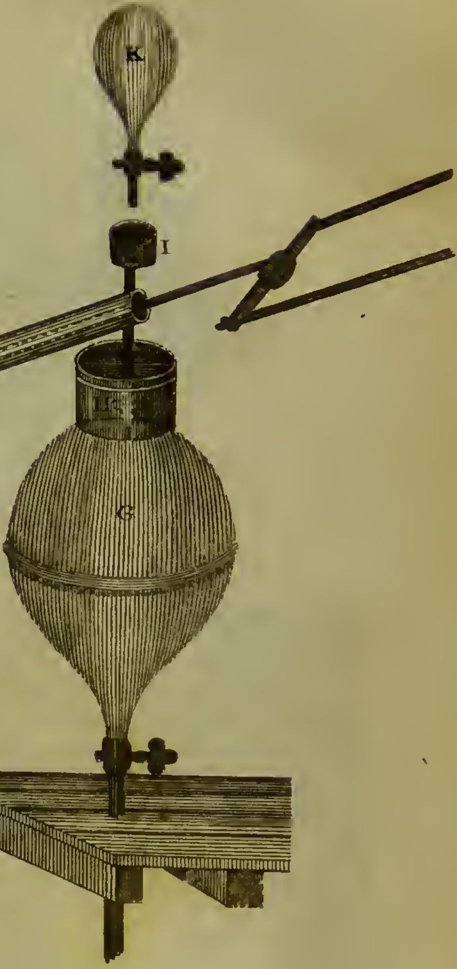

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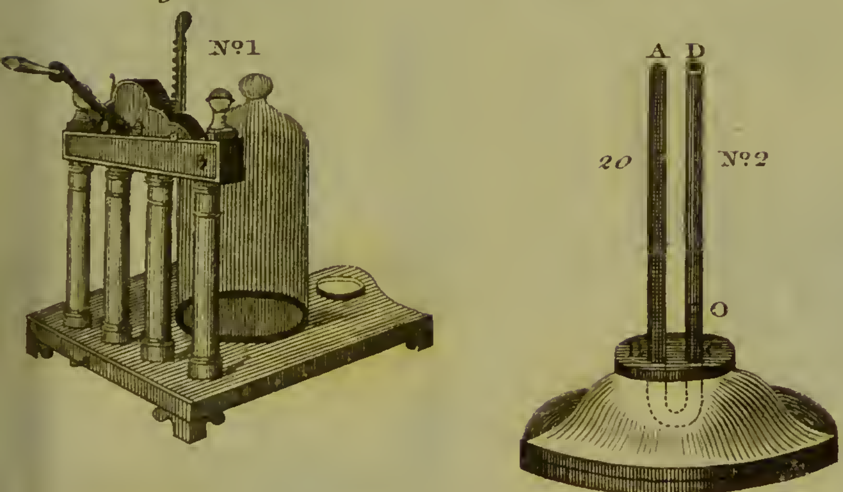

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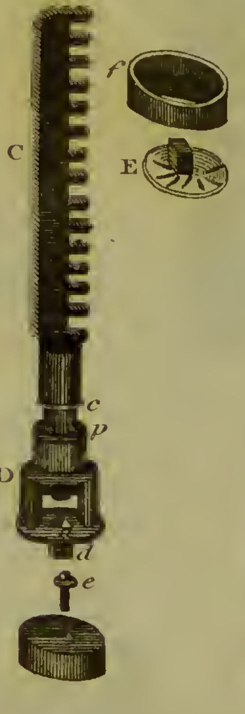

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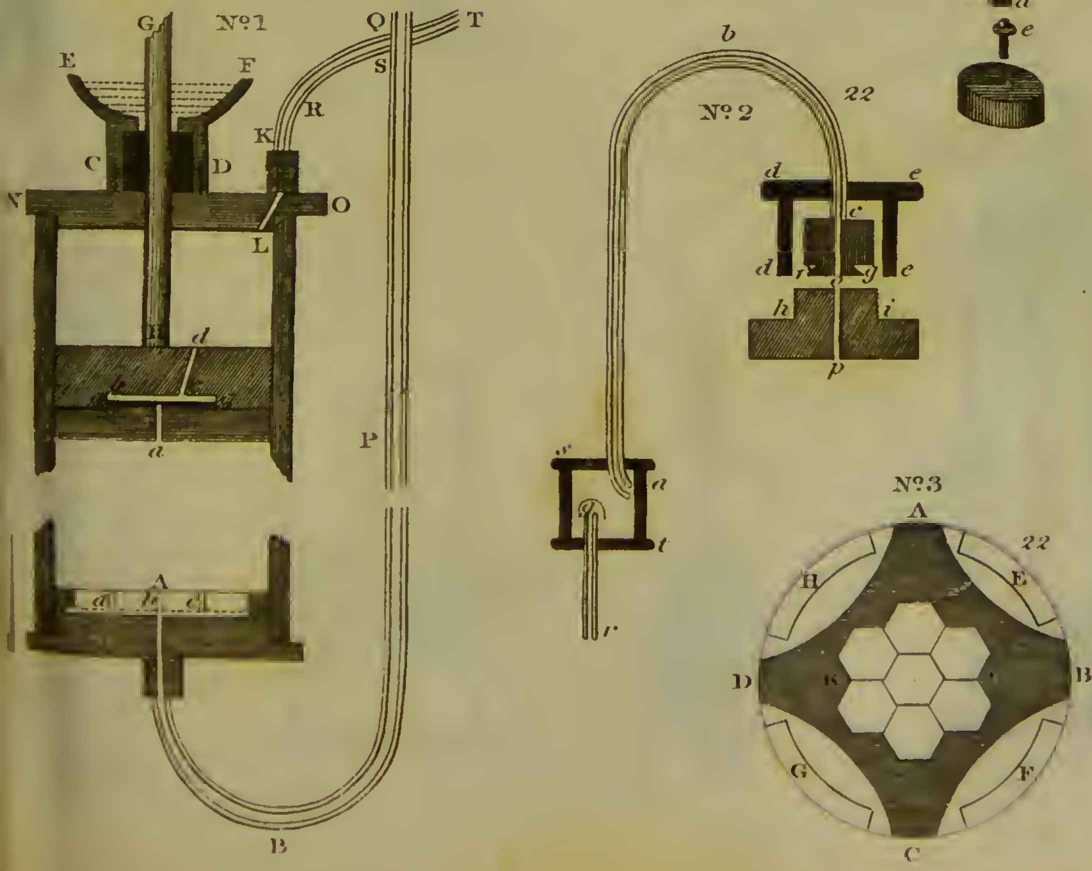

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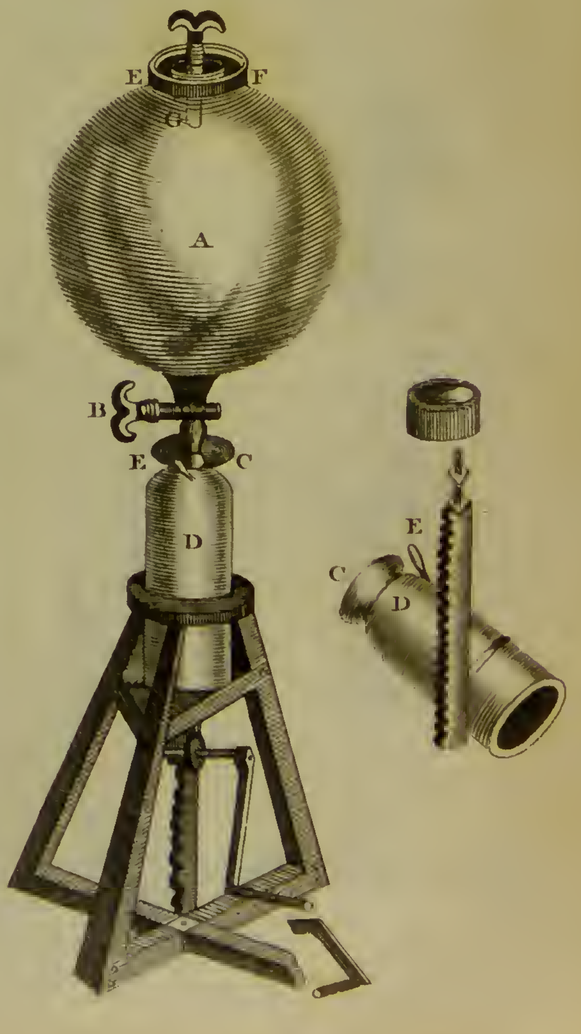

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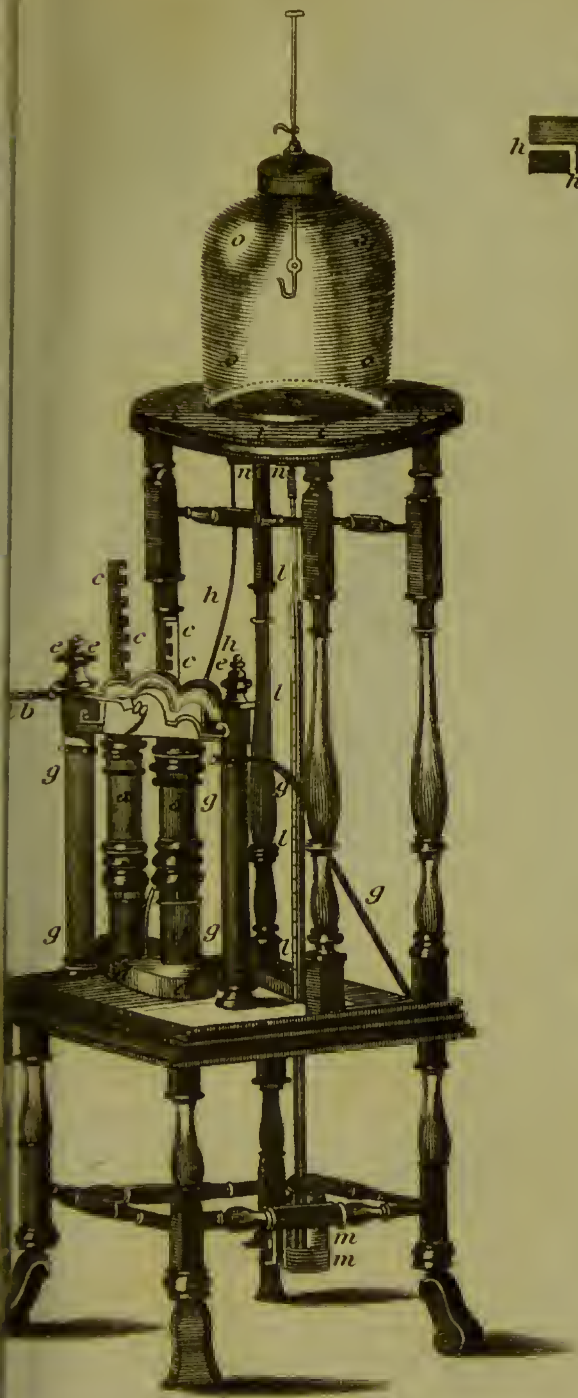
Fig. 19.



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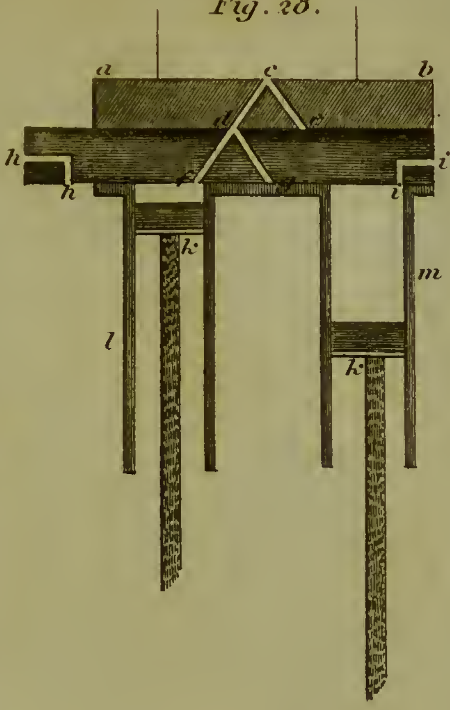

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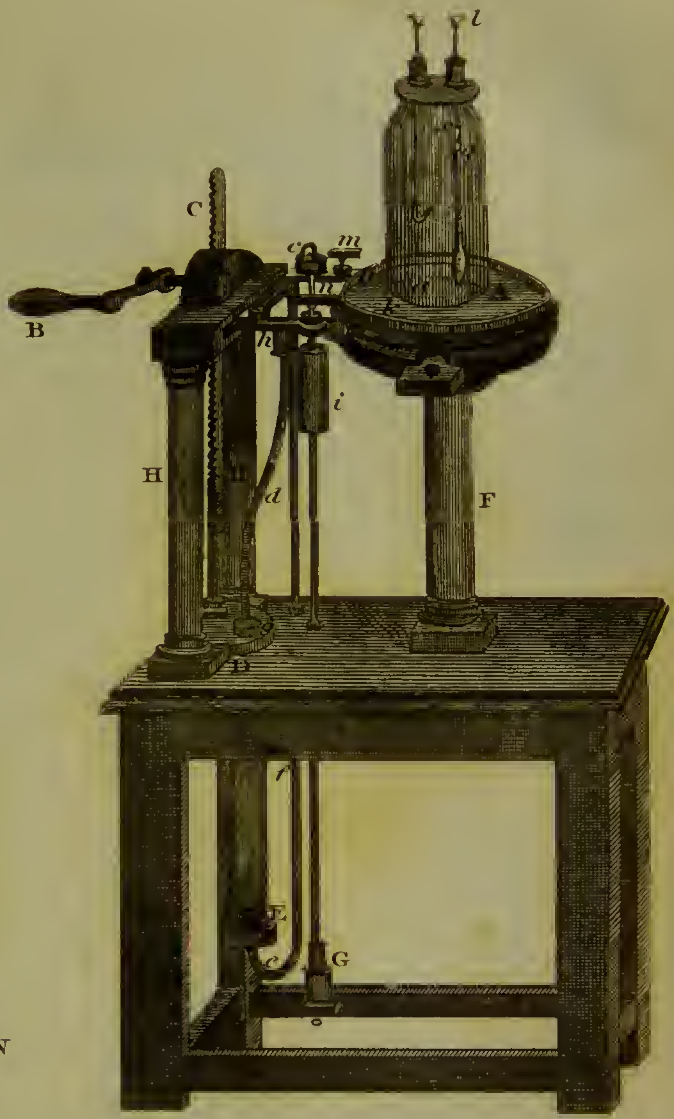

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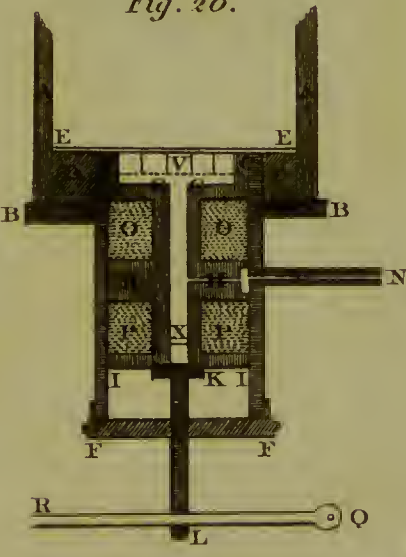

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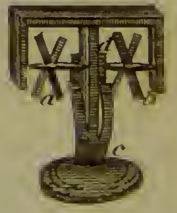

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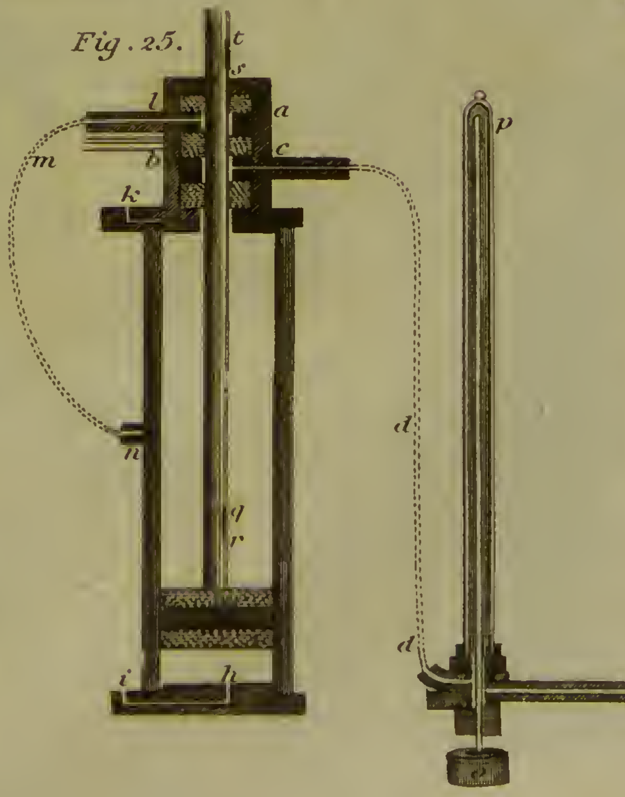

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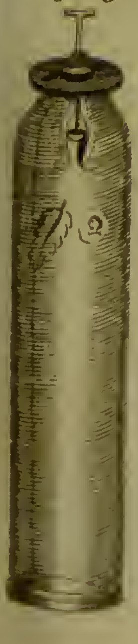

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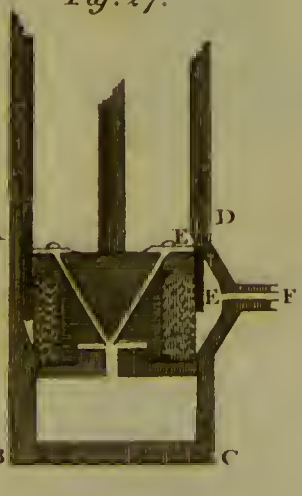

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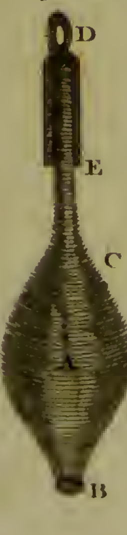

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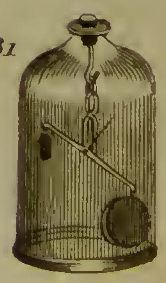


PNEUMATICS.

Fig. 32.

Fig. 33.

Fig. 34.

Fig. 35.

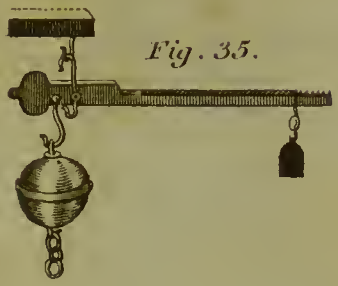
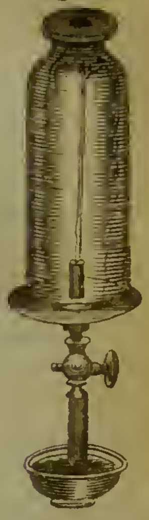


Fig. 36.

Fig. 37.



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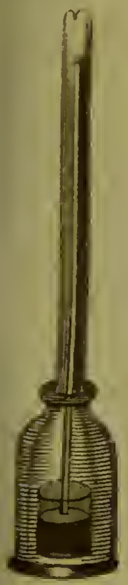

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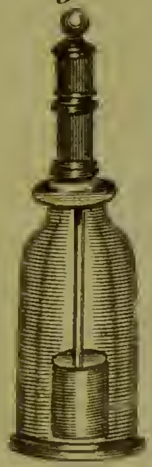

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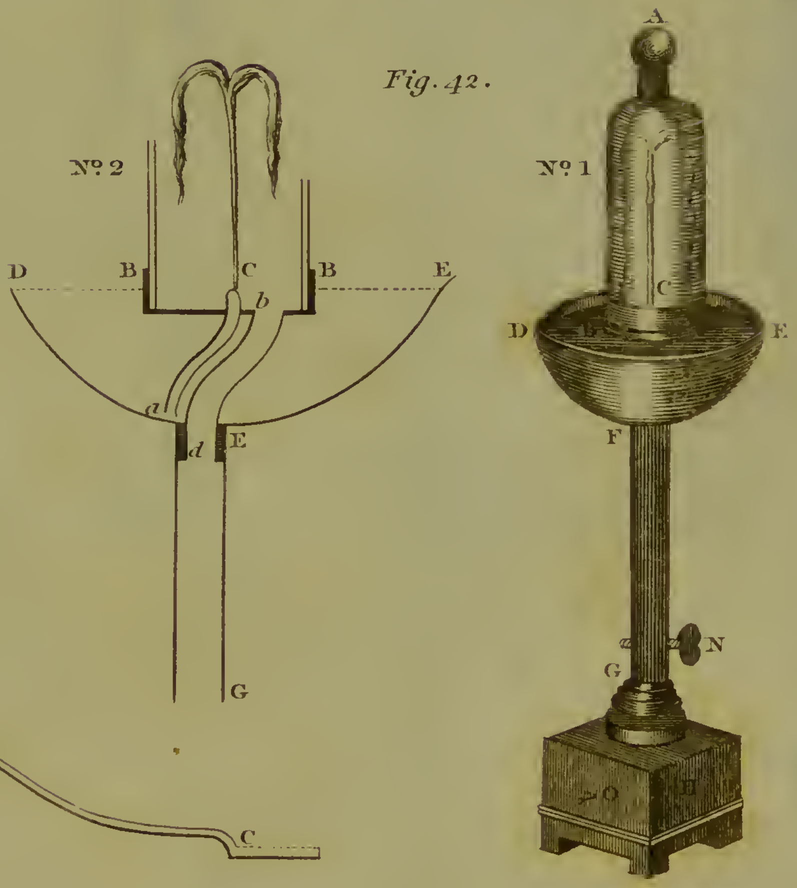

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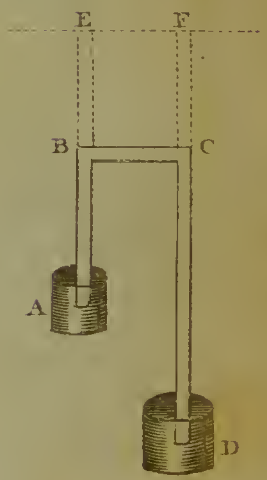

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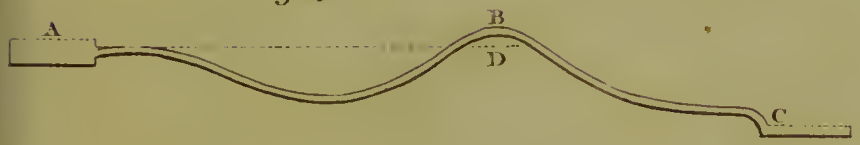

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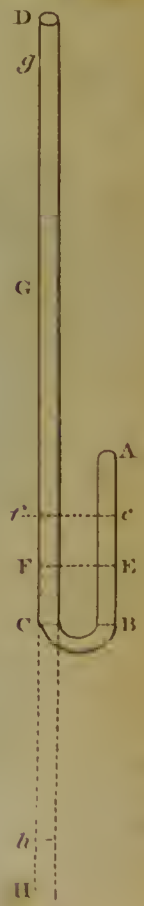

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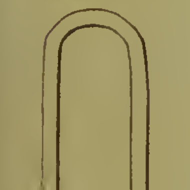

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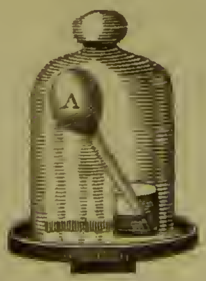
Fig. 45.



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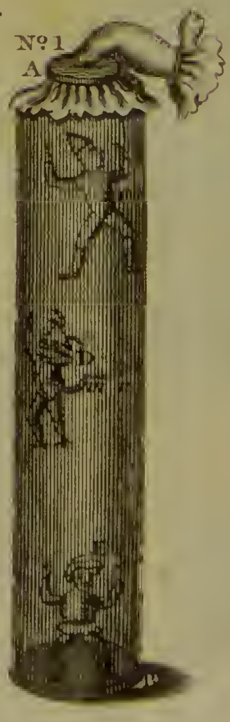

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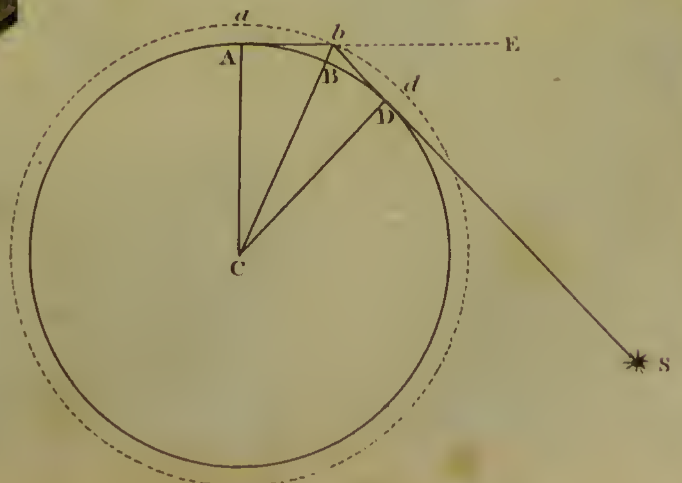
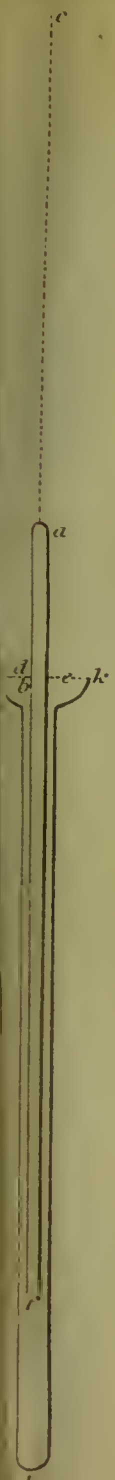


Fig. 46.

Fig. 48.

PNEUMATICS.

Fig. 50.



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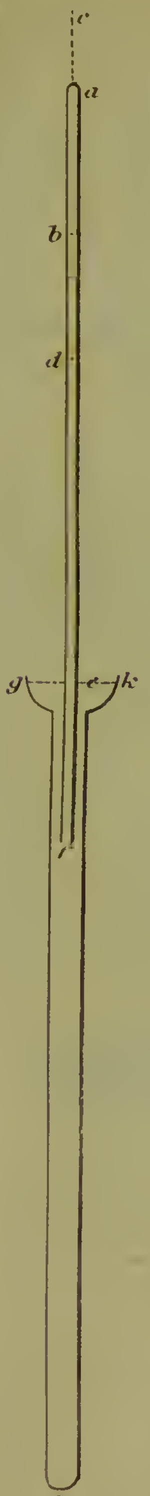

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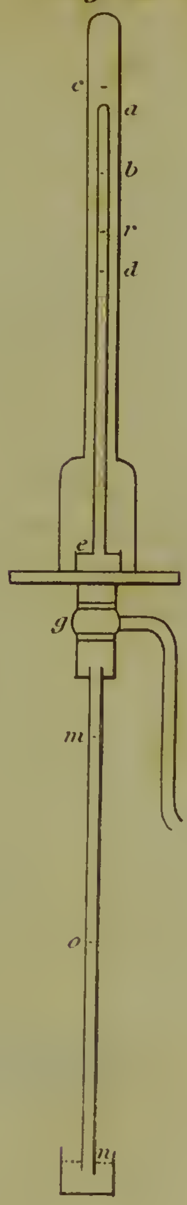

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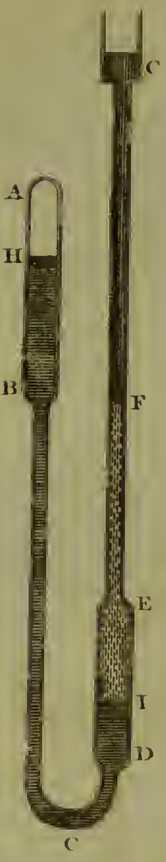

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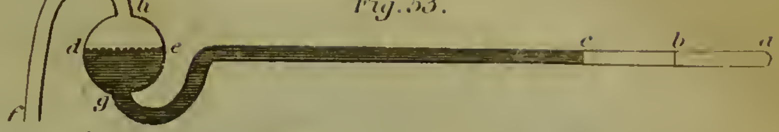

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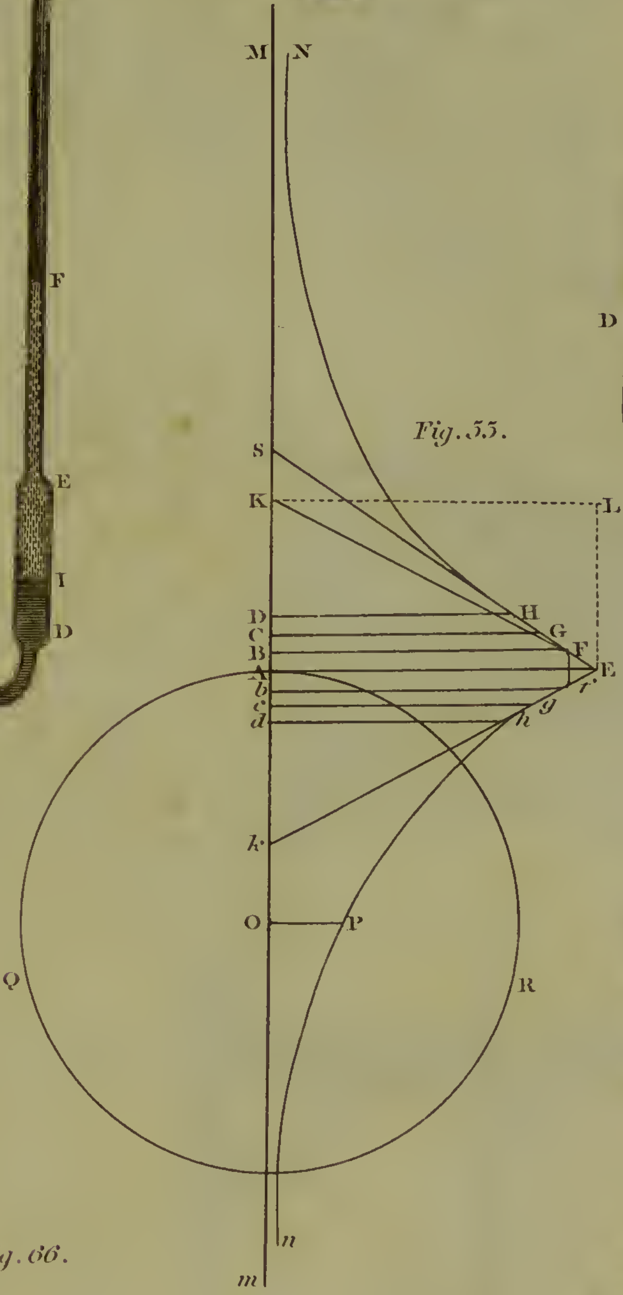

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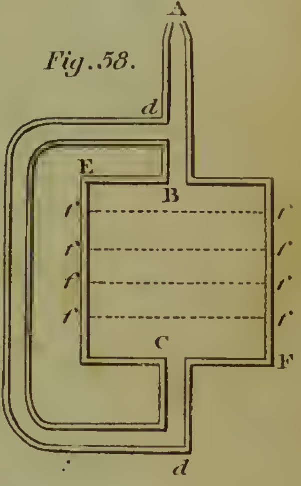

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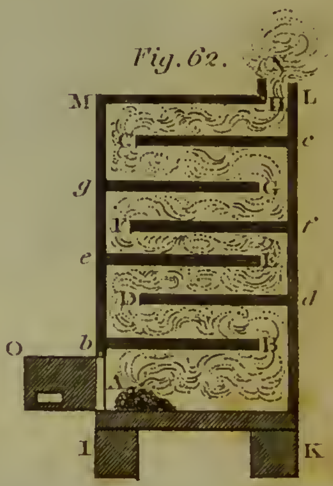

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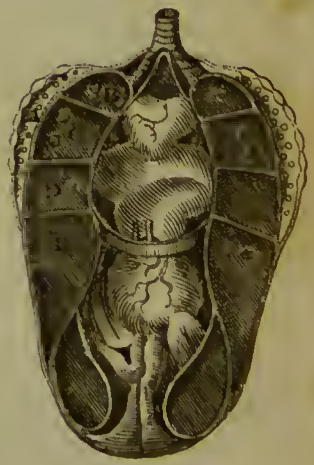

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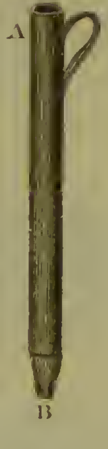

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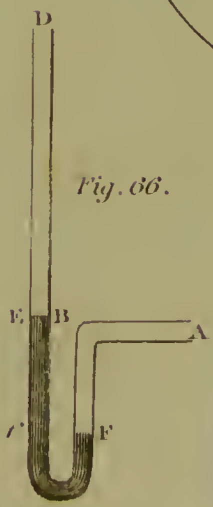

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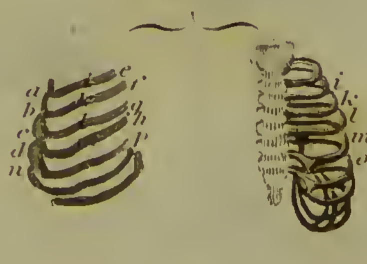

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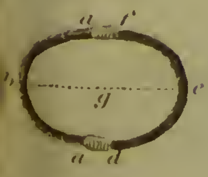

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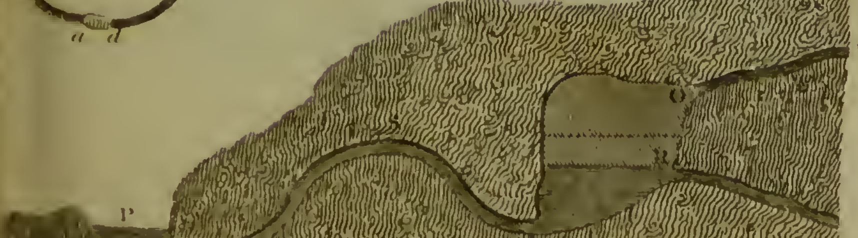

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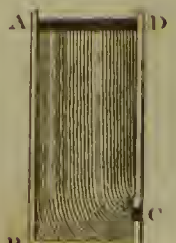

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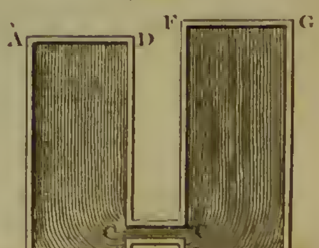
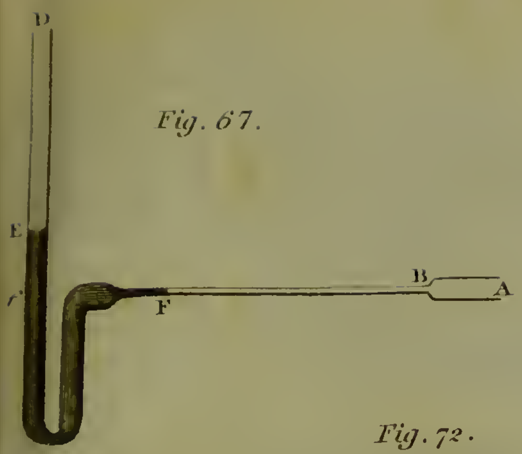


PNEUMATICS.

Fig. 67.



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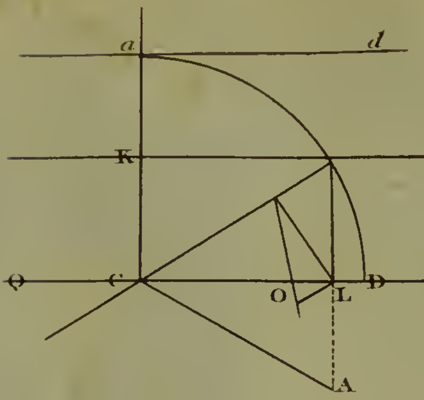

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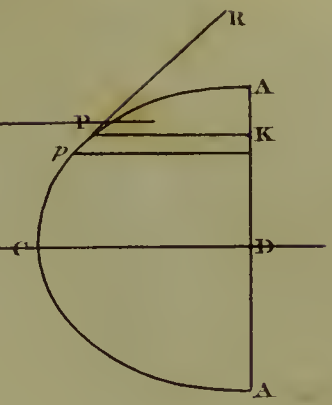

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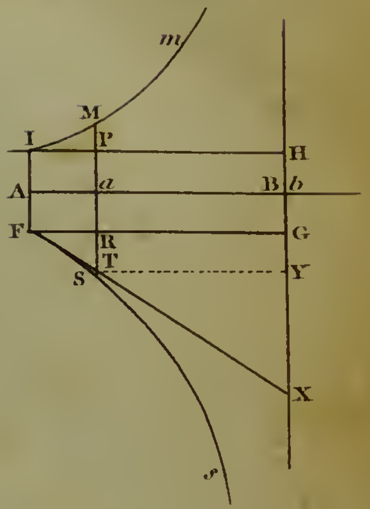

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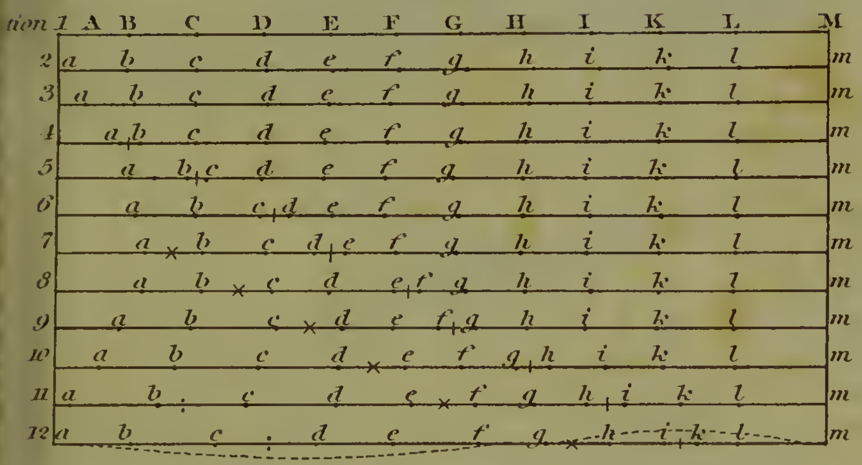
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Fig. 74.

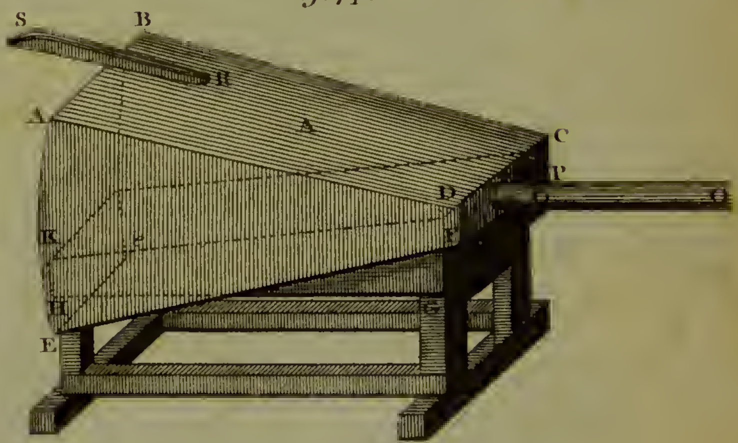
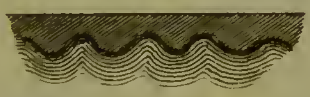


Fig. A.



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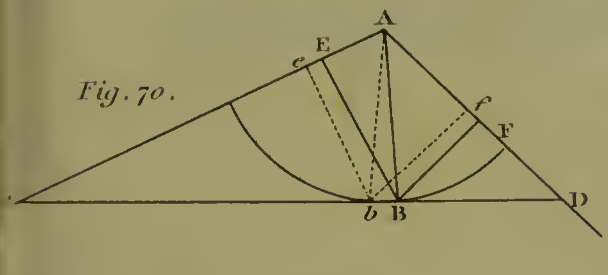

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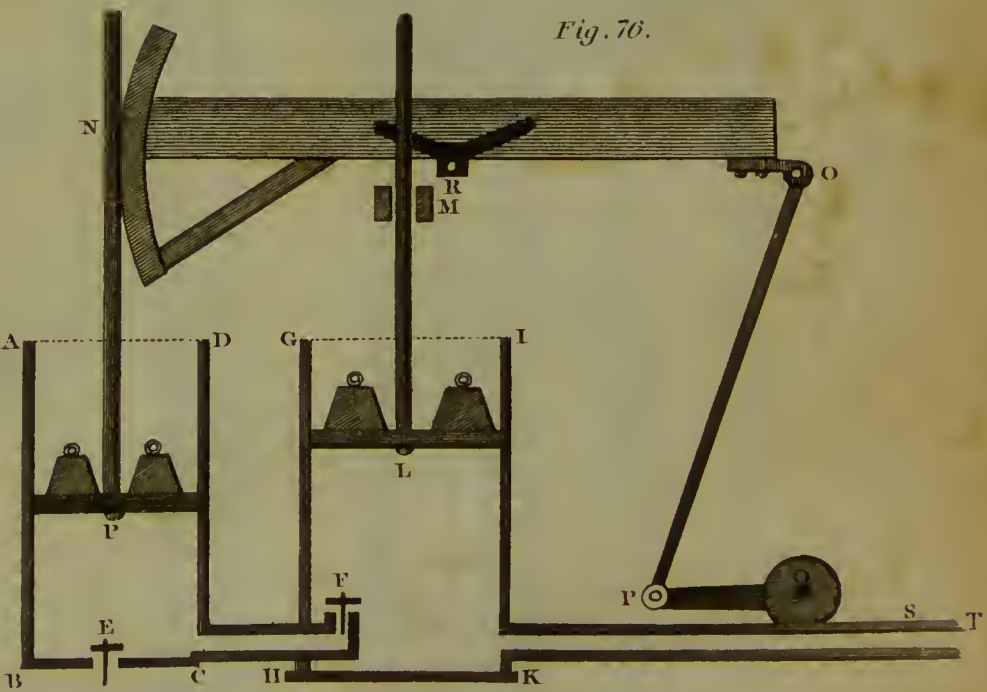

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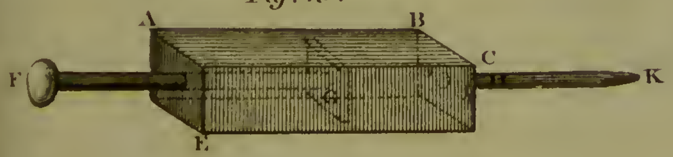

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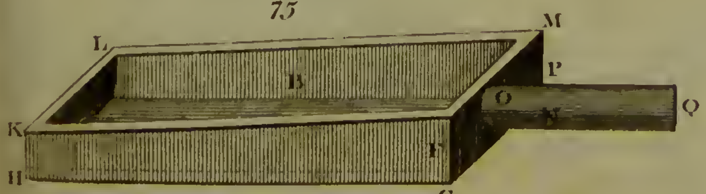

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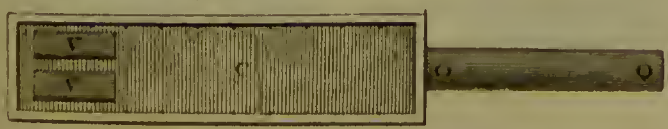

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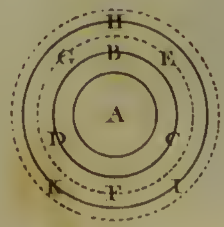
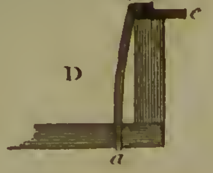
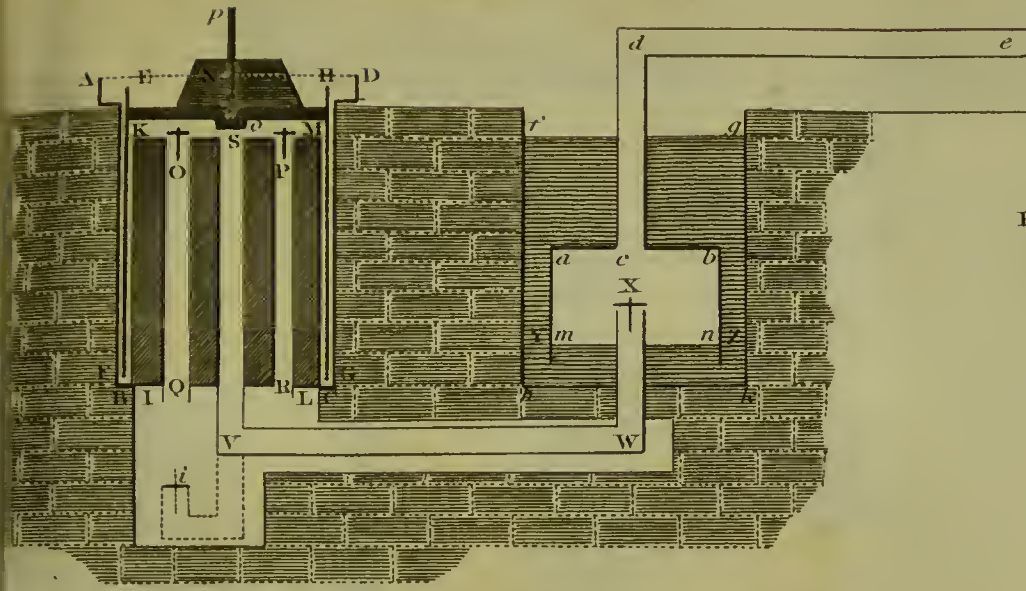




PNEUMATICS.

Fig. 78.



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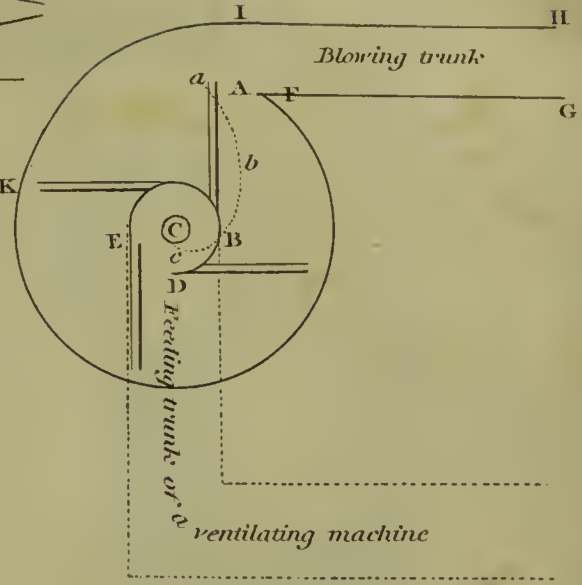

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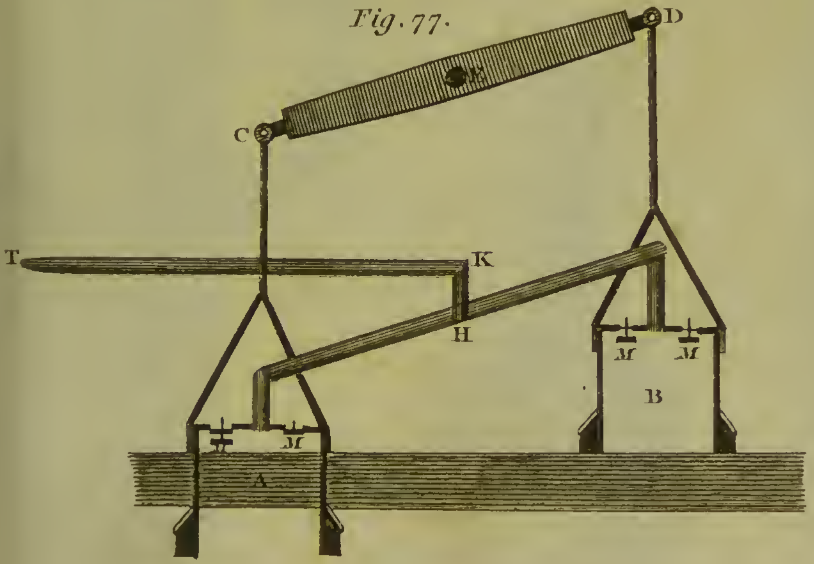
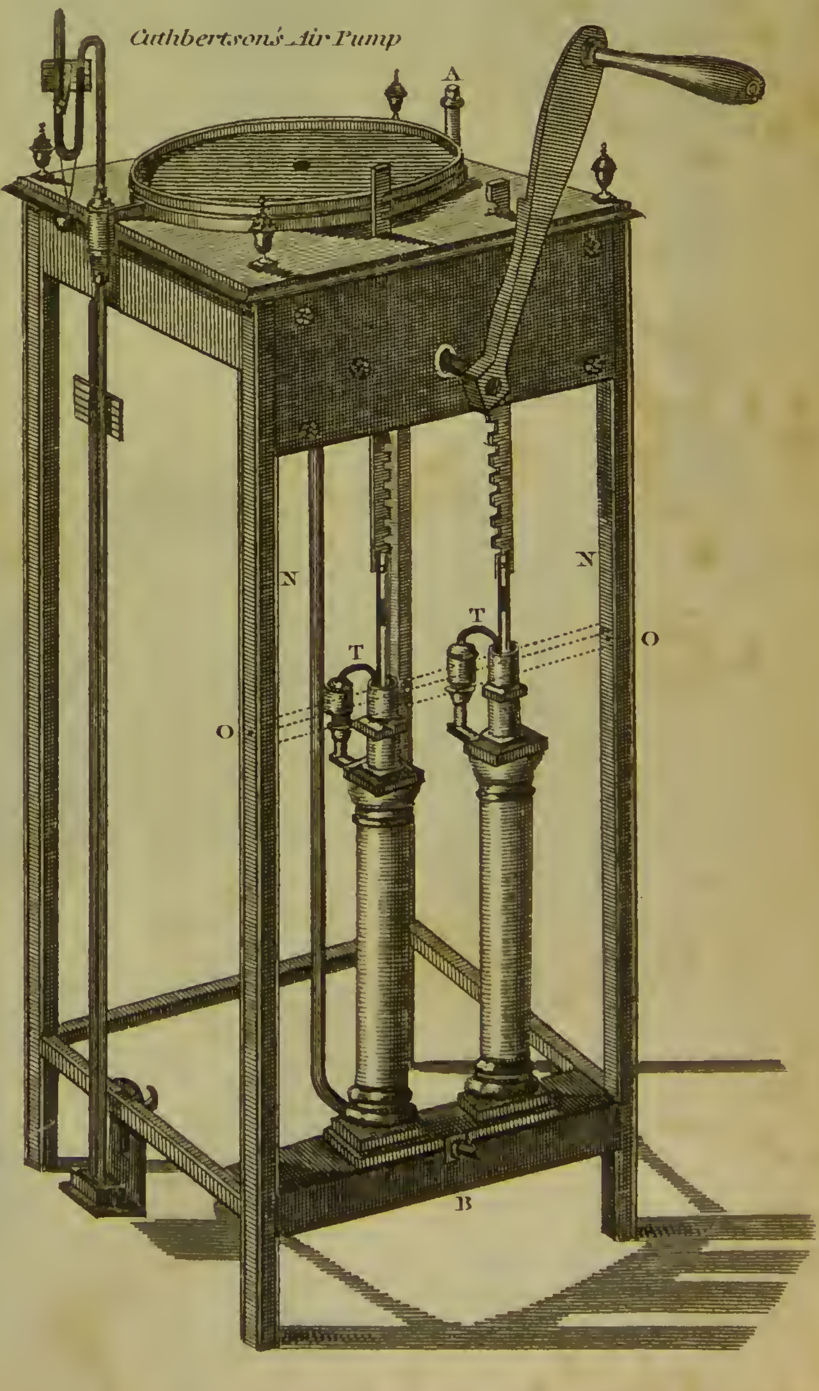


Cuthbertson's Air Pump



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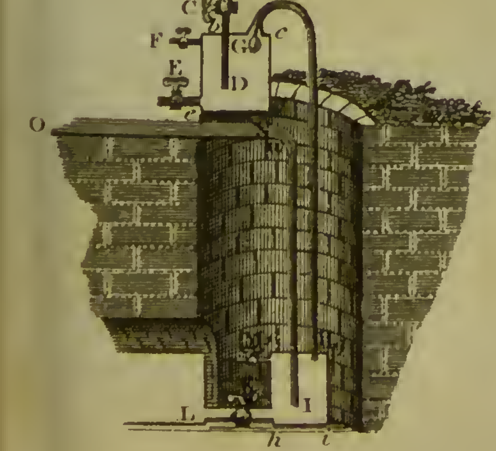

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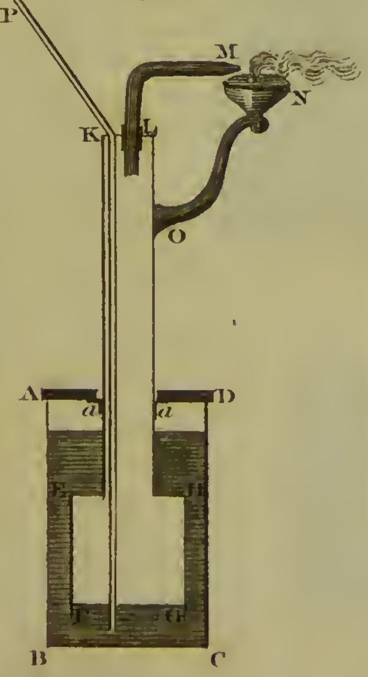


PNEUMATICS.

Section of Cuthbertsons air pump. Fig. 7.

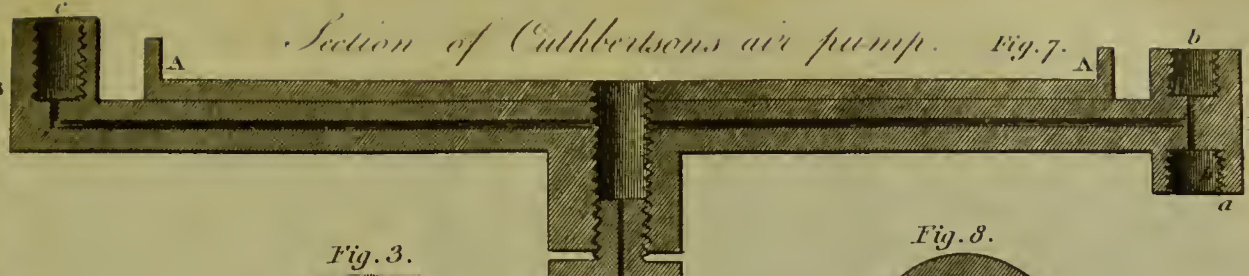


Fig. 1.

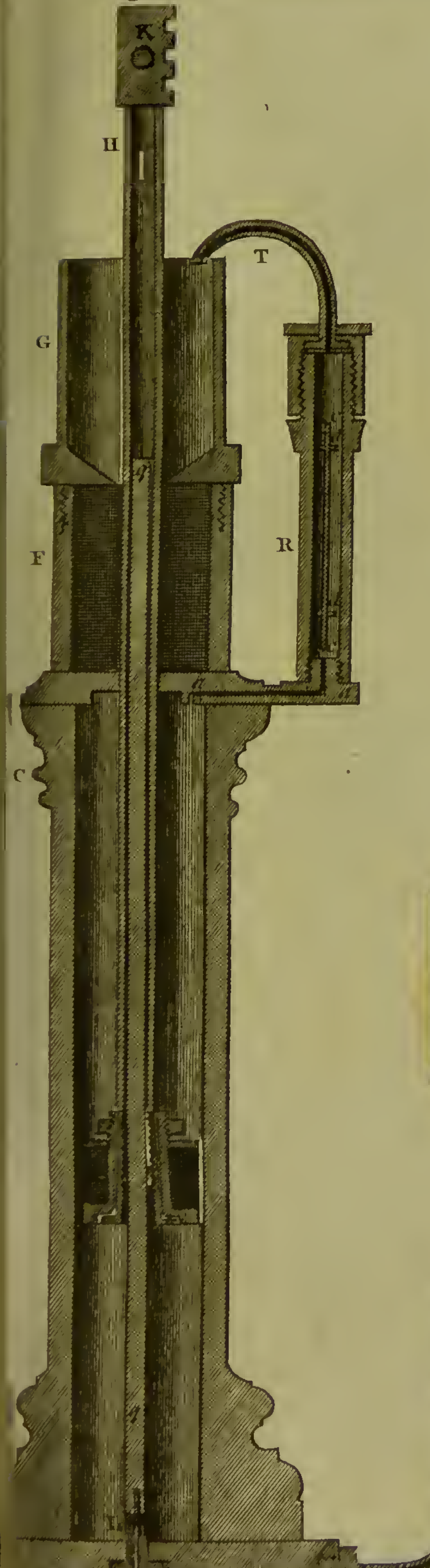


Fig. 3.

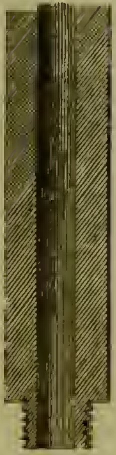


Fig. 8.

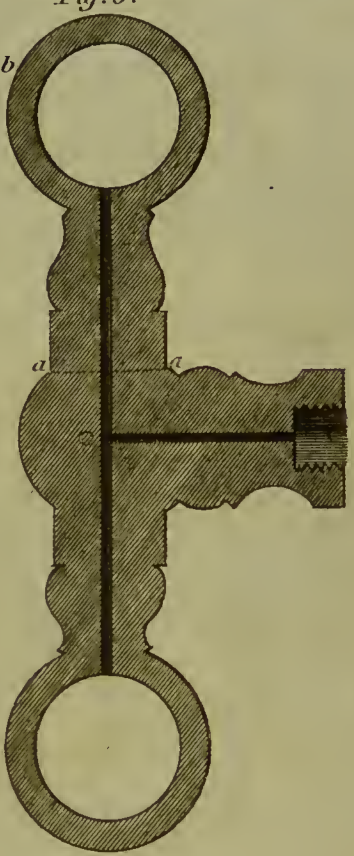
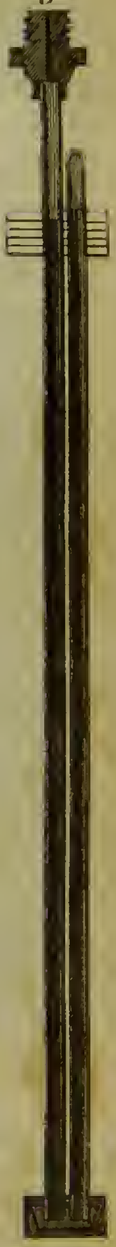


Fig. 10.



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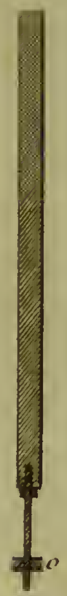

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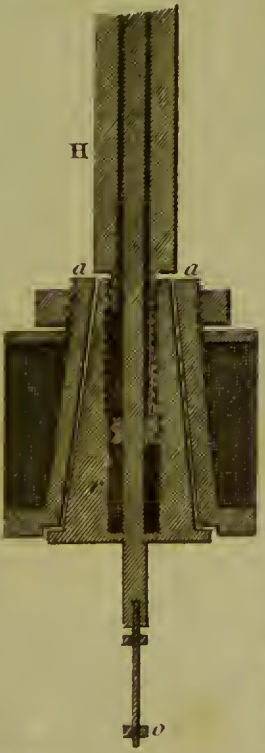

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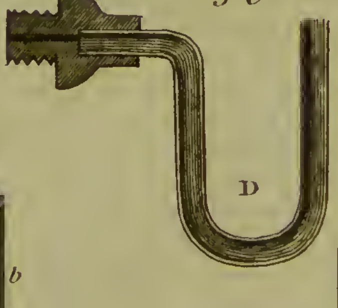

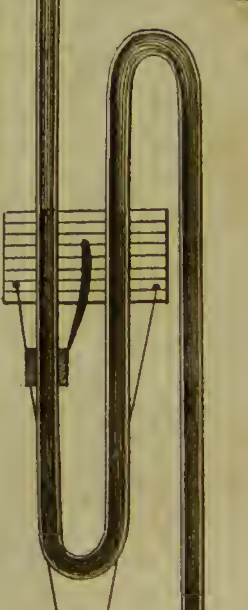

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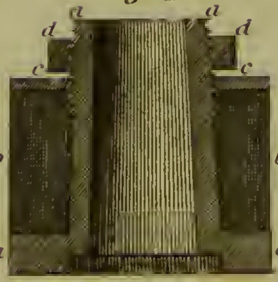

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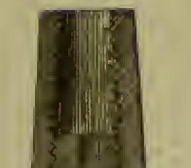

Scale of Inches.

Mutlow Sculp

drawing air out of a room: and we have but few obſervations to make on them.

The wings of the fanners are incloſed in a cylinder or drum, whoſe circular ſides have a large opening BDE (pl 13. fig. 81.) round the centre, to admit the air. By turning the wings rapidly round, the air is hurried round along with them, and thus acquires a centrifugal tendency, by which it preſſes ſtrongly on the outer rim of the drum: this is gradually detached from the circle as at KI, and terminated in a trunk IHGF, which goes off in a tangential direction: the air therefore is driven along this paſſage.

If the wings were diſpoſed in planes paſſing through the axis C, the compreſſion of the air by their anterior ſurface would give it ſome tendency to eſcape in every direction, and would obſtruct in ſome degree the arrival of more air through the ſide holes. They are therefore reclined a little backward, as repreſented in the figure. It may be ſhown that their beſt form would be that of a hyperbolic ſpiral *a b c*; but the ſtraight form approaches ſufficiently near to the moſt perfect ſhape.

Much labour is loſt, however, in carrying the air round thoſe parts of the drum where it cannot eſcape. The fanners would either draw or diſcharge almoſt twice as much air if an opening were made all round one ſide. This could be gradually contracted (where required for winnowing) by a ſurrounding cone, and thus directed againſt the falling grain: this has been verified by actual trial. When uſed for drawing air out of a room for ventilation, it would be much better to remove the outer ſide of the drum entirely, and let the air fly freely off on all ſides; but the flat ſides are neceſſary, in order to prevent the air from arriving at the fanners any other way but through the central holes, to which trunks ſhould be fitted leading to the apartment which is to be ventilated.

PNEUMATOSIS, in medicine; a diſeaſe deſcribed by Cullen as a tenſe elaſtic ſwelling of the body, crackling under the hand. It ariſes from confined air.

PNEUMONIA, in medicine; *Pyrexia*, with a pain in ſome part of the thorax, difficult reſpiration and cough. Of this affection there are two ſpecies, viz. peripneumony and pleuriſy.

PNEUMONICS, in pharmacy; medicines proper in diſeaſes of the lungs, in which reſpiration is affected.

PO, a large and celebrated river of Italy, which has its ſource at Mount Viſs in Piedmont, and on the confines of Dauphiny. It runs through Piedmont, Montferrat, the Milaneſe, and duchy of Mantua; from thence it runs to the borders of the Parmezan, and a part of the Modeneſe; and having entered the Ferareſe, it begins to divide at Ficheruolo, and proceeds to diſcharge itſelf into the Gulf of Venice by four principal mouths. As it paſſes along, it receives ſeveral rivers, and often overflows its banks, doing a great deal of miſchief: the reaſon of which is, that moſt of thoſe rivers deſcend from the Alps, and are increaſed by the melting of the ſnow.

POA, MEADOW-GRASS: a genus of the digynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the fourth order, *Gramina*. The calyx is bivalved and multiflorous; the ſpicula or partial ſpike is ovate, with the valvules ſcarious and a little ſharp, or thin on the margin. There are 20 ſpecies; moſt of them graſſes, and very agreeable food for cattle; for one ſpecies, which grows in marſhes, the cattle will frequently go ſo deep as to endanger their lives. This is called the *aquatica*, or *water reed-graſs*. It is the largeſt of the Britiſh graſſes, growing to the height of five or ſix feet. The leaves are ſmooth, and half an inch wide or more. The panicle is eight or ten inches long, greatly branched, and decked with numerous ſpicula; theſe are of a reddiſh brown colour intermixed with green, of a compreſſed lanceolate form, imbricated with about ſix flowers for the moſt part, but varying from five to ten.

POCHETTI. See BARBATELLI.

POCOCKE (DR. EDWARD), one of the moſt learned men in the oriental tongues in Europe, was the eldeſt ſon of the Rev. Edward Pococke; and was born at Oxford in 1604, were he was alſo bred. In 1628 he was admitted probationer-fellow of his college, and about the ſame time had prepared an edition of the Second Epiſtle of St. Peter, the Second and Third of St. John, and that of St. Jude, in Syriac and Greek, with a Latin Tranſlation and Notes. In 1629 he was ordained prieſt, and appointed chaplain to the Engliſh merchants at Aleppo, where he continued five or ſix years; in which time he diſtinguiſhed himſelf by his fortitude and zeal while the plague raged there. At length returning to England, he was in 1636 appointed reader of the Arabic lectures founded by archbiſhop Laud. Three years after he went to Conſtantinople, where he proſecuted his ſtudies of the eaſtern tongues, and procured many valuable manuſcripts. After near four years ſtay in that city, he embarked in 1640; and taking Paris in his way, viſited Gabriel Sionita the famous Maronite, and Hugo Grotius. In 1643 he was preſented to the rectory of Childrey in Berks; and about three years after married the daughter of Thomas Burdett, Eſq. About the middle of 1647 he obtained the reſtitution of the ſalary of his Arabic lecture, which had been detained from him about three years. In 1648 king Charles I. who was then priſoner in the Iſle of Wight, nominated Mr. Pococke to the profeſſorſhip of Hebrew, and the canonry of Chriſt-church annexed to it; but in 1650 he was ejected from his canonry for refuſing to take the engagement, and ſoon after a vote paſſed for depriving him of his Hebrew and Arabic lectures; but ſeveral governors of houſes, &c. preſenting a petition in his favour, he was ſuffered to enjoy both theſe places. He had ſome years before publiſhed his *Specimen Hiſtoriæ Arabum*; and now appeared his *Porta Moſis*: and ſoon after the Engliſh Polyglot edition of the Bible, to which he had largely contributed, and alſo Eutychius's Annals, with a Latin verſion. At the Reſtoration he was reſtored to the canonry of Chriſt-church, and alſo received the degree of doctor of divinity. He then publiſhed his Arabic verſion of Grotius's Treatiſe of the Truth of the Chriſtian Religion; and an Arabic poem intitled *Lamiato'l Ajam*, with a Latin tranſlation and notes. Soon after he publiſhed Gregory Abul Pharajius's *Hiſtoria Dynaſtiarum*. In 1674 he publiſhed an Arabic verſion of the chief parts of the Liturgy of the Church of England; and a few years after his Commentary on the Prophecies of Micah, Malachi, Hoſea, and Joel. This great man died in 1691, after having been for many years confeſſedly the firſt perſon in Europe for eaſtern learning; and was no leſs worthy of admiration for his uncommon modeſty and humility, and all the virtues that can adorn a Chriſtian. His theological works were republiſhed at London in 1740, in two volumes in folio.

PODAGRA, or the GOUT. See MEDICINE.

PODALIRIUS, ſon of Æſculapius and Epione, was one of the pupils of the Centaur Chiron, under whom he made himſelf ſuch a maſter of medicine, that during the Trojan war the

Greeks invited him to their camp to ſtop a peſtilence which had baffled the ſkill of all their phyſicians. Some ſuppoſe, however, that he went to the Trojan war, not in the capacity of a phyſician in the Grecian army, but as a warrior, attended by his brother Machaon, in 30 ſhips, with ſoldiers from Œchalia, Ithome, and Trica. At his return Podalirius was ſhip-wrecked on the coaſt of Caria, where he cured of the falling ſickneſs a daughter of the king of the place. He fixed his habitation there; and built two towns, one of which he called *Syrna*, after his wife. The Carians, on his death, built him a temple, and paid him divine honours.

PODEX, in anatomy; the ſame with Anus, ſee Anatomy.

PODOLIA, a province of Poland, bounded on the eaſt by Volhinia and the river Ukrain; on the north and north-eaſt by Budſiac Tartary; on the ſouth-eaſt by the river Nieſter, which ſeparates it from Beſſarabia and Moldavia in European Turkey on the ſouth-weſt; and by the province of Red Ruſſia on the north-weſt. It is uſually divided into the Upper and Lower. In the Upper, which is the weſtern part, the chief town is Kamieck, the capital of Podolia, and of a palatinate. In the Lower, or eaſtern part of Podolia, the chief town is Brackiaw, the capital of a palatinate.

PODOPHYLLUM, in botany: A genus of the monogynia order, belonging to the polyandria claſs of plants; and in the natural method ranking under the 27th order, *Rhœadeæ*. The corolla has nine petals; the calyx triphyllous; the berry unilocular, crowned with the ſtigma.

PODURA, or Spring Tail, in zoology, a genus of inſects of the order of aptera. *Lynn. Syſt. Nat.* p. 1013. They have ſix feet formed for running; two eyes compoſed of eight facets; a tail forked, bent under the body, elaſtic, and acting like a ſpring; the antennæ are long and ſetaceous. "This genus is diſtinguiſhed (ſays Barbut) into ſeveral ſpecies. Some inhabit ſtill waters, leaping and walking with eaſe on the ſurface of that element. They aſſemble in troops in the morning, on the banks of pools, fiſh ponds, and reſervoirs; others are found in damp places, under leaves, bark, and ſtones; others among heaps of rotton wood, muſhrooms, and in melon-beds. In Lapland, they are ſeen running upon the ſnow, but when it begins to melt they periſh. The podura, by its elaſticity, eludes the eager graſp of the naturaliſt. Its hard forky tail is a kind of ſpring, by means of which the body of the animal is thrown up into the air." The podura villoſa is one of the largeſt ſpecies found in Britain, and appears to be of a brown ſooty colour, though it is really of a yellow brown, interſperſed throughout with black-coloured ſpots and ſtreaks. The head and thorax are hairy, and ſtick to the fingers when touched: the abdomen is ſmooth: the antennæ, conſiſting of four articulations, are as long as two-thirds of the body. It is commonly found under ſtones.

POE-bird, in ornithology, is an inhabitant of ſome of the South Sea iſlands, where it is held in great eſteem and veneration by the natives. It goes by the name of *kogo* in New Zealand; but it is better known by that of *poë-bird.* It is ſomewhat leſs than our blackbird. The feathers are of a fine mazarine blue, except thoſe of its neck, which are of a moſt beautiful ſilver gray, and two or three ſhort white ones which are on the pinion-joint of the wing. Under its throat hang two little tufts of curled ſnow-white feathers, called its *poies* (the Otaheitian word for ear-rings); which occaſioned the name of *poë-bird* being given to it. It is remarkable for the ſweetneſs of its note, as well as the beauty of its plumage. Its fleſh is alſo delicate food.

PŒCILE was a famous portico at Athens, which received its name from the variety (ποικιλος) of paintings which it contained. Zeno kept his ſchool there; and there alſo the ſtoics received their leſſons, whence their name, *ἀ ϛοα, a porch.* The Pœcile was adorned, among many others, with a picture of the ſiege and ſacking of Troy, the battle of Theſeus againſt the Amazons, and the fight between the Lacedæmonians and Athenians at Œnoe in Argolis. The only reward which Miltiades obtained after the battle of Marathon was to have his picture drawn more conſpicuous than that of the reſt of the officers that fought with him, in the repreſentation which was made of the engagement, and which was hung up in the Pœcile in commemoration of that celebrated victory.

POEM, a poetical compoſition. See Poetry.

POESTUM, or Posidonia, an ancient city of Grecia Magna, now part of the kingdom of Naples. It was founded by one of thoſe colonies from Greece which in the early ages eſtabliſhed themſelves in Italy; and it flouriſhed before the foundation of Rome itſelf. It was deſtroyed by the Goths on the decline of the Roman empire, who in their barbarous zeal for the Chriſtian religion overturned every place of Pagan worſhip which was expoſed to their ravages. Since that time it has been in ruins; and theſe ruins were unknown till they were diſcovered in the following manner: "In the year 1755 (ſays the author of the *Antiquities, Hiſtory, and Views of Poeſtum*), an apprentice to a painter at Naples, who was on a viſit to his friends at Capaccio, by accident took a walk to the mountains which ſurround the territory of Poeſtum. The only habitation he perceived was the cottage of a farmer, who cultivated the beſt part of the ground, and reſerved the reſt for paſture. The ruins of the ancient city made a part of this view, and particularly ſtruck the eyes of the young painter; who, approaching nearer, ſaw with aſtoniſhment walls, towers, gates, and temples. Upon his return to Capaccio, he conſulted the neighbouring people about the origin of theſe monuments of antiquity. He could only learn, that this part of the country had been uncultivated and abandoned during their memory; that about ten years before, the farmer, whoſe habitation he had noticed, eſtabliſhed himſelf there; and that having dug in many places and ſearched among the ruins that lay round him, he had found treaſures ſufficient to enable him to purchaſe the whole. At the painter's return to Naples, he informed his maſter of theſe particulars, whoſe curioſity was ſo greatly excited by the deſcription, that he took a journey to the place, and made drawings of the principal views. Theſe were ſhown to the king of Naples, who ordered the ruins to be cleared, and Poeſtum aroſe from the obſcurity in which it had remained for upwards of 700 years, as little known to the neighbouring inhabitants as to travellers."

Our author gives the following deſcription of it in its preſent ſtate. It is, ſays he, of an oblong figure, about two miles and a half in circumference. It has four gates, which are oppoſite to each other. On the key-ſtone of the arch of the north gate, on the outſide, is the figure of Neptune in baſſo relievo, and within a hippocampus. The walls which ſtill remain are compoſed of large cubical ſtones, and are extremely thick, in ſome parts 18 feet. That the walls have remained unto this time is owing to the very exact manner in which the ſtones are fitted to one another (a circumſtance obſerved univerſally in the maſonry of the ancients), and perhaps in ſome meaſure to a ſtalactical concretion which has grown over them. On the walls here and there are placed towers of different heights; thoſe near the gates being much higher and larger than the others, and evidently of modern workmanſhip. He obſerves, that, from its ſituation among marſhes, bituminous and ſulphureous ſprings, Poeſtum muſt have been unwholeſome; a circumſtance mentioned by Strabo, *Morboſam eam facit fluvius in paludes diffuſus.* In ſuch a ſituation the water muſt have been bad. Hence the inhabitants were obliged to convey that neceſſary of life from purer ſprings by means of aqueducts, of which many veſtiges ſtill remain.

The principal monuments of antiquity are a theatre, an amphitheatre, and three temples. The theatre and amphitheatre are much ruined. The firſt temple is hexaſtylos, and amphiproſtylos. At one end, the pilaſters and two columns which divided the cella from the pronaos are ſtill remaining. Within the cella are two rows of ſmaller columns, with an architrave, which ſupport the ſecond order. This temple our author takes to be of that kind called by Vitruvius *hyphæthros*, and ſupports his opinion by a quotation from that author. The ſecond temple is alſo amphiproſtylos: it has 9 columns in front and 18 in flank, and ſeems to be of that kind called by Vitruvius *pſeudodipteros*. The third is likewiſe amphiproſtylos. It has 6 columns in front and 13 in flank. Vitruvius calls this kind of temple *peripteros*. "The columns of theſe temples (ſays our author) are of that kind of Doric order which we find employed in works of the greateſt antiquity. They are hardly five diameters in height. They are without baſes, which alſo has been urged as a proof of their antiquity; but we do not find that the ancients ever uſed baſes to this order, at leaſt till very late. Vitruvius makes no mention of baſes for this order: and the only inſtance we have of it is in the firſt order of the coliſæum at Rome, which was built by Veſpaſian. The pillars of theſe temples are fluted with very ſhallow flutings in the manner deſcribed by Vitruvius. The columns diminiſh from the bottom, which was the moſt ancient method almoſt univerſally in all the orders. The columns have aſtragals of a very ſingular form; which ſhows the error of thoſe who imagine that this member was firſt invented with the Ionic order, to which the Greeks gave an aſtragal, and that the Romans were the firſt who applied it to the Doric. The echinus of the capitol is of the ſame form with that of the temple of Corinth deſcribed by Le Roy." See *Swinburne's Travels in the Two Sicilies*, vol. ii. p. 131—140.

POET, the author of a poem. See the article POETRY.

Provençal POETS. See TROUBADOURS.

POETRY.

AMIDST thoſe thick clouds which envelope the firſt ages of the world, reaſon and hiſtory throw ſome lights on the origin and primitive employment of this divine art. Reaſon ſuggeſts, that before the invention of letters, all the people of the earth had no other method of tranſmitting to their deſcendants the principles of their worſhip, their religious ceremonies, their laws, and the renowned actions of their ſages and heroes, than by poetry; which included all theſe objects in a kind of hymns that fathers ſung to their children, in order to engrave them with indelible ſtrokes in their hearts. Hiſtory not only informs us, that Moſes and Miriam, the firſt authors that are known to mankind, ſung, on the borders of the Red Sea, a ſong of divine praiſe, to celebrate the deliverance which the Almighty had vouchſafed to the people of Iſrael, by opening a paſſage to them through the waters; but it has alſo tranſmitted to us the ſong itſelf, which is at once the moſt ancient monument and a maſter-piece of poetic compoſition.

The Greeks, a people the moſt ingenious, the moſt animated, and in every ſenſe the moſt accompliſhed, that the world ever produced—ſtrove to raviſh from the Hebrews the precious gift of poetry, which was vouchſafed them by the Supreme Author of all nature, that they might aſcribe it to their falſe deities. According to their ingenious fictions, Apollo became the god of poetry, and dwelt on the hills of Phocis, Parnaſſus, and Helicon, whoſe feet were waſhed by the waters of Hyppocrene, of which each mortal that ever drank was ſeized with a ſacred delirium. The immortal ſwans floated on its waves. Apollo was accompanied by the Muſes—thoſe nine learned ſiſters—the daughters of Memory: and he was conſtantly attended by the Graces. Pegaſus, his winged courſer, tranſported him with a rapid flight into all the regions of the univerſe. Happy emblems! by which we at this day embelliſh our poetry, as no one has ever yet been able to invent more brilliant images.

The literary annals of all nations afford veſtiges of poetry from the remoteſt ages. They are found among the moſt ſavage of the ancient barbarians, and the moſt deſolate of all the Americans. Nature aſſerts her rights in every country and every age. Tacitus mentions the verſes and the hymns of the Germans, at the time when that rough people yet inhabited the woods, and while their manners were ſtill ſavage. The firſt inhabitants of Runnia, and the other northern countries, thoſe of Gaul, Albion, Iberia, Auſonia, and other nations of Europe, had their poetry, as well as the ancient people of Aſia, and of the known borders of Africa. But the ſimple productions of nature have conſtantly ſomething unformed, rough, and ſavage. The Divine Wiſdom appears to have placed the ingenious and poliſhed part of mankind on the earth, in order to refine that which comes from her boſom rude and imperfect: and thus art has poliſhed poetry, which iſſued quite naked and ſavage from the brains of the firſt of mankind.

But what is Poetry? It would be to abridge the limits of the poetic empire, to contract the ſphere of this divine art, ſhould we ſay, in imitation of all the dictionaries and other treatiſes on verſification, that *poetry is the art of making verſes, of lines or periods that are in rhyme or metre*. This is rather a grammatical explanation of the word than a real definition of the thing, and it would be to degrade poetry thus to define it. The father of criticiſm has denominated poetry *τεχνη μιμητικη*, *an imitative art*: but this, though juſt in itſelf, is too general for a definition, as it does not diſcriminate poetry from other arts which depend equally on imitation. The juſteſt definition ſeems to be that given by baron Bielfield, *That poetry is the art of expreſſing our thoughts by fiction*. In fact, it is after this manner (if we reflect with attention) that all the metaphors and allegories, all the various kinds of fiction, form the firſt materials of a poetic edifice: it is thus that all images, all compariſons, alluſions, and figures, eſpecially thoſe which perſonify moral ſubjects, as virtues and vices, concur to the decorating of ſuch a ſtructure. A work, therefore, that is filled with invention, that inceſſantly preſents images which render the reader attentive and affected, where the author gives intereſting ſentiments to every thing that he makes ſpeak, and where he makes ſpeak by ſenſible figures all thoſe objects which would affect the mind but weakly when clothed in a ſimple proſaic ſtyle,—ſuch a work is a poem. While that, though it be in verſe, which is of a didactic, dogmatic, or moral nature, and where the objects are preſented in a manner quite ſimple, without fiction, without images or ornaments, cannot be called *poetry*, but merely a work in verſe: for the art of reducing thoughts, maxims, and periods, into rhyme or metre, is very different from the art of poetry.

An ingenious fable, a lively and intereſting romance, a comedy, the ſublime narrative of the actions of a hero, ſuch as the Telemachus of M. Fenelon, though written in proſe, but in meaſured proſe, is therefore a work of poetry: becauſe the foundation and the ſuperſtructure are the productions of genius, as the whole proceeds from fiction; and truth itſelf appears to have employed an innocent and agreeable deception to inſtruct with efficacy. This is ſo true, that the pencil alſo, in order to pleaſe and affect, has recourſe to fiction; and this part of painting is called the *poetic compoſition of a picture*. It is therefore by the aid of fiction that poetry, ſo to ſpeak, paints its expreſſions, that it gives a body and a mind to its thoughts, that it animates and exalts that which would otherwiſe have remained arid and inſenſible. It is the peculiar privilege of poetry to exalt inanimate things into animals, and abſtract ideas into perſons. The former licenſe is ſo common, that it is now conſidered as nothing more than a characteriſtical dialect appropriated by the poets to diſtinguiſh themſelves from the writers of proſe; and it is at the ſame time ſo eſſential, that we queſtion much if this ſpecies of compoſition could ſubſiſt without it: for it will perhaps, upon examination, be found, that in every poetical deſcription ſome of the qualities of Animal Nature are aſcribed to things not having life. Every work, therefore, where the thoughts are expreſſed by fictions or images, is poetic; and every work where they are expreſſed naturally, ſimply, and without ornament, although it be in verſe, is proſaic.

Verſe, however, is not to be regarded as foreign or ſuperfluous to poetry. To reduce thoſe images, thoſe fictions, into verſe, is one of the greateſt difficulties in poetry, and one of the greateſt merits in a poem: and for theſe reaſons, the cadence, the harmony of ſounds, particularly that of rhyme, delight the ear to a high degree, and the mind inſenſibly repeats them while the eye reads them. There reſults therefore a pleaſure to the mind, and a ſtrong attachment to theſe ornaments: but this pleaſure would be frivolous, and even childiſh, if it were not attended by a real utility. Verſes were invented in the firſt ages of the world, merely to aid and to ſtrengthen the memory: for cadence, harmony, and eſpecially rhyme, afford the greateſt aſſiſtance to the memory that art can invent; and the images, or poetic fictions, that ſtrike our ſenſes, aſſiſt in graving them with ſuch deep traces in our minds as even time itſelf frequently cannot efface. How many excellent apophthegms, ſentences, maxims, and precepts, would have been buried in the abyſs of oblivion, if poetry had not preſerved them by its harmony! To give more efficacy to this lively impreſſion, the firſt poets ſung their verſes, and the words and phraſes muſt neceſſarily have been reduced, at leaſt to cadence, or they could not have been ſuſceptible of muſical expreſſion. One of the great excellencies, therefore, though not a neceſſary conſtituent, of poetry, conſiſts in its being expreſſed in verſe. See Part III.

PART I. GENERAL PRINCIPLES OF THE ART.

SECT. I. *Of the Eſſence and End of Poetry.*

THE *eſſence* of *Polite* ARTS in general, and conſequently of poetry in particular, conſiſts in *expreſſion;* and we think that, to be poetic, the expreſſion muſt neceſſarily ariſe from *fiction* or invention. This invention, which is the fruit of happy genius alone, ariſes, 1. From the ſubject itſelf of which we undertake to treat: 2. From the manner in which we treat that ſubject, or the ſpecies of writing of which we make uſe: 3. From the plan that we propoſe to follow in conformity to this manner; and, 4. From the method of executing this plan in its full detail. Our firſt guides, the ancients, afford us no lights that can elucidate all theſe objects in general. The precepts which Ariſtotle lays down relate to epic and dramatic poetry only: and which, by the way, confirms our idea, that antiquity itſelf made the eſſence of poetry to conſiſt in fiction, and not in that ſpecies of verſe which is deſtitute of it, or in that which is not capable of it. But ſince this art has arrived to a great degree of perfection; and as poetry, like electricity, communicates its fire to every thing it touches, and animates and embelliſhes whatever it treats; there ſeems to be no ſubject in the univerſe to which poetry cannot be applied, and which it cannot render equally brilliant and pleaſing. From this univerſality of poetry, from its peculiar property of expreſſion by fiction, which is applicable to all ſubjects, have ariſen its different ſpecies, of which a particular deſcription will be given in the *ſecond* part.

Horace, in a well-known verſe, has been ſuppoſed to declare the *end* of poetry to be two-fold, to pleaſe or to inſtruct:

Aut prodeſſe volunt, aut delectare poetæ.

But Dr. Beattie maintains, that the ultimate end of this art is to pleaſe; inſtruction being only one of the means (and not always a neceſſary one) by which that ultimate end is to be accompliſhed. The paſſage rightly underſtood, he obſerves, will not appear to contain any thing inconſiſtent with this doctrine. The author is there ſtating a compariſon between the Greek and Roman writers, with a view to the poetry of the ſtage; and, after commending the former for their correctneſs, and for the liberal ſpirit wherewith they conducted their literary labours, and blaming his countrymen for their inaccuracy and avarice, he proceeds thus: "The ends propoſed by our dramatic poets (or by poets in general), are, to pleaſe, to inſtruct, or to do both. When inſtruction is your aim, let your moral ſentences be expreſſed with brevity, that they may be readily underſtood, and long remembered: where you mean to pleaſe, let your fictions be conformable to truth, or probability. The elder part of your audience (or readers) have no reliſh for poems that give pleaſure only without inſtruction; nor the younger for ſuch writings as give inſtruction without pleaſure. He only can ſecure the univerſal ſuffrage in his favour, who blends the uſeful with the agreeable, and delights at the ſame time that he inſtructs the reader. Such are the works that bring money to the bookſeller, that paſs into foreign countries, and perpetuate the author's name through a long ſucceſſion of ages."—Now, what is the meaning of all this? What, but that to the *perfection* of dramatic poetry (or, if you pleaſe, of poetry in general) both ſound morals and beautiful fiction are requiſite? But Horace never meant to ſay, that inſtruction, as well as pleaſure, is neceſſary to give to any compoſition the *poetical character*; or he would not in another place have celebrated with ſo much affection and rapture the melting ſtrains of Sappho, and the playful genius of Anacreon,—two authors tranſcendently ſweet, but not remarkably inſtructive. We are ſure, that pathos, and harmony, and elevated language, were, in Horace's opinion, eſſential to poetry; and of theſe decorations nobody will affirm that inſtruction is the end, who conſiders that the moſt inſtructive books in the world are written in plain proſe.

In ſhort, our author has endeavoured by many ingenious arguments and illuſtrations to eſtabliſh it as a truth in criticiſm, that the end of poetry is *to pleaſe*. Verſes, if pleaſing, may be poetical, though they contain little or no inſtruction; but verſes, whoſe ſole merit it is that they convey inſtruction, are not poetical. Inſtruction, however, he admits, eſpecially in poems of length, is neceſſary to their *perfection*, becauſe they would not be *perfectly agreeable* without it.

SECT. II. *Of the Standard of Poetical Invention.*

HOMER's beautiful deſcription of the heavens and earth, as they appear in a calm evening by the light of the moon and ſtars, concludes with this circumſtance. "And the heart of the ſhepherd is glad." Madame Dacier, from the turn ſhe gives to the paſſage in her verſion, ſeems to think, and Pope, in order perhaps to make out his couplet, inſinuates, that the gladneſs of the ſhepherd is owing to his ſenſe of the utility of thoſe luminaries. And this may in part be the caſe: but this is not in Homer; nor is it a neceſſary conſideration. It is true, that, in contemplating the material univerſe, they who diſcern the cauſes and effects of things muſt be more rapturouſly entertained than thoſe who perceive nothing but ſhape and ſize, colour and motion. Yet, in the mere outſide of Nature's work, there is a ſplendor and a magnificence to which even untutored minds cannot attend without great delight.

Not that all peaſants or all philoſophers are equally ſuſceptible of theſe charming impreſſions. It is ſtrange to obſerve the calloufneſs of ſome men, before whom all the glories of heaven and earth paſs in daily ſucceſſion, without touching their hearts, elevating their fancy, or leaving any durable remembrance. Even of thoſe who pretend to ſenſibility, how many are there to whom the luſtre of the riſing or ſetting ſun; the ſparkling concave of the midnight-ſky; the mountain-foreſt toſſing and roaring to the ſtorm, or warbling with all the melodies of a ſummer-evening; the ſweet interchange of hill and dale, ſhade and ſun-ſhine, grove, lawn, and water, which an extenſive landſcape offers to the view; the ſcenery of the ocean, ſo lovely, ſo majeſtic, and ſo tremendous; and the many pleaſing varieties of the animal and vegetable kingdoms, could never afford ſo much real ſatisfaction, as the ſteams and noiſe of a ball-room, the inſipid fiddling and ſqueaking of an opera, or the vexations and wranglings of a card-table!

But ſome minds there are of a different make; who, even in the early part of life, receive from the contemplation of Nature a ſpecies of delight which they would hardly exchange for any other, and who, as avarice and ambition are not the infirmities of that period, would, with equal ſincerity and rapture, exclaim,

> I care not, Fortune, what you me deny;
> You cannot rob me of free Nature's grace;
> You cannot ſhut the windows of the ſky,
> Through which Aurora ſhows her bright'ning face;
> You cannot bar my conſtant feet to trace
> The woods and lawns by living ſtream at eve.
>
> *Caſtle of Indolence.*

Such minds have always in them the ſeeds of true taſte, and frequently of imitative genius. At leaſt, though their enthuſiaſtic or viſionary turn of mind (as the man of the world would call it) ſhould not always incline them to practiſe poetry or painting, we need not ſcruple to affirm, that without ſome portion of this enthuſiaſm no perſon ever became a true poet or painter. For he, who would imitate the works of nature, muſt firſt accurately obſerve them; and accurate obſervation is to be expected from thoſe only who take great pleaſure in it.

To a mind thus diſpoſed no part of creation is indifferent. In the crowded city and howling wilderneſs; in the cultivated province and ſolitary iſle; in the flowery lawn and craggy mountain; in the murmur of the rivulet and in the uproar of the ocean; in the radiance of ſummer and gloom of winter; in the thunder of heaven and in the whiſper of the breeze; he ſtill finds ſomething to rouſe or to ſooth his imagination, to draw forth his affections, or to employ his underſtanding. And from every mental energy that is not attended with pain, and even from ſome of thoſe that are, as moderate terror and pity, a ſound mind derives ſatisfaction; exerciſe being equally neceſſary to the body and the ſoul, and to both equally productive of health and pleaſure.

This happy ſenſibility to the beauties of nature ſhould be cheriſhed in young perſons. It engages them to contemplate the Creator in his wonderful works; it purifies and harmonizes the ſoul, and prepares it for moral and intellectual diſcipline; it ſupplies an endleſs ſource of amuſement; it contributes even to bodily health: and, as a ſtrict analogy ſubſiſts between material and moral beauty, it leads the heart by an eaſy tranſition from the one to the other; and thus recommends virtue for its tranſcendent lovelineſs, and makes vice appear the object of contempt and abomination. An intimate acquaintance with the beſt deſcriptive poets, Spenſer, Milton, and Thomſon, but above all with the divine Georgics, joined to ſome practice in the art of drawing, will promote this amiable ſenſibility in early years; for then the face of nature has novelty ſuperadded to its other charms, the paſſions are not pre-engaged, the heart is free from care, and the imagination warm and romantic.

But, not to inſiſt longer on thoſe ardent emotions that are peculiar to the enthuſiaſtic diſciple of nature, may it not be affirmed of all men, without exception, or at leaſt of all the enlightened part of mankind, that they are gratified by the contemplation of things natural, as oppoſed to unnatural? Monſtrous ſights pleaſe but for a moment, if they pleaſe at all; for they derive their charm from the beholder's amazement, which is quickly over. We read indeed of a man of rank in Sicily, who chooſes to adorn his villa with pictures and ſtatues of moſt unnatural deformity: but it is a ſingular inſtance; and one would not be much more ſurpriſed to hear of a perſon living without food, or growing fat by the uſe of poiſon. To ſay of any thing, that it is *contrary to nature*, denotes cenſure and diſguſt on the part of the ſpeaker; as the epithet *natural* intimates an agreeable quality, and ſeems for the moſt part to imply, that a thing is as it ought to be, ſuitable to our own taſte, and congenial with our own conſtitution. Think with what ſentiments we ſhould peruſe a poem, in which nature was totally miſrepreſented, and principles of thought and of operation ſuppoſed to take place, repugnant to every thing we had ſeen or heard of:—in which, for example, avarice and coldneſs were aſcribed to youth, and prodigality and paſſionate attachment to the old; in which men were made to act at random, ſometimes according to character, and ſometimes contrary to it; in which cruelty and envy were productive of love, and beneficence and kind affection of hatred; in which beauty was invariably the object of diſlike, and uglineſs of deſire; in which ſociety was rendered happy by atheiſm and the promiſcuous perpetration of crimes, and juſtice and fortitude were held in univerſal contempt. Or think, how we ſhould reliſh a painting, where no regard was had to the proportions, colours, or any of the phyſical laws, of Nature:—where the ears and eyes of animals were placed in their ſhoulders; where the ſky was green and the graſs crimſon; where trees grew with their branches in the earth and their roots in the air; where men were ſeen fighting after their heads were cut off, ſhips ſailing on the land, lions entangled in cobwebs, ſheep preying on dead carcaſes, fiſhes ſporting in the woods, and elephants walking on the ſea. Could ſuch figures and combinations give pleaſure, or merit the appellation of ſublime or beautiful? Should we heſitate to pronounce their author mad? And are the abſurdities of madmen proper ſubjects either of amuſement or of imitation to reaſonable beings?

Let it be remarked, too, that though we diſtinguiſh our internal powers by different names, becauſe otherwiſe we could not ſpeak of them ſo as to be underſtood, they are all but ſo many energies of the ſame individual mind; and therefore it is not to be ſuppoſed, that what contradicts any one leading faculty ſhould yield permanent delight to the reſt. That cannot be agreeable to reaſon, which conſcience diſapproves; nor can that gratify imagination which is repugnant to reaſon.——Beſides, belief and acquieſcence of mind are pleaſant, as diſtruſt and diſbelief are painful: and therefore, that only can give ſolid and general ſatisfaction, which has ſomething of plauſibility in it; ſomething which we conceive it poſſible for a rational being to believe. But no rational being can acquieſce in wh is obviouſly contrary to nature, or implies palpable abſurdity.

Poetry, therefore, and indeed every art whoſe end is to pleaſe, muſt be natural; and if ſo, muſt exhibit real matter of fact, or ſomething like it; that is, in other words, muſt be either according to truth or according to veriſimilitude.

And though every part of the material univerſe abounds in objects of pleaſureable comtemplation, yet nothing in nature ſo powerfully touches our hearts, or gives ſo great variety of exerciſe to our moral and intellectual faculties, as man. Human affairs and human feelings are univerſally intereſting. There are many who have no great reliſh for the poetry that delineates only irrational or inanimate beings; but to that which exhibits the fortunes, the characters, and the conduct of men, there is hardly any perſon who does not liſten with ſympathy and delight. And hence, to imitate human action is conſidered by Ariſtotle as eſſential to this art; and muſt be allowed to be eſſential to the moſt pleaſing and moſt inſtructive part of it, Epic and Dramatic compoſition. Mere deſcriptions, however beautiful, and moral reflections, however juſt, become tireſome, where our paſſions are not occaſionally awakened by ſome event that concerns our fellow-men. Do not all readers of taſte rereceive peculiar pleaſure from thoſe little tales or epiſodes with which Thomſon's deſcriptive poem on the Seaſons is here and there enlivened? and are they not ſenſible that the thunder-ſtorm would not have been half ſo intereſting without the tale of the two lovers (*Summ.* v. 1171); nor the harveſt-ſcene, without that of Palemon and Lavinia (*Aut.* v. 177.); nor the driving ſnows, without that exquiſite picture of a man periſhing among them (*Wint.* v. 276.)? It is much to be regretted that Young did not employ the ſame artifice to animate his Night-Thoughts. Sentiments and deſcriptions may be regarded as the pilaſters, carvings, gildings, and other decorations of the poetical fabric: but human actions are the columns and the rafters that give it ſtability and elevation. Or, changing the metaphor, we may conſider theſe as the ſoul which informs the lovely frame; while thoſe are little more than the ornaments of the body.

Whether the pleaſure we take in things natural, and our diſlike to what is the reverſe, be the effect of habit or of conſtitution, is not a material inquiry. There is nothing abſurd in ſuppoſing, that between the ſoul, in its firſt formation, and the reſt of nature, a mutual harmony and ſympathy may have been eſtabliſhed, which experience may indeed confirm, but no perverſe habits could entirely ſubdue. As no ſort of education could make man believe the contrary of a ſelf-evident axiom, or reconcile him to a life of perfect ſolitude; ſo we ſhould imagine, that our love of nature and regularity might ſtill remain with us in ſome degree, though we had been born and bred in the Sicilian villa above-mentioned, and never heard any thing applauded but what deſerved cenſure, nor cenſured but what merited applauſe. Yet habit muſt be allowed to have a powerful influence over the ſentiments and feelings of mankind: for objects to which we have been long accuſtomed we are apt to contract a fondneſs: we conceive them readily, and contemplate them with pleaſure; nor do we quit our old tracts of ſpeculation or practice without reluctance and pain. Hence in part ariſes our attachment to our own profeſſions, our old acquaintance, our native ſoil, our homes, and to the very hills, ſtreams, and rocks in our neighbourhood. It would therefore be ſtrange, if man, accuſtomed as he is from his earlieſt days to the regularity of nature, did not contract a liking to her productions and principles of operation.

Yet we neither expect nor deſire that every human invention, where the end is only to pleaſe, ſhould be an exact tranſcript of real exiſtence. It is enough that the mind acquieſce in it as probable or plauſible, or ſuch as we think might happen without any direct oppoſition to the laws of nature;—or, to ſpeak more accurately, it is enough that it be conſiſtent either, firſt, with general experience; or, ſecondly, with popular opinion; or, thirdly, that it be conſiſtent with itſelf, and connected with probable circumſtances.

Firſt: If a human invention be conſiſtent with *general* experience, we acquieſce in it as ſufficiently probable. *Particular* experiences, however, there may be, ſo uncommon, and ſo little expected, that we ſhould not admit their probability, if we did not know them to be true. No man of ſenſe believes, that he has any likelihood of being enriched by the diſcovery of hidden treaſure; or thinks it probable, on purchaſing a lottery-ticket, that he ſhall gain the firſt prize: and yet great wealth has actually been acquired by ſuch good fortune. But we ſhould look upon theſe as poor expedients in a play or romance for bringing about a happy cataſtrophe. We expect that fiction ſhould be more conſonant to the general tenor of human affairs; in a word, that not poſſibility, but probability ſhould be the ſtandard of poetical invention.

Secondly: Fiction is admitted as conformable to this ſtandard, when it accords with received opinions. Theſe may be erroneous, but are not often *apparently* repugnant to nature. On this account, and becauſe they are familiar to us from our infancy, the mind readily acquieſces in them, or at leaſt yields them that degree of credit which is neceſſary to render them pleaſing: hence the fairies, ghoſts, and witches of Shakeſpeare, are admitted as probable beings; and angels obtain a place in religious pictures though we know that they do not now appear in the ſcenery of real life. A poet who ſhould at this day make the whole action of his tragedy depend upon enchantment, and produce the chief events by the aſſiſtance of ſupernatural agents, would indeed be cenſured as tranſgreſſing the bounds of probability, be baniſhed from the theatre to the nurſery, and condemned to write fairy-tales inſtead of tragedies. But Shakeſpeare was in no danger of ſuch cenſures: in his days the doctrine of witchcraft was eſtabliſhed both by law and by the faſhion; and it was not only impolite, but criminal, to do it. Now indeed it is admitted only by the vulgar; but it does not therefore follow that an old poem built upon it ſhould not be acceptable to the learned themſelves. When a popular opinion has long been exploded, and has become repugnant to philoſophical belief, the fictions built upon it are ſtill admitted as natural, both becauſe we all remember to have liſtened to them in childhood with ſome degree of credit, and becauſe we know that they were accounted natural by the people to whom they were firſt addreſſed; whoſe ſentiments and views of things we are willing to adopt, when, by the power of pleaſing deſcription, we are introduced into their ſcenes, and made acquainted with their manners. Hence we admit the theology of the ancient poets, their Elyſium and Tartarus, Scylla and Charybdis, Cyclops and Circe, and the reſt of thoſe "beautiful wonders" (as Horace calls them) which were believed in the heroic ages; as well as the demons and enchantments of Taſſo, which may be ſuppoſed to have obtained no ſmall degree of credit among the Italians of the 16th century, and are ſuitable enough to the notions that prevailed univerſally in Europe not long before *. In fact, when poetry is in other reſpects true, when it gives an accurate diſplay of thoſe parts of nature about which we know that men in all ages muſt have entertained the ſame opinion, namely, thoſe appearances in the viſible creation, and thoſe feelings and workings of the human mind, which are obvious to all mankind;—when poetry is thus far according to nature, we are very willing to be indulgent to what is fictitious in it, and to grant a temporary allowance to any ſyſtem of fable which the author pleaſes to adopt: provided that he lay the ſcene in a diſtant country, or fix the date to a remote period. This is no unreaſonable piece of complaiſance; we owe it both to the poet and to ourſelves; for without it we ſhould neither form a right eſtimate of his genius, nor receive from his works that pleaſure which they were intended to impart. Let him, however, take care, that his ſyſtem of fable be ſuch as his countrymen and cotemporaries (to whom his work is immediately addreſſed) might be ſuppoſed capable of yielding their aſſent to; for otherwiſe we ſhould not believe him to be in earneſt: and let him connect it as much as he can with probable circumſtances, and make it appear in a ſeries of events conſiſtent with itſelf.

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* In the 14th century, the common people of Italy believed, that the poet Dante went down to hell; that the *Inferno* was a true account of what he ſaw there; and that his ſallow complexion, and ſtunted beard (which ſeemed by its growth and colour to have been too near the fire), were the conſequence of his paſſing ſo much of his time in that hot and ſmoky region. See *Vicende della Literatura del Sig. C. Denina*, cap. 4.

For (thirdly) if this be the caſe, we ſhall admit his ſtory as probable, or at leaſt as natural, and conſequently be intereſted in it, even though it be not warranted by general experience, and derive but ſlender authority from popular opinion. Calyban, in the Tempeſt, would have ſhocked the mind as an improbability, if we had not been made acquainted with his origin, and ſeen his character diſplayed in a ſeries of conſiſtent behaviour. But when we are told that he ſprung from a witch and a demon, a connection not contrary to the laws of nature, as they were underſtood in Shakeſpeare's time, and find his manners conformable to his deſcent, we are eaſily reconciled to the fiction. In the ſame ſenſe, the Lilliputians of Swift may paſs for probable beings; not ſo much becauſe we know that a belief in pigmies was once current in the world (for the true ancient pigmy was at leaſt thrice as tall as thoſe whom Gulliver viſited), but becauſe we find that every circumſtance relating to them accords with itſelf, and with their ſuppoſed character. It is not the ſize of the people only that is diminutive; their country, ſeas, ſhips, and towns, are all in exact proportion; their theological and political principles, their paſſions, manners, cuſtoms, and all the parts of their conduct, betray a levity and littleneſs perfectly ſuitable; and ſo ſimple is the whole narration, and apparently ſo artleſs and ſincere, that we ſhould not much wonder if it had impoſed (as we have been told it has) upon ſome perſons of no contemptible underſtanding. The ſame degree of credit may perhaps for the ſame reaſons be due to his giants. But when he grounds his narrative upon a contradiction to nature; when he preſents us with rational brutes, and irrational men; when he tells us of horſes building houſes for habitation, milking cows for food, riding in carriages, and holding converſations on the laws and politics of Europe; not all his genius (and he there exerts it to the utmoſt) is able to reconcile us to ſo monſtrous a fiction; we may ſmile at ſome of his abſurd exaggerations; we may be pleaſed with the energy of ſtyle, and accuracy of deſcription, in particular places; and a malevolent heart may triumph in the ſatire; but we can never reliſh it as a fable, becauſe it is at once unnatural and ſelf-contradictory. Swift's judgment ſeems to have forſaken him on this occaſion: he wallows in naſtineſs and brutality: and the general run of his ſatire is downright defamation. Lucian's *True Hiſtory* is a heap of extravagancies put together without order or unity, or any other apparent deſign than to ridicule the language and manner of grave authors. His ravings, which have no better right to the name of *fable*, than a hill of rubbiſh has to that of palace, are deſtitute of every colour of plauſibility. Animal trees, ſhips ſailing in the ſky, armies of monſtrous things travelling between the ſun and moon on a pavement of cobwebs, rival nations of men inhabiting woods and mountains in a whale's belly,—are liker the dreams of a bedlamite than the inventions of a rational being.

If we were to proſecute this ſubject any further, it would be proper to remark, that in ſome kinds of poetical invention a ſtricter probability is required than in others:—that, for inſtance, Comedy, whether dramatic or narrative *, muſt ſeldom deviate from the ordinary courſe of human affairs, becauſe it exhibits the manners of real and even of familiar life: —that the tragic poet, becauſe he imitates characters more exalted, and generally refers to events little known, or long ſince paſt, may be allowed a wider range; but muſt never attempt the marvellous fictions of the epic muſe, becauſe he addreſſes his work, not only to the paſſions and imagination of mankind, but alſo to their eyes and ears, which are not eaſily impoſed on, and refuſe to be gratified with any repreſentation that does not come very near the truth:—that the epic poem may claim ſtill ampler privileges, becauſe its fictions are not ſubject to the ſcrutiny of any outward ſenſe, and becauſe it conveys information in regard both to the higheſt human characters, and the moſt important and wonderful events, and alſo to the affairs of unſeen worlds and ſuperior beings. Nor would it be improper to obſerve, that the ſeveral ſpecies of comic, of tragic, of epic compoſition, are not confined to the ſame degree of probability: for that farce may be allowed to be leſs probable than the regular comedy; the maſque than the regular tragedy; and the mixed epic, ſuch as the Fairy Queen, and Orlando Furioſo, than the pure epopee of Homer, Virgil, and Milton. But this part of the ſubject ſeems not to require further illuſtration. Enough has been ſaid to ſhow, that nothing unnatural can pleaſe; and that therefore poetry, whoſe end is to pleaſe, muſt be *according to nature.*

And if ſo, it muſt be either according to real nature, or according to nature ſomewhat different from the reality.

SECT. III. *Of the Syſtem of Nature exhibited by Poetry.*

To exhibit *real nature* is the buſineſs of the hiſtorian; who, if he were ſtrictly to confine himſelf to his own ſphere, would never record even the minuteſt circumſtance of any ſpeech, event, or deſcription, which was not warranted by ſufficient authority. It has been the language of critics in every age, that the hiſtorian ought to relate nothing as true which is falſe or dubious, and to conceal nothing material which he knows to be true. But it is to be doubted whether any writer of profane hiſtory has ever been ſo ſcrupulous. Thucydides himſelf, who began his hiſtory when that war began which he records, and who ſet down every event ſoon after it happened, according to the moſt authentic information, ſeems, however, to have indulged his fancy not a little in his harangues and deſcriptions, particularly that of the plague of Athens: and the ſame thing has been practiſed, with greater latitude, by Livy and Tacitus, and more or leſs by all the beſt hiſtorians both ancient and modern. Nor are they to be blamed for it. By theſe improved or invented ſpeeches, and by the heightenings thus given to their deſcriptions, their work becomes more intereſting, and more uſeful; nobody is deceived, and hiſtorical truth is not materially affected. A medium is, however, to be obſerved in this, as in other things. When the hiſtorian lengthens a deſcription into a detail of fictitious events, as Voltaire has done in his account of the battle of Fontenoy, he loſes his credit with us, by raiſing a ſuſpicion that he is more intent upon a pretty ſtory than upon the truth. And we are diſguſted with his inſincerity, when, in defiance even of veriſimilitude, he puts long elaborate orations in the mouth of thoſe, of whom we know, either from the circumſtances that they could not, or from more authentic records that they did not, make any ſuch orations; as Dionyſius of Halicarnaſſus has done in the caſe of Volumnia haranguing her ſon Coriolanus, and Flavius Joſephus in that of Judah addreſſing his brother as viceroy of Egypt. From what theſe hiſtorians relate, one would conjecture that the Roman matron had ſtudied at Athens under ſome long-winded rhetorician, and that the Jewiſh patriarch muſt have been one of the moſt flowery orators of antiquity. But the fictitious part of hiſtory, or of ſtory-telling, ought never to take up much room; and muſt be highly blameable when it leads into any miſtake either of facts or of characters.

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* Fielding's *Tom Jones*, *Amelia*, and *Joſeph Andrews*, are examples of what may be called the *Epic* or *Narrative Comedy*, or more properly perhaps the *Comic Epopee*.

Now, why do hiſtorians take the liberty to embelliſh their works in this manner? One reaſon, no doubt, is, that they may diſplay their talents in oratory and narration: but the chief reaſon, as hinted already, is, to render their compoſition more agreeable. It would ſeem, then, that ſomething more pleaſing than real nature, or ſomething which ſhall add to the pleaſing qualities of real nature, may be deviſed by human fancy. And this may certainly be done; and this it is the poet's buſineſs to do: and when this is in any degree done by the hiſtorian, his narrative becomes in that degree poetical.

The poſſibility of thus improving upon nature muſt be obvious to every one. When we look at a landſcape, we can fancy a thouſand additional embelliſhments. Mountains loftier and more pictureſque; rivers more copious, more limpid, and more beautifully winding; ſmoother and wider lawns; valleys more richly diverſified; caverns and rocks more gloomy and more ſtupendous; ruins more majeſtic; buildings more magnificent; oceans more varied with iſlands, more ſplendid with ſhipping, or more agitated by ſtorm, than any we have ever ſeen—it is eaſy for human imagination to conceive. Many things in art and nature exceed expectation; but nothing ſenſible tranſcends or equals the capacity of thought:—a ſtriking evidence of the dignity of the human ſoul! The fineſt woman in the world appears to every eye ſuſceptible of improvement, except perhaps to that of her lover. No wonder, then, if in poetry events can be exhibited more compact, and of more pleaſing variety, than thoſe delineated by the hiſtorian, and ſcenes of inanimate nature more dreadful or more lovely, and human characters more ſublime and more exquiſite, both in good and evil. Yet ſtill let nature ſupply the ground-work and materials, as well as the ſtandard, of poetical fiction. The moſt expert painters uſe a layman, or other viſible figure, to direct their hand and regulate their fancy. Homer himſelf founds his two poems on authentic tradition; and tragic as well as epic poets have followed the example. The writers of romance, too, are ambitious to interweave true adventures with their fables: and when it can be conveniently done, to take the outlines of their plan from real life. Thus the tale of Robinſon Cruſoe is founded on an incident that actually befel one Alexander Selkirk, a ſea-faring man, who lived ſeveral years alone in the iſland of Juan Fernandes: Smollet is thought to have given us ſeveral of his own adventures in the hiſtory of Roderic Random: and the chief characters in Tom Jones, Joſeph Andrews, and Pamela, are ſaid to have been copied from real originals. Dramatic comedy, indeed, is for the moſt part purely fictitious: for if it were to exhibit real events as well as preſent manners, it would become too perſonal to be endured by a well-bred audience, and degenerate into downright abuſe; which appears to have been the caſe with the old comedy of the Greeks. But, in general, hints taken from real exiſtence will be found to give no little grace and ſtability to fiction, even in the moſt fanciful poems. Thoſe hints, however, may be improved by the poet's imagination, and ſet off with every probable ornament that can be deviſed, conſiſtently with the deſign and genius of the work; or, in other words, with the ſympathies that the poet means to awaken in the mind of his reader. For mere poetical ornament, when it fails to intereſt the affections, is not only uſeleſs, but improper; all true poetry being addreſſed to the heart, and intended to give pleaſure by raiſing or ſoothing the paſſions;—the only effectual way of pleaſing a rational and moral creature. And therefore we would take Horace's maxim to be univerſal in poetry: "*Non ſatis eſt, pulchra eſſe poemata*; dulcia *ſunto*:" "It is not enough that poems be beautiful; let them alſo be *affecting*:"—For that this is the meaning of the word *dulcia* in this place, is admitted by the beſt interpreters, and is indeed evident from the context.

That the ſentiments and feelings of percipient beings, when expreſſed in poetry, ſhould call forth our affections, is natural enough; but can deſcriptions of inanimate things alſo be made affecting? Certainly they can: and the more they affect, the more they pleaſe us, and the more poetical we allow them to be. Virgil's Georgic is a noble ſpecimen (and indeed the nobleſt in the world) of this ſort of poetry. His admiration of external nature gains upon a reader of taſte, till it riſe to perfect enthuſiaſm. The following obſervations will perhaps explain this matter.

Every thing in nature is complex in itſelf, and bears innumerable relations to other things; and may therefore be viewed in an endleſs variety of lights, and conſequently deſcribed in an endleſs variety of ways. Some deſcriptions are good, and others bad. An hiſtorical deſcription, that enumerates all the qualities of any object, is certainly good, becauſe it is true; but may be as unaffecting as a logical definition. In poetry, no unaffecting deſcription is good, however conformable to truth: for here we expect not a complete enumeration of qualities (the chief end of the art being to pleaſe), but only ſuch an enumeration as may give a lively and intereſting idea. It is not memory, or the knowledge of rules, that can qualify a poet for this ſort of deſcription; but a peculiar livelineſs of fancy and ſenſibility of heart, the nature whereof we may explain by its effects, but we cannot lay down rules for the attainment of it.

When our mind is occupied by any emotion, we naturally uſe words and meditate on things that are ſuitable to it and tend to encourage it. If a man were to write a letter when he is very angry, there would probably be ſomething of vehemence or bitterneſs in the ſtyle, even though the perſon to whom he wrote were not the object of his anger. The ſame thing holds true of every other ſtrong paſſion or emotion:—while it predominates in the mind, it gives a peculiarity to our thoughts, as well as to our voice, geſture, and countenance: And hence we expect, that every perſonage introduced in poetry ſhould ſee things through the medium of his ruling paſſion, and that his thoughts and language ſhould be tinctured accordingly. A melancholy man walking in a grove attends to thoſe things that ſuit and encourage his melancholy; the ſighing of the wind in the trees, the murmuring of waters, the darkneſs and ſolitude of the ſhades: A cheerful man, in the ſame place, finds many ſubjects of cheerful meditation, in the ſinging of birds, the briſk motions of the babbling ſtream, and the livelineſs and variety of the verdure. Perſons of different characters, contemplating the ſame thing, a Roman triumph, for inſtance, feel different emotions, and turn their view to different objects. One is filled with wonder at ſuch a diſplay of wealth and power; another exults in the idea of conqueſt, and pants for military renown; a third, ſtunned with clamour, and haraſſed with confuſion, wiſhes for ſilence, ſecurity, and ſolitude; one melts with pity to the vanquiſhed, and makes many a ſad reflection upon the inſignificance of worldly grandeur, and the uncertainty of human things; while the buffoon, and perhaps the philoſopher, conſiders the whole as a vain piece of pageantry, which, by its ſolemn procedure, and by the admiration of ſo many people, is only rendered the more ridiculous:—and each of theſe perſons would deſcribe it in a way ſuitable to his own feelings, and tending to raiſe the ſame in others. We ſee in Milton's Allegro and Penſeroſo how a different caſt of mind produces a variety in the manner of conceiving and contemplating the ſame rural ſcenery. In the former of theſe excellent poems, the author perſonates a cheerful man, and takes notice of thoſe things in external nature that are ſuitable to cheerful thoughts, and tend to encourage them: in the latter, every object deſcribed is ſerious and ſolemn, and productive of calm reflection and tender melancholy: and we ſhould not be eaſily perſuaded, that Milton wrote the firſt under the influence of ſorrow, or the ſecond under that of gladneſs. We often ſee an author's character in his works; and if every author were in earneſt when he writes, we ſhould oftener ſee it. Thomſon was a man of piety and benevolence, and a warm admirer of the beauties of nature; and every deſcription in his delightful poem on the Seaſons tends to raiſe the ſame laudable affections in his reader. The parts of nature that attract his notice are thoſe which an impious or hard-hearted man would neither attend to, nor be affected with, at leaſt in the ſame manner. In Swift we ſee a turn of mind very different from that of the amiable Thomſon; little reliſh for the ſublime or beautiful, and a perpetual ſucceſſion of violent emotions. All his pictures of human life ſeem to ſhow, that deformity and meanneſs were the favourite objects of his attention, and that his ſoul was a conſtant prey to indignation *, diſguſt, and other gloomy paſſions, ariſing from ſuch a view of things. And it is the tendency of almoſt all his writings (though it was not always the author's deſign), to communicate the ſame paſſions to his reader: inſomuch, that notwithſtanding his erudition and knowledge of the world, his abilities as a popular orator and man of buſineſs, the energy of his ſtyle, the elegance of ſome of his verſes, and his extraordinary talents in wit and humour, there is reaſon to doubt whether, by ſtudying his works, any perſon was ever much improved in piety or benevolence.

And thus we ſee how the compoſitions of an ingenious author may operate upon the heart, whatever be the ſubject. The affections that prevail in the author himſelf direct his attention to objects congenial, and give a peculiar bias to his inventive powers, and a peculiar colour to his language. Hence his work, as well as face, if nature is permitted to exert herſelf freely in it, will exhibit a picture of his mind, and awaken correſpondent ſympathies in the reader. When theſe are favourable to virtue, which they always ought to be, the work will have that ſweet pathos to which Horace alludes in the paſſage above mentioned; and which we ſo highly admire, and ſo warmly approve, even in thoſe parts of the Georgic that deſcribe inanimate nature.

Horace's account of the matter in queſtion differs not from what is here given. "It is not enough (ſays he) that poems be beautiful; let them be affecting, and agitate the mind with whatever paſſions the poet wiſhes to impart. The human countenance, as it ſmiles on thoſe who ſmile, accompanies alſo with ſympathetic tears thoſe who mourn. If you would have me weep, you muſt firſt weep yourſelf; then, and not before, ſhall I be touched with your misfortunes.—For nature firſt makes the emotions of our mind correſpond with our circumſtances, infuſing real joy, ſorrow, or reſentment, according to the occaſion: and afterwards gives the true pathetic utterance to the voice and language." This doctrine, which concerns the orator and the player no leſs than the poet, is ſtrictly philoſophical, and equally applicable to dramatic, to deſcriptive, and indeed to every ſpecies of intereſting poetry. The poet's ſenſibility muſt firſt of all engage him warmly in his ſubject, and in every part of it; otherwiſe he will labour in vain to intereſt the reader. If he would paint external nature, as Virgil and Thomſon have done, ſo as to make her amiable to others, he muſt firſt be enamoured of her himſelf; if he would have his heroes and heroines ſpeak the language of love or ſorrow, devotion or courage, ambition or anger, benevolence or pity, his heart muſt be ſuſceptible of thoſe emotions, and in ſome degree feel them, as long at leaſt as he employs himſelf in framing words for them; being aſſured, that

> He beſt ſhall paint them who can feel them moſt.
> Pope's *Eloiſa*, v. 366.

The true poet, therefore, muſt not only ſtudy nature, and know the reality of things, but muſt alſo poſſeſs fancy, to invent additional decorations; judgment, to direct him in the choice of ſuch as accord with veriſimilitude; and ſenſibility, to enter with ardent emotions into every part of his ſubject, ſo as to transfuſe into every part of his work a pathos and energy ſufficient to raiſe correſponding emotions in the reader.

"The hiſtorian and the poet (ſays Ariſtotle) differ in this, that the former exhibits things as they are, the latter as they might be;"—*i.e.* in that ſtate of perfection which is conſiſtent with probability, and in which, for the ſake of our own gratification, we wiſh to find them. If the poet, after all the liberties he is allowed to take with the truth, can produce nothing more exquiſite than is commonly to be met with in hiſtory, his reader will be diſappointed and diſſatisfied. Poetical repreſentations muſt therefore be framed after a pattern of the higheſt probable perfection that the genius of the work will admit:—external nature muſt in them be more pictureſque than in reality; action more animated; ſentiments more expreſſive of the feelings and character, and more ſuitable to the circumſtances, of the ſpeaker; perſonages better accompliſhed in thoſe qualities that raiſe admiration, pity, terror, and other ardent emotions: and events more compact, more clearly connected with cauſes and conſequences, and unfolded in an order more flattering to the fancy, and more intereſting to the paſſions. But where, it may be ſaid, is this pattern of perfection to be found? Not in real nature; otherwiſe hiſtory, which delineates real nature, would alſo delineate this pattern of perfection. It is to be found only in the mind of the poet; and it is imagination, regulated by knowledge, that enables him to form it.

In the beginning of life, and while experience is confined to a ſmall circle, we admire every thing, and are pleaſed with very moderate excellence. A peaſant thinks the hall of his landlord the fineſt apartment in the univerſe, liſtens with rapture to the ſtrolling ballad-ſinger, and wonders at the rude wooden cuts that adorn his ruder compoſitions. A child looks upon his native village as a town; upon the brook that runs by as a river: and upon the meadows and hills in the neighbourhood as the moſt ſpacious and beautiful that can be. But when, after long abſence, he returns in his declining years, to viſit, once before he die, the dear ſpot that gave him birth, and thoſe ſcenes whereof he remembers rather the original charms than the exact proportions; how is he diſappointed to find every thing ſo debaſed and ſo diminiſhed! The hills ſeem to have ſunk into the ground, the brook to be dried up, and the village to be forſaken of its people; the pariſh-church, ſtripped of all its fancied magnificence, is become low, gloomy, and narrow; and the fields are now only the miniature of what they were. Had he never left this ſpot, his notions might have remained the ſame as at firſt; and had he travelled but a little way from it, they would not perhaps have received any material enlargement. It ſeems then to be from obſervation of many things of the ſame or ſimilar kinds, that we acquire the talent of forming ideas more perfect than the real objects that lie immediately around us: and theſe ideas we may improve gradually more and more, according to the vivacity of our mind, and extent of our experience, till at laſt we come to raiſe them to a degree of perfection ſuperior to any thing to be found in real life. There cannot ſure be any myſtery in this doctrine; for we think and ſpeak to the ſame purpoſe every day. Thus nothing is more common than to ſay, that ſuch an artiſt excels all we have ever known in his profeſſion, and yet that we can ſtill conceive a ſuperior performance. A moraliſt, by bringing together into one view the ſeparate virtues of many perſons, is enabled to lay down a ſyſtem of duty more perfect than any he has ever ſeen exemplified in human conduct. Whatever be the emotion the poet intends to raiſe in his reader, whether admiration or terror, joy or ſorrow; and whatever be the object he would exhibit, whether Venus or Tiſiphone, Achilles or Therſites, a palace or a pile of ruins, a dance or a battle; he generally copies an idea of his own imagination; conſidering each quality as it is found to exiſt in ſeveral individuals of a ſpecies, and thence forming an aſſemblage more or leſs perfect in its kind, according to the purpoſe to which he means to apply it.

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* For part of this remark we have his own authority, often in his letters, and very explicitly in the Latin epitaph which he compoſed for himſelf:—"ubi ſæva indignatio ulterius cor lacerare nequit." *See his laſt will and teſtament.*

Hence it would appear, that the ideas of poetry are rather general than ſingular; rather collected from the examination of a ſpecies or claſs of things than copied from an individual. And this, according to Ariſtotle, is in fact the caſe, at leaſt for the moſt part; whence that critic determines, that poetry is ſomething more exquiſite and more philoſophical than hiſtory. The hiſtorian may deſcribe Bucephalus, but the poet delineates a war horſe; the former muſt have ſeen the animal he ſpeaks of, or received authentic information concerning it, if he mean to deſcribe it hiſtorically: for the latter, it is enough that he has ſeen ſeveral animals of that ſort. The former tells us what Achilles actually did and ſaid; the latter, what ſuch a ſpecies of human character as that which bears the name of Achilles would probably do or ſay in certain given circumſtances.

It is indeed true, that the poet may, and often does, copy after individual objects. Homer, no doubt, took his characters from the life; or at leaſt, in forming them, was careful to follow tradition as far as the nature of his plan would allow. But he probably took the freedom to add or heighten ſome qualities, and take away others; to make Achilles, for example, ſtronger, perhaps, and more impetuous, and more eminent for filial affection, and Hector more patriotic and more amiable than he really was. If he had not done this, or ſomething like it, his work would have been rather a hiſtory than a poem; would have exhibited men and things as they were, and not as they might have been; and *Achilles* and *Hector* would have been the names of individual and real heroes; whereas, according to Ariſtotle, they are rather to be conſidered as two diſtinct modifications or ſpecies of the heroic character. Shakeſpeare's account of the cliffs of Dover comes ſo near the truth, that we cannot doubt of its having been written by one who had ſeen them: but he who takes it for an exact hiſtorical deſcription, will be ſurpriſed when he comes to the place, and finds thoſe cliffs not half ſo lofty as the poet had made him believe. An hiſtorian would be to blame for ſuch amplification; becauſe, being to deſcribe an individual precipice, he ought to tell us juſt what it is; which if he did, the deſcription would ſuit that place, and perhaps no other in the whole world. But the poet means only to give an idea of what ſuch a precipice may be; and therefore his deſcription may perhaps be equally applicable to many ſuch chalky precipices on the ſea-ſhore.

This method of copying after general ideas formed by the artiſt from obſervation of many individuals, diſtinguiſhes the Italian and all the ſublime painters from the Dutch and their imitators. Theſe give us bare nature, with the imperfections and peculiarities of individual things or perſons; but thoſe give nature improved as far as probability and the deſign of the piece will admit. Teniers and Hogarth draw faces, and figures, and dreſſes, from real life and preſent manners; and therefore their pieces muſt in ſome degree loſe the effect, and become aukward, when the preſent faſhions become obſolete.——Raphael and Reynolds take their models from general nature; avoiding, as far as poſſible (at leaſt in all their great performances), thoſe peculiarities that derive their beauty from mere faſhion; and therefore their works muſt give pleaſure, and appear elegant, as long as men are capable of forming general ideas, and of judging from them. The laſt-mentioned incomparable artiſt is particularly obſervant of children, whoſe looks and attitudes, being leſs under the controul of art and local manners, are more characteriſtical of the ſpecies than thoſe of men and women. This field of obſervation has ſupplied him with many fine figures, particularly that moſt exquiſite one of Comedy, ſtruggling for and winning (for, who could reſiſt her?) the affections of Garrick:—a figure which could never have occured to the imagination of a painter who had confined his views to grown perſons looking and moving in all the formality of polite life;—a figure which in all ages and countries would be pronounced natural and engaging;—whereas thoſe human forms that we ſee every day bowing and courteſying, and ſtrutting, and turning out their toes *ſecundem artem*, and dreſſed in ruffles, and wigs, and flounces and hoop-petticoats, and full-trimmed ſuits, would appear elegant no further than the preſent faſhions are propagated, and no longer than they remain unaltered.

There is, in the progreſs of human ſociety, as well as of human life, a period to which it is of great importance for the higher order of poets to attend, and from which they will do well to take their characters and manners, and the æra of their events; namely, that wherein men are raiſed above ſavage life, and conſiderably improved by arts, government, and converſation; but not advanced ſo high in the aſcent towards politeneſs, as to have acquired a habit of diſguiſing their thoughts and paſſions, and of reducing their behaviour to the uniformity of the mode. Such was the period which Homer had the good fortune (as a poet) to live in, and to celebrate. This is the period at which the manners of men are moſt pictureſque, and their adventures moſt romantic. This is the period when the appetites unperverted by luxury, the powers unenervated by effeminacy, and the thoughts diſengaged from artificial reſtraint, will, in perſons of ſimilar diſpoſitions and circumſtances, operate in nearly the ſame way; and when, conſequently, the characters of particular men will approach to the nature of poetical or general ideas, and, if well imitated, give pleaſure to the whole, or at leaſt to a great majority of mankind. But a character tinctured with the faſhions of polite life would not be ſo generally intereſting. Like a human figure adjuſted by a modern dancing-maſter, and dreſſed by a modern tailor, it may have a good effect in ſatire, comedy, or farce; but if introduced into the higher poetry, it would be admired by thoſe only who had learned to admire nothing but preſent faſhions, and by them no longer than the preſent faſhions laſted; and to all the reſt of the world would appear aukward, unaffecting, and perhaps ridiculous. But Achilles and Sarpedon, Diomede and Hector, Neſtor and Ulyſſes, as drawn by Homer, muſt in all ages, independently of faſhion, command the attention and admiration of mankind. Theſe have the qualities that are univerſally known to belong to human nature; whereas the modern fine gentleman is diſtinguiſhed by qualities that belong only to a particular age, ſociety, and corner of the world. We ſpeak not of moral or intellectual virtues, which are objects of admiration to every age; but of thoſe outward accompliſhments, and that particular temperature of the paſſions, which form the moſt perceptible part of a human character. As, therefore, the politician, in diſcuſſing the rights of mankind, muſt often allude to an imaginary ſtate of nature; ſo the poet who intends to raiſe admiration, pity, terror, and other important emotions, in the generality of mankind, eſpecially in thoſe readers whoſe minds are moſt improved, muſt take his pictures of life and manners, rather from the heroic period we now ſpeak of, than from the ages of refinement; and muſt therefore (to repeat the maxim of Ariſtotle) "exhibit things, not as they are, but as they might be."

Sect. IV. *Of Poetical Characters.*

Horace ſeems to think, that a competent knowledge of moral philoſophy will fit an author for aſſigning the ſuitable qualities and duties to each poetical perſonage: (*Art. Poet.* v. 309.—316.). The maxim may be true, as far as mere morality is the aim of the poet; but cannot be underſtood to refer to the delineation of poetical characters in general: for a thorough acquaintance with all the moral philoſophy in the world would not have enabled Blackmore to paint ſuch a perſonage as Homer's Achilles, Shakeſpeare's Othello, or the Satan of Paradiſe Loſt. To a competency of moral ſcience, there muſt be added an extenſive knowledge of mankind, a warm and elevated imagination, and the greateſt ſenſibility of heart, before a genius can be formed equal to ſo difficult a taſk. Horace is indeed ſo ſenſible of the danger of introducing a new character in poetry, that he even diſcourages the attempt, and adviſes the poet rather to take his perſons from the ancient authors, or from tradition: *Ibid.* v. 119.—130.

To conceive the idea of a good man, and to invent and ſupport a great poetical character, are two very different things, however they may ſeem to have been confounded by ſome late critics. The firſt is eaſy to any perſon ſufficiently inſtructed in the duties of life: the laſt is perhaps of all the efforts of human genius the moſt difficult; ſo very difficult, that, though attempted by many, Homer, Shakeſpeare, and Milton, are almoſt the only authors who have ſucceeded in it. But characters of perfect virtue are not the moſt proper for poetry. It ſeems to be agreed, that the Deity ſhould not be introduced in the machinery of a poetical fable. To aſcribe to him words and actions of our own invention, ſeems very unbecoming; nor can a poetical deſcription, that is known to be, and muſt of neceſſity be, infinitely inadequate, ever ſatisfy the human mind. Poetry, according to the beſt critics, is an imitation of human action; and therefore poetical characters, though elevated, ſhould ſtill partake of the paſſions and frailties of humanity. If it were not for the vices of ſome principal perſonages, the Iliad would not be either ſo intereſting or ſo moral; the moſt moving and eventful parts of the Æneid are thoſe that deſcribe the effects of unlawful paſſion: the moſt inſtructive tragedy in the world, we mean Macbeth, is founded in crimes of dreadful enormity: and if Milton had not taken into his plan the fall of our firſt parents, as well as their ſtate of innocence, his divine poem muſt have wanted much of its pathos, and could not have been (what it now is) ſuch a treaſure of important knowledge, as no other uninſpired writer ever comprehended in ſo ſmall a compaſs. Virtue, like truth, is uniform and unchangeable. We may anticipate the part a good man will act in any given circumſtances: and therefore the events that depend on ſuch a man muſt be leſs ſurpriſing than thoſe which proceed from paſſion; the viciſſitudes whereof it is frequently impoſſible to foreſee. From the violent temper of Achilles, in the Iliad, ſpring many great incidents; which could not have taken place, if he had been calm and prudent like Ulyſſes, or pious and patriotic like Æneas: his rejection of Agamemnon's offers, in the ninth book, ariſes from the violence of his reſentment; his yielding to the requeſt of Patroclus, in the 16th, from the violence of his friendſhip (if we may ſo ſpeak) counteracting his reſentment; and his reſtoring to Priam the dead body of Hector, in the 24th, from the violence of his affection to his own aged father, and his regard to the command of Jupiter, counteracting, in ſome meaſure, both his ſorrow for his friend, and his thirſt for vengeance.—Beſides, except where there is ſome degree of vice, it pains us too exquiſitely to ſee misfortune; and therefore poetry would ceaſe to have a pleaſurable influence over our tender paſſions, if it were to exhibit virtuous characters only. And as in life, evil is neceſſary to our moral probation, and the poſſibility of error to our intellectual improvement; ſo bad or mixed characters are uſeful in poetry, to give to the good ſuch oppoſition as puts them upon diſplaying and exerciſing their virtue.

All thoſe perſonages, however, in whoſe fortune the poet means that we ſhould be intereſted, muſt have agreeable and admirable qualities to recommend them to our regard. And perhaps the greateſt difficulty in the art lies in ſuitably blending thoſe faults which the poet finds it expedient to give to any particular hero, with ſuch moral, intellectual, or corporeal accompliſhments, as may engage our eſteem, pity, or admiration, without weakening our hatred of vice, or love of virtue. In moſt of our novels, and in many of our plays, it happens unluckily, that the hero of the piece is ſo captivating, as to incline us to be indulgent to every part of his character, the bad as well as the good. But a great maſter knows how to give the proper direction to human ſenſibility; and, without any perverſion of our faculties, or any confuſion of right and wrong, to make the ſame perſon the object of very different emotions, of pity and hatred, of admiration and horror. Who does not eſteem and admire Macbeth for his courage and generoſity? who does not pity him when beſet with all the terrors of a pregnant imagination, ſuperſtitious temper, and awakened conſcience? who does not abhor him as a monſter of cruelty, treachery, and ingratitude? His good qualities, by drawing us near to him, make us, as it were, eye-witneſſes of his crime, and give us a fellow-feeling of his remorſe; and therefore his example cannot fail to have a powerful effect in cheriſhing our love of virtue, and fortifying our minds againſt criminal impreſſions: whereas, had he wanted thoſe good qualities, we ſhould have kept aloof from his concerns, or viewed them with a ſuperficial attention; in which caſe his example would have had little more weight than that of the robber, of whom we know nothing, but that he was tried, condemned, and executed. Satan, in Paradiſe Loſt, is a character drawn and ſupported with the moſt conſummate judgment. The old furies and demons, Hecate, Tiſiphone, Alecto, Megara, are objects of unmixed and unmitigated abhorrence; Tityus, Enceladus, and their brethren, are remarkable for nothing but impiety, deformity, and vaſtneſs of ſize; Pluto is, at beſt, an inſipid perſonage; Mars, a hair-brained ruffian; Taſſo's infernal tyrant, an ugly and overgrown monſter:—but in the Miltonic Satan, we are forced to admire the majeſty of the ruined archangel, at the ſame time that we deteſt the unconquerable depravity of the fiend. "But, of all poetical characters, (ſays the elegant critic from whom we are extracting), the Achilles of Homer * ſeems to me the moſt exquiſite of invention, and the moſt highly finiſhed. The utility of this character in a moral view is obvious; for it may be conſidered as the ſource of all the morality of the Iliad. Had not the generous and violent temper of Achilles determined him to patroniſe the augur Calchas in defiance of Agamemnon, and afterwards, on being affronted by that vindictive commander, to abandon for a time the common cauſe of Greece;—the fatal effects of diſſention among confederates, and of capricious and tyrannical behaviour in a ſovereign, would not have been the leading moral of Homer's poetry; nor could Hector, Sarpedon, Æneas, Ulyſſes, and the other amiable heroes, have been brought forward to ſignalize their virtues, and to recommend themſelves to the eſteem and imitation of mankind.

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* "I ſay the *Achilles of* Homer. Latter authors have degraded the character of this hero, by ſuppoſing every part of his body invulnerable except the heel. I know not how often I have heard this urged as one of Homer's abſurdities; and indeed the whole Iliad is one continued abſurdity, on this ſuppoſition. But Homer all along makes his hero equally liable to wounds and death with other men. Nay, to prevent all miſtakes in regard to this matter, (if thoſe who cavil at the poet would but read

"They who form their judgment of Achilles from the imperfect ſketch given of him by Horace in the *Art of Poetry*, (v. 121, 122.); and conſider him only as a hateful compoſition of anger, revenge, fierceneſs, obſtinacy, and pride, can never enter into the views of Homer, nor be ſuitably affected with his narration. All theſe vices are no doubt, in ſome degree, combined in Achilles; but they are tempered with qualities of a different ſort, which render him a moſt intereſting character, and of courſe make the Iliad a moſt intereſting poem. Every reader abhors the faults of this hero: and yet, to an attentive reader of Homer, this hero muſt be the object of eſteem, admiration, and piety; for he has many good as well as bad affections, and is equally violent in all:—Nor is he poſſeſſed of a ſingle vice or virtue, which the wonderful art of the poet has not made ſubſervient to the deſign of the poem, and to the progreſs and cataſtrophe of the action; ſo that the hero of the Iliad, conſidered as a poetical perſonage, is juſt what he ſhould be, neither greater nor leſs, neither worſe nor better He is everywhere diſtinguiſhed by an abhorrence of oppreſſion, by a liberal and elevated mind, by a paſſion for glory, and by a love of truth, freedom, and ſincerity. He is for the moſt part attentive to the duties of religion; and, except to thoſe who have injured him, courteous and kind: he is affectionate to his tutor Phenix; and not only pities the misfortunes of his enemy Priam, but in the moſt ſoothing manner adminiſters to him the beſt conſolation that Homer's poor theology could furniſh. Though no admirer of the cauſe in which his evil deſtiny compels him to engage, he is warmly attached to his native land; and, ardent as he is in vengeance, he is equally ſo in love to his aged father Peleus, and to his friend Patroclus. He is not luxurious like Paris, nor clowniſh like Ajax; his accompliſhments are princely, and his amuſements worthy of a hero. Add to this, as an apology for the vehemence of his anger, that the affront he had received was (according to the manners of that age) of the moſt atrocious nature; and not only unprovoked, but ſuch as, on the part of Agamemnon, betrayed a brutal inſenſibility to merit, as well as a proud, ſelfiſh, ungrateful, and tyrannical diſpoſition. And though he is often inexcuſably furious; yet it is but juſtice to remark, that he was not naturally cruel *; and that his wildeſt outrages were ſuch as in thoſe rude times might be expected from a violent man of invincible ſtrength and valour, when exaſperated by injury, and frantic with ſorrow. Our hero's claim to the admiration of mankind is indiſputable. Every part of his character is ſublime and aſtoniſhing. In his perſon, he is the ſtrongeſt, the ſwifteſt, the moſt beautiful of men:—this laſt circumſtance, however, occurs not to his own obſervation, being too trivial to attract the notice of ſo great a mind. The Fates had put it in his power, either to return home before the end of the war, or to remain at Troy:—if he choſe the former, he would enjoy tranquillity and happineſs in his own country to a good old age; if the latter, he muſt periſh in the bloom of his youth:—his affection to his father and native country, and his hatred to Agamemnon, ſtrongly urged him to the firſt; but a deſire to avenge the death of his friend determines him to accept the laſt, with all its conſequences. This at once diſplays the greatneſs of his fortitude, the warmth of his friendſhip, and the violence of his ſanguinary paſſions: and it is this that ſo often and ſo powerfully recommends him to the pity, as well as admiration, of the attentive reader."

It is equally a proof of rich invention and exact judgment in Homer, that he mixes ſome good qualities in all his bad characters, and ſome degree of imperfection in almoſt all his good ones.——Agamemnon, notwithſtanding his pride, is an able general, and a valiant man, and highly eſteemed as ſuch by the greater part of the army.——Paris, though effeminate, and vain of his dreſs and perſon, is, however, good-natured, patient of reproof, not deſtitute of courage, and eminently ſkilled in muſic and other fine arts.——Ajax is a huge giant; fearleſs rather from inſenſibility to danger, and confidence in his maſſy arms, than from any nobler principle; boaſtful and rough; regardleſs of the gods, though not downright impious: yet there is in his manner ſomething of frankneſs and blunt ſincerity, which entitle him to a ſhare in our eſteem; and he is ever ready to aſſiſt his countrymen, to whom he renders good ſervice on many a perilous emergency.——The character of Helen in ſpite of her faults, and of the many calamities whereof ſhe is the guilty cauſe, Homer has found means to recommend to our pity, and almoſt to our love; and this he does, without ſeeking to extenuate the crime of Paris, of which the moſt reſpectable perſonages in the poem are made to ſpeak with becoming abhorrence. She is ſo full of remorſe, ſo ready on every occaſion to condemn her paſt conduct, ſo affectionate to her friends, ſo willing to do juſtice to every body's merit, and withal ſo finely accompliſhed, that ſhe extorts our admiration, as well as that of the Trojan ſenators.——Menelaus, though ſufficiently ſenſible of the injury he had received, is yet a man of moderation, clemency, and good-nature, a valiant ſoldier, and a moſt affectionate brother: but there is a daſh of vanity in his compoſition, and he entertains rather too high an opinion of his own abilities, yet never overlooks nor undervalues the merit of others. Priam would claim unreſerved eſteem, as well as pity, if it were not for his inexcuſable weakneſs, in gratifying the humour, and by indulgence abetting the crimes, of the moſt worthleſs of all his children, to the utter ruin of his people, family, and kingdom. Madame Dacier ſuppoſes, that he had loſt his authority, and was obliged to fall in with the politics of the times: but of this there appears no evidence; on the contrary, he and his unworthy favourite Paris ſeem to have been the only perſons of diſtinction in Troy who were averſe to the reſtoring of Helen. Priam's foible (if it can be called by ſo ſoft a name), however faulty, is not uncommon, and has often produced calamity both in private and public life. The Scripture gives a memorable inſtance in the hiſtory of the good old Eli.——Sarpedon comes nearer a perfect character than any other of Homer's heroes; but the part he has to act is ſhort: It is a character which one could hardly have expected in thoſe rude times: a ſovereign prince, who conſiders himſelf as a magiſtrate ſet up by the people for the public good, and there-

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his work), he actually wounds him in the right arm by the lance of Aſteropæus, in the battle near the river Scamander." See *Iliad*, xxi. ver. 161.—168.

[*] See *Iliad* xxi. 100. and xxiv. 485—673.—In the firſt of theſe paſſages, Achilles himſelf declares, that before Patroclus was ſlain, he often ſpared the lives of his enemies, and took pleaſure in doing it. It is ſtrange, as Dr. Beattie obſerves, that this ſhould be left out in Pope's Tranſlation.

fore bound in honour and gratitude to be himſelf their example, and ſtudy to excel as much in virtue as in rank and authority.——Hector is the favourite of every reader, and with good reaſon. To the trueſt valour he joins the moſt generous patriotiſm. He abominates the crime of Paris: but not being able to prevent the war, he thinks it his duty to defend his country, and his father and ſovereign, to the laſt. He too, as well as Achilles, foreſees his own death; which heightens our compaſſion, and raiſes our idea of his magnanimity. In all the relations of private life, as a ſon, a father, a huſband, a brother, he is amiable in the higheſt degree; and he is diſtinguiſhed among all the heroes for tenderneſs of affection, gentleneſs of manners, and a pious regard to the duties of religion. One circumſtance of his character, ſtrongly expreſſive of a great and delicate mind, we learn from Helen's lamentation over his dead body, that he was almoſt the only perſon in Troy who had always treated her with kindneſs, and never uttered one reproachful word to give her pain, nor heard others reproach her without blaming them for it. Some tendency to oſtentation (which, however, may be pardonable in a commander in chief), and temporary fits of timidity, are the only blemiſhes diſcoverable in this hero; whoſe portrait Homer appears to have drawn with an affectionate and peculiar attention.

By aſcribing ſo many amiable qualities to Hector and ſome others of the Trojans, the poet intereſts us in the fate of that people, notwithſtanding our being continually kept in mind that they are the injurious party. And by thus blending good and evil, virtue and frailty, in the compoſition of his characters, he makes them the more conformable to the real appearances of human nature, and more uſeful as examples for our improvement; and at the ſame time, without hurting veriſimilitude, gives every neceſſary embelliſhment to particular parts of his poem, and variety, coherence, and animation, to the whole fable. And it may alſo be obſerved, that though ſeveral of his characters are complex, not one of them is made up of incompatible parts: all are natural and probable, and ſuch as we think we have met with, or might have met with, in our intercourſe with mankind.

From the ſame extenſive views of good and evil, in all their forms and combinations, Homer has been enabled to make each of his characters perfectly diſtinct in itſelf, and different from all the reſt; inſomuch, that before we come to the end of the Iliad, we are as well acquainted with his heroes, as with the faces and tempers of our moſt familiar friends. Virgil, by confining himſelf to a few general ideas of fidelity and fortitude has made his ſubordinate heroes a very good ſort of people; but they are all the ſame, and we have no clear knowledge of any one of them. Achates is faithful, and Gyas is brave, and Cloanthus is brave; and this is all we can ſay of the matter. We ſee theſe heroes at a diſtance, and have ſome notion of their ſhape and ſize; but are not near enough to diſtinguiſh their features; and every face ſeems to exhibit the ſame faint and ambiguous appearance. But of Homer's heroes we know every particular that can be known. We eat, and drink, and talk, and fight, with them: we ſee them in action and out of it; in the field and in their tents and houſes: the very face of the country about Troy we ſeem to be as well acquainted with as if we had been there. Similar characters there are among theſe heroes, as there are ſimilar faces in every ſociety; but we never miſtake one for another. Neſtor and Ulyſſes are both wiſe and both eloquent: but the wiſdom of the former ſeems to be the effect of experience; that of the latter of genius: the eloquence of the one is ſweet and copious, but not always to the purpoſe, and apt to degenerate into ſtory-telling; that of the other is cloſe, emphatical, and perſuaſive, and accompanied with a peculiar modeſty and ſimplicity of manner. Homer's heroes are all valiant; yet each diſplays a modification of valour peculiar to himſelf; one is valiant from principle, another from conſtitution; one is raſh, another cautious; one is impetuous and head-ſtrong, another impetuous but tractable; one is cruel, another merciful; one is inſolent and oſtentatious, another gentle and unaſſuming; one is vain of his perſon, another of his ſtrength, and a third of his family.——It would be tedious to give a complete enumeration. Almoſt every ſpecies of the heroic character is to be found in Homer.

Of the agents in Paradiſe Loſt, it has been obſerved by Johnſon in his Life of Milton, that "the weakeſt are the higheſt and nobleſt of human beings, the original parents of mankind; with whoſe actions the elements conſented; on whoſe rectitude or deviation of will depended the ſtate of terreſtrial nature, and the condition of all the future inhabitants of the globe. Of the other agents in the poem, the chief are ſuch as it is irreverence to name on ſlight occaſions: the reſt are lower powers;

——Of which the leaſt could wield
Theſe elements, and arm him with the force
Of all their regions:

Powers, which only the controul of Omnipotence reſtrains from laying creation waſte, and filling the vaſt expanſe of ſpace with ruin and confuſion. To diſplay the motives and actions of beings thus ſuperior, ſo far as human reaſon can examine, or human imagination repreſent them, is the taſk which Milton undertook and performed. The characters in the Paradiſe Loſt, which admit of examination, are thoſe of angels and of men; of angels good and evil; of man in his innocent and ſinful ſtate.

"Among the angels, the virtue of Raphael is mild and placid, of eaſy condeſcenſion, and free communication: that of Michael is regal and lofty, attentive to the dignity of his own nature. Abdiel and Gabriel appear occaſionally, and act as every incident requires: the ſolitary fidelity of Abdiel is very amiably painted.

Of the evil angels, the characters are more diverſified. To Satan ſuch ſentiments are given as ſuit the moſt exalted and moſt depraved being. Milton has been cenſured for the impiety which ſometimes breaks from Satan's mouth; for there are thoughts, it is juſtly remarked, which no obſervation of character can juſtify; becauſe no good man would willingly permit them to paſs, however tranſiently, through his mind. This cenſure has been ſhown to be groundleſs by the great critic from whom we quote. To make Satan ſpeak as a rebel, ſays he, without any ſuch expreſſions as might taint the readers imagination, was indeed one of the greateſt difficulties in Milton's undertaking; and I cannot but think that he has extricated himſelf with great happineſs. There is in Satan's ſpeeches little that can give pain to a pious ear. The language of rebellion cannot be the ſame with that of obedience: the malignity of Satan foams in haughtineſs and obſtinacy; but his expreſſions are commonly general, and no otherwiſe offenſive than as they are wicked.—The other chiefs of the celeſtial rebellion are very judiciouſly diſcriminated; and the ferocious character of Moloch appears, both in the battle and in the council, with exact conſiſtency.

"To Adam and to Eve are given, during their innocence, ſuch ſentiments as innocence can generate and utter. Their love is pure benevolence and mutual veneration; their repaſts are without luxury, and their diligence without toil. Their addreſſes to their Maker have little more than the voice of admiration and gratitude: fruition left them nothing to aſk, and innocence left them nothing to fear.—But with guilt enter diſtruſt and diſcord, mutual accuſation and ſtubborn ſelf-defence: they regard each other with alienated minds, and dread their Creator as the avenger of their tranſgreſſion; at laſt, they ſeek ſhelter in his mercy, ſoften to repentance, and melt in ſupplication. Both before and after the fall, the different ſentiments ariſing from difference of ſex are traced out with inimitable delicacy and philoſophical propriety. Adam has always that pre-eminence in dignity, and Eve in lovelineſs, which we ſhould naturally look for in the father and mother of mankind."

From what has been ſaid, it ſeems abundantly evident, —That the end of poetry is to pleaſe; and therefore that the moſt perfect poetry muſt be the moſt pleaſing;—that what is unnatural cannot give pleaſure; and therefore that poetry muſt be according to nature:—that it muſt be either according to real nature, or according to nature ſomewhat different from the reality;—that, if according to real nature, it would give no greater pleaſure than hiſtory, which is a tranſcript of real nature;—that greater pleaſure is, however, to be expected from it, becauſe we grant it ſuperior indulgence, in regard to fiction, and the choice of words;—and, conſequently, that poetry muſt be, not according to real nature, but according to nature improved to that degree which is conſiſtent with probability and ſuitable to the poet's purpoſe.——And hence it is that we call poetry, *An imitation of nature.*—For that which is properly termed *imitation* has always in it ſomething which is not in the original. If the prototype and tranſcript be exactly alike; if there be nothing in the one which is not in the other; we may call the latter a *repreſentation*, a *copy*, a *draught*, or a *picture*, of the former; but we never call it an *imitation*.

SECT. V. *Of Arrangement, Unity, Digreſſions.—Further remarks on Nature in Poetry.*

I. The origin of nations, and the beginnings of great events, are little known, and ſeldom intereſting; whence the firſt part of every hiſtory, compared with the ſequel, is ſomewhat dry and tedious. But a poet muſt, even in the beginning of his work, intereſt the readers, and raiſe high expectation; not by any affected pomp of ſtyle, far leſs by ample promiſes or bold profeſſions; but by ſetting immediately before them ſome incident, ſtriking enough to raiſe curioſity, in regard both to its cauſes and to its conſequences. He muſt therefore take up his ſtory, not at the beginning, but in the middle; or rather, to prevent the work from being too long, as near the end as poſſible; and afterwards take ſome proper opportunity to inform us of the preceding events, in the way of narrative, or by converſation of the perſons introduced, or by ſhort and natural digreſſions.

The action of both the *Iliad* and *Odſſey* begins about ſix weeks before its concluſion; although the principal events of the war of Troy are to be found in the former; and the adventures of a ten years voyage, followed by the ſuppreſſion of a dangerous domeſtic enemy, in the latter. One of the firſt things mentioned by Homer in the Iliad, is a plague, which Apollo in anger ſent into the Grecian army commanded by Agamemnon and now encamped before Troy. Who this Agamemnon was, and who the Grecians were; for what reaſon they had come hither; how long the ſiege had laſted; what memorable actions had been already performed; and in what condition both parties now were:—all this, and much more, we ſoon learn from occaſional hints and converſations interſperſed through the poem.

In the *Æneid*, which, though it comprehends the tranſactions of ſeven years, opens within a few months of the concluding event, we are firſt preſented with a view of the Trojan fleet at ſea, and no leſs a perſon than Juno intereſting herſelf to raiſe a ſtorm for their deſtruction. This excites a curioſity to know ſomething further: who theſe Trojans were, whence they had come, and whither they were bound; why they had left their own country, and what had befallen them ſince they had left it.' On all theſe points, the poet, without quitting the track of his narrative, ſoon gives the fulleſt information: The ſtorm riſes; the Trojans are driven to Africa, and hoſpitably received by the queen of the country; at whoſe deſire their commander relates his adventures.

The action of *Paradiſe Loſt* commences not many days before Adam and Eve are expelled from the garden of Eden, which is the concluding event. This poem, as its plan is incomparably more ſublime and more important than that of either the Iliad or Æneid, opens with a far more intereſting ſcene: a multitude of angels and archangels ſhut up in a region of torment and darkneſs, and rolling on a lake of unquenchable fire. Who theſe angels are, and what brought them into this miſerable condition, we naturally wiſh to know; and the poet in due time informs us; partly from the converſation of the fiends themſelves; and more particularly by the mouth of a happy ſpirit, ſent from heaven to caution the father and mother of mankind againſt temptation, and confirm their good reſolutions by unfolding the dreadful effects of impiety and diſobedience.

This poetical arrangement of events, ſo different from the hiſtorical, has other advantages beſides thoſe ariſing from brevity and compactneſs of detail: it is obviouſly more affecting to the fancy, and more alarming to the paſſions; and, being more ſuitable to the order and the manner in which the actions of other men ſtrikes our ſenſes, is a more exact imitation of human affairs. I hear a ſudden noiſe in the ſtreet, and run to ſee what is the matter. An inſurrection has happened, a great multitude is brought together, and ſomething very important is going forward. The ſcene before me is the firſt thing that engages my attention; and is in itſelf ſo intereſting, that for a moment or two I look at it in ſilence and wonder. By and by, when I get time for reflection, I begin to inquire into the cauſe of all this tumult, and what it is the people would be at; and one who is better informed than I, explains the affair from the beginning; or perhaps I make this out for myſelf, from the words and actions of the perſons principally concerned.—This is a ſort of picture of poetical arrangement, both in epic and dramatic compoſition; and this plan has been followed in narrative odes and ballads both ancient and modern.—The hiſtorian purſues a different method. He begins perhaps with an account of the manners of a certain age, and of the political conſtitution of a certain country; then introduces a particular perſon, gives the ſtory of his birth, connections, private character, purſuits, diſappointments, and of the events that promoted his views, and brought him acquainted with other turbulent ſpirits like himſelf; and ſo proceeds, unfolding, according to the order of time, the cauſes, principles, and progreſs of the conſpiracy, if that be the ſubject which he undertakes to illuſtrate. It cannot be denied, that this latter method is more favourable to calm information: but the former, compared with it, will be found to have all the advantages already ſpecified, and to be more effectually productive of that mental pleaſure which depends on the paſſions and imagination.

II. If a work have no determined end, it has no meaning; and if it have many ends, it will diſtract by its multiplicity. Unity of deſign, therefore, belongs in ſome meaſure to all compoſitions, whether in verſe or proſe. But to ſome it is more eſſential than to others; and to none ſo much as in the higher poetry. In certain kinds of hiſtory, there is unity ſufficient if all the events recorded be referred to one perſon; in others, if to one period of time, or to one people, or even to the inhabitants of one and the ſame planet. But it is not enough that the ſubject of a poetical fable be the exploits of one perſon; for theſe may be of various and even of oppoſite ſorts and tendencies, and take up longer time than the nature of poetry can admit:—far leſs can a regular poem comprehend the affairs of one period or of one people: it muſt be limited to one great action or event, to the illuſtration of which all the ſubordinate events muſt contribute; and theſe muſt be ſo connected with one another, as well as with the poet's general purpoſe, that one cannot be changed, tranſpoſed, or taken away, without affecting the conſiſtence and ſtability of the whole. In itſelf an incident may be intereſting, a character well drawn, a deſcription beautiful; and yet, if it disfigure the general plan, or if it obſtruct or incumber the main action, inſtead of helping it forward, a correct artiſt would conſider it but as a gaudy ſuperfluity or ſplendid deformity; like a piece of ſcarlet cloth ſewed upon a garment of a different colour. Not that all the parts of the fable either are, or can be, equally eſſential. Many deſcriptions and thoughts, of little conſequence to the plan, may be admitted for the ſake of variety; and the poet may, as well as the hiſtorian and philoſopher, drop his ſubject for a time, in order to take up an affecting or inſtructive digreſſion.

III. The doctrine of poetical digreſſions and epiſodes has been largely treated by the critics. We ſhall here only remark, that, in eſtimating their propriety, three things are to be attended to:—their connection with the fable or ſubject; their own peculiar excellence; and their ſubſerviency to the poet's deſign.

(1.) Thoſe digreſſions that both ariſe from and terminate in the ſubject, like the epiſode of the angel Raphael in Paradiſe Loſt, and the tranſition to the death of Cæſar and the civil wars in the firſt book of the Georgics, are the moſt artful, and if ſuitably executed claim the higheſt praiſe:—thoſe that ariſe from, but do not terminate in, the ſubject, are perhaps ſecond in the order of merit; like the ſtory of Dido in the Æneid, and the encomium on a country life in the ſecond book of the Georgics:—thoſe come next that terminate in, but do not riſe from, the fable; of which there are ſeveral in the third book of the Æneid, and in the Odyſſey:—and thoſe that neither terminate in the fable nor riſe from it are the leaſt artful; and, if long, cannot eſcape cenſure, unleſs their beauty be very great.

But (2.) we are willing to excuſe a beautiful epiſode at whatever expenſe to the ſubject it may be introduced. They who can blame Virgil for obtruding upon them the charming tale of Orpheus and Eurydice in the fourth Georgic, or Milton for the apoſtrophe to light in the beginning of his third book, ought to forfeit all title to the peruſal of good poetry; for of ſuch divine ſtrains one would rather be the author than of all the books of criticiſm in the world. Yet ſtill it is better that an epiſode poſſeſs the beauty of connection, together with its own intrinſic elegance, than this without the other.

Moreover, in judging of the propriety of epiſodes and other ſimilar contrivances, it may be expedient to attend (3.) to the deſign of the poet, as diſtinguiſhed from the fable or ſubject of the poem. The great deſign, for example, of Virgil, was to intereſt his countrymen in a poem written with a view to reconcile them to the perſon and government of Auguſtus. Whatever, therefore, in the poem, tends to promote this deſign, even though it ſhould in ſome degree hurt the contexture of the fable, is really a proof of the poet's judgment; and may be not only allowed, but applauded.—The progreſs of the action of the Æneid may ſeem to be too long obſtructed in one place by the ſtory of Dido, which, though it riſes from the preceding part of the poem, has no influence upon the ſequel; and, in another, by the epiſode of Cacus, which, without injury to the fable, might have been omitted altogether. Yet theſe epiſodes, intereſting as they are to us and all mankind, becauſe of the tranſcendent merit of the poetry, muſt have been ſtill more intereſting to the Romans becauſe of their connection with the Roman affairs; for the one accounts poetically for their wars with Carthage; and the other not only explains ſome of their religious ceremonies, but alſo gives a moſt charming rural picture of thoſe hills and valleys in the neighbourhood of the Tiber, on which, in after times, their majeſtic city was fated to ſtand.—And if we conſider, that the deſign of Homer's Iliad was not only to ſhow the fatal effects of diſſenſion among confederates, but alſo to immortalize his country, and celebrate the moſt diſtinguiſhed families in it, we ſhall be inclined to think more favourably than critics generally do of ſome of his long ſpeeches and digreſſions; which, though to us they may ſeem trivial, muſt have been very intereſting to his countrymen on account of the genealogies and private hiſtory recorded in them.—Shakeſpeare's hiſtorical plays, conſidered as dramatic fables, and tried by the laws of tragedy and comedy, appear very rude compoſitions; but if we attend to the poet's deſign (as the elegant author of Eſſays on the Writings and Genius of Shakeſpeare has with equal truth and beauty explained it), we ſhall be forced to admire his judgment in the general conduct of thoſe pieces, as well as unequalled ſucceſs in the execution of particular parts.

There is yet another point of view in which theſe digreſſions may be conſidered. If they tend to elucidate any important character, or to introduce any intereſting event not otherwiſe within the compaſs of the poem, or to give an amiable diſplay of any particular virtue, they may be entitled, not to our pardon only, but even to our admiration, however looſely they may hang upon the fable. All theſe three ends are effected by that moſt beautiful epiſode of Hector and Andromache in the ſixth book of the Iliad; and the two laſt, by the no leſs beautiful one of Euryalus and Niſus in the ninth of the Æneid.

IV. And now, from the poſition formerly eſtabliſhed, that the end of this divine art is to give pleaſure, it has been endeavoured to prove, that, whether in diſplaying the appearances of the material univerſe, or in imitating the workings of the human mind, and the varieties of human character, or in arranging and combining into one whole the ſeveral incidents and parts whereof his fable conſiſts,—the aim of the poet muſt be to copy nature, not as it is, but in that ſtate of perfection in which, conſiſtently with the particular genius of the work, and the laws of veriſimilitude, it may be ſuppoſed to be.

Such, in general, is the nature of that poetry which is intended to raiſe admiration, pity, and other ſerious emotions. But in this art, as in all others, there are different degrees of excellence; and we have hitherto directed our view chiefly to the higheſt. All ſerious poets are not equally ſolicitous to improve nature. Euripides is ſaid to have repreſented men as they were; Sophocles, more poetically, as they ſhould or might be. Theocritus in his Idyls, and Spenſer in his Shepherd's Calendar, give us language and ſentiments more nearly approaching thoſe of the *rus verum et barbarum* than what we meet with in the Paſtorals of Virgil and Pope. In the hiſtorical drama, human characters and events muſt be according to hiſtorical truth, or at leaſt not ſo remote from it as to lead into any important miſapprehenſion of fact. And in the hiſtorical epic poem, ſuch as the Pharſalia of Lucan, and the Campaign of Addiſon, the hiſtorical arrangement is preferred to the poetical, as being nearer the truth. Yet nature is a little improved even in theſe poems. The perſons in Shakeſpeare's hiſtorical plays, and the heroes of the Pharſalia, talk in verſe, and ſuitably to their characters, and with a readineſs, beauty, and harmony of expreſſion, not to be met with in real life, nor even in hiſtory: ſpeeches are invented, and, to heighten the deſcription, circumſtances added, with great latitude: real events are rendered more compact and more ſtrictly dependent upon one another; and fictitious ones brought in, to elucidate human characters and diverſify the narration.

The more poetry improves nature, by copying after general ideas collected from extenſive obſervation, the more it partakes (according to Ariſtotle) of the nature of philoſophy; the greater ſtretch of fancy and of obſervation it requires in the artiſt, the better chance it has to be univerſally agreeable.

Yet poetry, when it falls ſhort of this perfection, may have great merit as an inſtrument of both inſtruction and pleaſure. To moſt men, ſimple unadorned nature is, at certain times, and in certain compoſitions, more agreeable than the moſt elaborate improvements of art; as a plain ſhort period, without modulation, gives a pleaſing variety to a diſcourſe. Many ſuch portraits of ſimple nature there are in the ſubordinate parts both of Homer's and of Virgil's poetry: and an excellent effect they have in giving probability to the fiction, as well as in gratifying the reader's fancy with images diſtinct and lively, and eaſily comprehended. The hiſtorical plays of Shakeſpeare raiſe not our pity and terror to ſuch a height as Lear, Macbeth, or Othello; but they intereſt and inſtruct us greatly notwithſtanding. The rudeſt of the eclogues of Theocritus, or even of Spenſer, have by ſome authors been extolled above thoſe of Virgil, becauſe more like real life. Nay, Corneille is known to have preferred the Pharſalia to the Æneid, perhaps from its being nearer the truth, or perhaps from the ſublime ſentiments of ſtoical morality ſo forcibly and ſo oſtentatiouſly diſplayed in it.

Poets may refine upon nature too much as well as too little; for affectation and ruſticity are equally remote from true elegance. The ſtyle and ſentiments of comedy ſhould no doubt be more correct and more pointed than thoſe of the moſt polite converſation: but to make every footman a wit, and every gentleman and lady an epigrammatiſt, as Congreve has done, is an exceſſive and faulty refinement. The proper medium has been hit by Menander and Terence, by Shakeſpeare in his happier ſcenes, and by Garrick, Cumberland, and ſome others of late renown. To deſcribe the paſſion of love with as little delicacy as ſome men ſpeak of it would be unpardonable; but to tranſform it into mere Platonic adoration is to run into another extreme, leſs criminal indeed, but too remote from univerſal truth to be univerſally intereſting. To the former extreme Ovid inclines, and Petrarch and his imitators to the latter. Virgil has happily avoided both: but Milton has painted this paſſion as diſtinct from all others, with ſuch peculiar truth and beauty, that we cannot think Voltaire's encomium too high, when he ſays, that love in all other poetry ſeems a weakneſs, but in Paradiſe Loſt a virtue. There are many good ſtrokes of nature in Ramſay's Gentle Shepherd; but the author's paſſion for the *rus verum* betrays him into ſome indelicacies: a cenſure that falls with greater weight upon Theocritus, who is often abſolutely indecent. The Italian paſtoral of Taſſo and Guarini, and the French of Fontenelle, run into the oppoſite extreme (though in ſome parts beautifully ſimple), and diſplay a ſyſtem of rural manners ſo quaint and affected as to outrage all probability. In fine, though mediocrity of execution in poetry be allowed to deſerve the doom pronounced upon it by Horace; yet it is true, notwithſtanding, that in this art, as in many other good things, the point of excellence lies in a middle between two extremes; and has been reached by thoſe only who ſought to improve nature as far as the genius of their work would permit, keeping at an equal diſtance from ruſticity on the one hand, and affected elegance on the other.

Sect. VI. *Of Poetical Language.*

Words in poetry are choſen, firſt, for their *ſenſe*; and, ſecondly, for their *ſound*. That the firſt of theſe grounds of choice is the more excellent nobody can deny. He who in literary matters prefers ſound to ſenſe is a fool. Yet ſound is to be attended to even in proſe, and in verſe demands particular attention. We ſhall conſider poetical language, firſt, as SIGNIFICANT; and, ſecondly, as SUSCEPTIBLE OF HARMONY.

§ 1. *Of Poetical Language conſidered as* SIGNIFICANT.

If, as it has been endeavoured to prove, poetry be imitative of nature, poetical fictions of real events, poetical images of real appearances in the viſible creation, and poetical perſonages of real human characters; it would ſeem to follow, that the *language of poetry* muſt be an imitation of the *language of nature*.

According to Dr. Beattie, that language is natural which is ſuited to the ſpeaker's condition, character, and circumſtances. And as, for the moſt part, the images and ſentiments of ſerious poetry are copied from the images and ſentiments, not of real, but of improved, nature; ſo the language of ſerious poetry muſt (as hinted already) be a tranſcript, not of the real language of nature, which is often diſſonant and rude, but of natural language improved as far as may be conſiſtent with probability, and with the ſuppoſed character of the ſpeaker. If this be not the caſe, if the language of poetry be ſuch only as we hear in converſation or read in hiſtory, it will, inſtead of delight, bring diſappointment: becauſe it will fall ſhort of what we expect from an art which is recommended rather by its pleaſurable qualities than by its intrinſic utility; and to which, in order to render it pleaſing, we grant higher privileges than to any other kind of literary compoſition, or any other mode of human language.

The next inquiry muſt therefore be, "What are thoſe improvements that peculiarly belong to the language of poetry?" And theſe may be comprehended under two heads; *poetical words*, and *tropes and figures*.

Art. I. Of Poetical Words.

One mode of improvement peculiar to poetical diction reſults from the uſe of thoſe words and phraſes which, becauſe they rarely occur in proſe, and frequently in verſe, are by the grammarian and lexicographer termed *poetical*. In theſe ſome languages abound more than others; but no language perhaps is altogether without them, and perhaps no language can be ſo in which any number of good poems have been written: for poetry is better remembered than proſe, eſpecially by poetical authors, who will always be apt to imitate the phraſeology of thoſe they have been accuſtomed to read and admire; and thus, in the works of poets down through ſucceſſive generations, certain phraſes may have been conveyed, which, though originally perhaps in common uſe, are now confined to poetical compoſition. Proſe-writers are not ſo apt to imitate one another, at leaſt in words and phraſes, both becauſe they do not ſo well remember one another's phraſeology, and alſo becauſe their language is leſs artificial, and muſt not, if they would make it eaſy and flowing (without which it cannot be elegant), depart eſſentially from the ſtyle of correct converſation. Poets, too, on account of the greater difficulty of their numbers, have, both in the choice and in the arrangement of words, a better claim to indulgence, and ſtand more in need of a diſcretionary power.

The language of Homer differs materially from what was written and ſpoken in Greece in the days of Socrates. It differs in the mode of inflection, it differs in the ſyntax, it differs even in the words; ſo that one might read Homer with eaſe who could not read Xenophon; or Xenophon, without being able to read Homer. Yet we cannot believe that Homer, or the firſt Greek poet who wrote in his ſtyle, would make choice of a dialect quite different from what was intelligible in his own time; for poets have in all ages written with a view to be read, and to be read with pleaſure; which they could not be if their diction were hard to be underſtood. It is more reaſonable to ſuppoſe that the language of Homer is according to ſome ancient dialect, which, though not perhaps in familiar uſe among the Greeks at the time he wrote, was, however, intelligible. From the Homeric to the Socratic age, a period had elapſed of no leſs than 400 years; during which the ſtyle both of diſcourſe and of writing muſt have undergone great alterations. Yet the Iliad continued the ſtandard of heroic poetry, and was conſidered as the very perfection of poetical language; notwithſtanding that ſome words in it were become ſo antiquated, or ſo ambiguous, that Ariſtotle himſelf ſeems to have been ſomewhat doubtful in regard to their meaning. And if Chaucer's merit as a poet had been as great as Homer's, and the Engliſh tongue under Edward III. as perfect as the Greek was in the ſecond century after the Trojan war, the ſtyle of Chaucer would probably have been our model for poetical diction at this day; even as Petrarch, his contemporary, is ſtill imitated by the beſt poets of Italy.

The rudeneſs of the ſtyle of Ennius has been imputed by the old critics to his having copied too cloſely the dialect of common life. But this appears to be a miſtake. For, if we compare the fragments of that author with the comedies of Plautus, who flouriſhed in the ſame age, and whoſe language was certainly copied from that of common life, we ſhall be ſtruck with an air of antiquity in the former that is not in the latter. Ennius, no doubt, like moſt other ſublime poets, affected ſomething of the antique in his expreſſion: and many of his words and phraſes, not adopted by any proſe-writer now extant, are to be found in Lucretius and Virgil, and were by them tranſmitted to ſucceeding poets. Theſe form part of the Roman poetical dialect; which appears from the writings of Virgil, where we have it in perfection, to have been very copious. The ſtyle of this charming poet is indeed ſo different from proſe, and is altogether ſo peculiar, that it is perhaps impoſſible to analyſe it on the common principles of Latin grammar. And yet no author can be more perſpicuous or more expreſſive; notwithſtanding the frequency of Greciſm in his ſyntax, and his love of old words, which he, in the judgment of Quintilian, knew better than any other man how to improve into decoration.

The poetical dialect of modern Italy is ſo different from the proſaic, that perſons who can read the hiſtorians, and even ſpeak with tolerable fluency the language, of that country, may yet find it difficult to conſtrue a page of Petrarch or Taſſo. Yet it is not probable, that Petrarch, whoſe works are a ſtandard of the Italian poetical diction, made any material innovations in his native tongue. It is rather probable that he wrote it nearly as it was ſpoken in his time, that is, in the 14th century; omitting only harſh combinations, and taking that liberty which Homer probably, and Virgil certainly, took before him, of reviving ſuch old, but not obſolete, expreſſions as ſeemed peculiarly ſignificant and melodious; and poliſhing his ſtyle to that degree of elegance which human ſpeech, without becoming unnatural, may admit of, and which the genius of poetry, as an art ſubſervient to pleaſure, may be thought to require.

The French poetry in general is diſtinguiſhed from proſe rather by the rhime and the meaſure, than by any old or uncommon phraſeology. Yet the French, on certain ſubjects, imitate the ſtyle of their old poets, of Marot in particular; and may therefore be ſaid to have ſomething of a poetical dialect, though far leſs extenſive than the Italian, or even than the Engliſh. And it may be preſumed, that in future ages they will have more of this dialect than they have at preſent. This may be inferred from the very uncommon merit of ſome of their late poets, particularly Boileau and La Fontaine, who, in their reſpective departments, will continue to be imitated when the preſent modes of French proſe are greatly changed: an event that, for all the pains they take to preſerve their language, muſt inevitably happen, and whereof there are not wanting ſome preſages already.

The Engliſh poetical dialect is not characteriſed by any peculiarities of inflection, nor by any great latitude in the uſe of foreign idioms. More copious it is, however, than one would at firſt imagine; as may appear from the following ſpecimen and obſervations.

(1.) A few Greek and Latin idioms are common in Engliſh poetry, which are ſeldom or never to be met with in proſe. QUENCHED OF HOPE. Shakeſpeare.—SHORN OF HIS BEAMS. Milton.—*Created thing* NOR VALUED HE NOR SHUNN'D. Milton.—*'Tis thus we riot, while* WHO SOW IT STARVE. Pope.—*This day* BE BREAD AND PEACE MY LOT. Pope.—INTO WHAT PIT THOU SEE'ST FROM WHAT HEIGHT FALLEN. Milton.—*He deceived The mother of mankind,* WHAT TIME HIS PRIDE HAD CAST HIM *out of heaven.* Milton.——Some of theſe, with others to be found in Milton, ſeem to have been adopted for the ſake of brevity, which in the poetical tongue is indiſpenſable. For the ſame reaſon, perhaps, the articles *a* and *the* are ſometimes omitted by our poets, though leſs frequently in ſerious than burleſque compoſition.——In Engliſh, the adjective generally goes before the ſubſtantive, the nominative before the verb, and the active verb before (what we call) the accuſative. Exceptions, however, to this rule are not uncommon even in proſe: but in poetry they are more frequent. *Their homely joys and* DESTINY OBSCURE. *Now fades the glimmering landſcape on the ſight; and all the air a ſolemn ſtillneſs holds.* In general, that verſification may be leſs difficult, and the cadence more uniformly pleaſing; and ſometimes, too, in order to give energy to expreſſion, or vivacity to an image;—the Engliſh poet is permitted to take much greater liberties than the proſe-writer in arranging his words, and modulating his lines and periods. Examples may be ſeen in every page of Paradiſe Loſt.

(2.) Some of our poetical words take an additional ſyllable, that they may ſuit the verſe the better; as *diſpart, diſtain, diſport, affright, enchain,* for part, ſtain, ſport, fright, chain. Others ſeem to be nothing elſe than common words made ſhorter, for the convenience of the verſifier. Such are, *auxiliar, ſublunar, trump, vale, part, clime, ſubmiſs, frolic, plain, drear, dread, helm, morn, mead, eve* and *even, gan illume* and *illumine, ope, hoar, bide, ſwage, ſcape*; for auxiliary, ſublunary, trumpet, valley, depart, climate, ſubmiſſive, frolicſome, complain, dreary, dreadful, helmet, morning, meadow, evening, began or begun to illuminate, open, hoary, abide, aſſuage, eſcape.——Of ſome of theſe the ſhort form is the more ancient. In Scotland, *even, morn, bide, ſwage,* are ſtill in vulgar uſe; but *morn,* except when contradiſtinguiſhed to *even,* is ſynonymous, not with *morning,* (as in the Engliſh poetical dialect), but with *morrow.*—The Latin poets, in a way ſomewhat ſimilar, and perhaps for a ſimilar reaſon, ſhortened *fundamentum, tutamentum, munimentum,* &c. into fundamen, tutamen, munimen.

(3.) Of the following words, which are now almoſt peculiar to poetry, the greater part are ancient, and were once no doubt in common uſe in England, as many of them ſtill are in Scotland. *Afield, amain, annoy* (a noun), *anon, aye* (ever), *beheſt, blithe, brand* (ſword), *bridal, carol, dame* (lady), *featly, fell* (an adjective), *gaude, gore, hoſt* (army), *lambkin, late* (of late), *lay* (poem), *lea, glade, gleam, hurl, lore, meed, oriſons, plod* (to travel laboriouſly), *ringlet, rue* (a verb), *ruth, ruthleſs, ſojourn* (a noun), *ſmite, ſpeed* (an active verb), *ſave* (except), *ſpray* (twig), *ſteed, ſtrain* (ſong), *ſtrand, ſwain, thrall, thrill, trail* (a verb), *troll, wail, welter, warble, wayward, woo, the while* (in the meantime), *yon, of yore.*

(4.) Theſe that follow are alſo poetical; but, ſo far as appears, were never in common uſe. *Appal, arrowy, attune, battailous, breezy, car* (chariot), *clarion, cates, courſer, darkling, flicker, floweret, emblaze, gairiſh, circlet, impearl, nightly, noiſeleſs, pinion* (wing), *ſhadowy, ſlumberous, ſtreamy, troublous, wilder* (a verb), *ſhrill* (a verb), *ſhook* (ſhaken), *madding, viewleſs.*—The following, too, derived from the Greek and Latin, ſeem peculiar to poetry. *Clang, clangor, choral, bland, boreal, dire, enſanguined, ire, ireful, lave* (to waſh), *nymph* (lady, girl), *orient, panoply, philomel, infuriate, jocund, radiant, rapt, redolent, refulgent, verdant, vernal, zephyr, zone* (girdle), *ſylvan, ſuffuſe.*

(5.) In moſt languages, the rapidity of pronunciation abbreviates ſome of the commoneſt words, or even joins two, or perhaps more, of them, into one; and ſome of thoſe abbreviated forms find admiſſion into writing. The Engliſh language was quite disfigured by them in the end of the laſt century; but Swift, by his ſatire and example, brought them into diſrepute: and, though ſome of them be retained in converſation, as *don't, ſhan't, can't,* they are now avoided in ſolemn ſtyle; and by elegant writers in general, except where the colloquial dialect is imitated, as in comedy. *'Tis* and *'twas,* ſince the time of Shafteſbury, ſeem to have been daily loſing credit, at leaſt in proſe; but ſtill have a place in poetry, perhaps becauſe they contribute to conciſeneſs. *'Twas on a lofty vaſe's ſide.* Gray.—*'Tis true, 'tis certain, man, though dead, retains part of himſelf.* Pope.—In verſe too *over* may be ſhortened into *o'er,* (which is the Scotch, and probably was the old Engliſh, pronunciation); *never* into *ne'er*; and from *the* and *to,* when they go before a word beginning with a vowel, the final letter is ſometimes cut off. *O'er hills, o'er dales, o'er crags, o'er rocks, they go.* Pope.—*Where'er ſhe turns, the Graces homage pay. And all that beauty, all that wealth, e'er gave. Rich with the ſpoils of time did ne'er unroll.* Gray.—*T' alarm th' eternal midnight of the grave.*——Theſe abbreviations are now peculiar to the poetical tongue, but not neceſſary to it. They ſometimes promote brevity, and render verſification leſs difficult.

(6.) Thoſe words which are commonly called *compound epithets,* as *roſy-finger'd, roſy-boſom'd, many-twinkling, many-ſounding, moſs-grown, bright-eyed, ſtraw-built, ſpirit-ſtirring, incenſe-breathing, heaven-taught, love-whiſpering, lute-reſounding,* are alſo to be conſidered as part of our poetical dialect. It is true, we have compounded adjectives in familiar uſe, as *high-ſeaſoned, well-natured, ill-bred,* and innumerable others; but we ſpeak of thoſe that are leſs common, that ſeldom occur except in poetry, and of which in proſe the uſe would appear affected: and that they ſometimes promote brevity and vivacity of expreſſion, cannot be denied; but as they give, when too frequent, a ſtiff and finical air to a performance; as they are not always explicit in the ſenſe, nor agreeable in the ſound; as they are apt to produce a confuſion, or too great a multiplicity, of images; as they tend to disfigure the language, and furniſh a pretext for endleſs innovation; they ought to be uſed ſparingly; and thoſe only uſed which the practice of popular authors has rendered familiar to the ear, and which are in themſelves peculiarly emphatical and harmonious.

(7.) In the transformation of nouns into verbs and participles, our poetical dialect admits of greater latitude than proſe. Hymn, pillow, curtain, ſtory, pillar, picture, peal, ſurge, cavern, honey, career, cincture, boſom, ſphere, are common nouns; but *to hymn, to pillow, curtained, pillared, pictured, pealing, ſurging, cavern'd, honeyed, careering, cinctured, boſomed, ſphered,* would appear affected in proſe, and yet in verſe they are warranted by great authorities, though it muſt be confeſſed that they are cenſured by Dr. Johnſon, who had ſtudied the Engliſh language, both poetical and proſaic, with wonderful diligence.

Some late poets, particularly the Imitators of Spenſer, have introduced a great variety of uncommon words, as certes, eftſoons, ne, whilom, tranſmew, moil, ſone, loſel, albe, hight, dight, pight, thews, couthful, aſſot, muchel, wend, arrear, &c. Theſe were once poetical words, no doubt; but they are now obſolete, and to many readers unintelligible. No man of the preſent age, however converſant in this dialect, would naturally expreſs himſelf in it on any intereſting emergence; or, ſuppoſing this natural to the antiquarian, it would never appear ſo to the common hearer or reader. A mixture of theſe words, therefore, muſt ruin the pathos of modern language; and as they are not familiar to our ear, and plainly appear to be ſought after and affected, will generally give a ſtiffneſs to modern verſification. Yet in ſubjects approaching to the ludicrous they may have a good effect; as in the *Schoolmiſtreſs* of Shenſtone, Parnel's Fairy-Tale, Thomſon's Caſtle of Indolence, and Pope's lines in the Dunciad upon Wormius. But this effect will be moſt pleaſing to thoſe who have leaſt occaſion to recur to the gloſſary.

Indeed, it is not always eaſy to fix the boundary between poetical and obſolete expreſſions. To many readers, *lore, mead, beheſt, blithe, gaude, ſpray, thrall,* may already appear antiquated; and to ſome the ſtyle of Spenſer, or even of Chaucer, may be as intelligible as that of Dryden. This however we may venture to affirm, that a word, which the majority of readers cannot underſtand without a gloſſary, may with reaſon be conſidered as obſolete; and ought not to be uſed in modern compoſition, unleſs revived, and recommended to the public ear, by ſome very eminent writer. There are but few words in Milton, as *nathleſs, tine, frore, boſky,* &c.; there are but one or two in Dryden, as *falſify**; and in Pope, there are none at all, which every reader of our poetry may not be ſuppoſed to underſtand: whereas in Shakeſpeare there are many, and in Spenſer many more, for which one who knows Engliſh very well may be obliged to conſult the dictionary. The practice of Milton, Dryden, or Pope, may therefore, in almoſt all caſes, be admitted as good authority for the uſe of a poetical word; and in them all the words above enumerated as poetical, and in preſent uſe, may actually be found. And of ſuch poets as may chooſe to obſerve this rule, it will not be ſaid either that they reject the judgment of Quintilian, who recommends the neweſt of the old words and the oldeſt of the new, or that they are inattentive to Pope's precept;

> Be not the firſt by whom the new are tried,
> Nor yet the laſt to lay the old aſide.
>
> *Eſſ. on Crit.* v. 335.

We muſt not ſuppoſe that theſe poetical words never occur at all except in poetry. Even from converſation they are not excluded: and the ancient critics allow, that they may be admitted into proſe, where they occaſionally confer dignity upon a ſublime ſubject, or heighten the ludicrous qualities of a mean one. But it is in poetry only where the frequent uſe of them does not ſavour of affectation.

Nor muſt we ſuppoſe them eſſential to this art. Many paſſages there are of exquiſite poetry, wherein not a ſingle phraſe occurs that might not be uſed in proſe. In fact, the influence of theſe words in adorning Engliſh verſe is not very extenſive. Some influence however they have. They ſerve to render the poetical ſtyle, firſt, more melodious; and, ſecondly, more ſolemn.

Firſt, They render the poetical ſtyle more melodious, and more eaſily reducible into meaſure. Words of unwieldy ſize, or difficult pronunciation, are never uſed by correct poets, where they can be avoided: unleſs in their ſound they have ſomething imitative of the ſenſe. Homer's poetical inflections contribute wonderfully to the ſweetneſs of his numbers: and if the reader is pleaſed to look back to the ſpecimen above given of the Engliſh poetical dialect, he will find that the words are in general well-ſounding, and ſuch as may coaleſce with other words, without producing harſh combinations. Quintilian obſerves, that poets, for the ſake of their verſe, are indulged in many liberties, not granted to the orator, of lengthening, ſhortening, and dividing their words:—and if the Greek and Roman poets claimed this indulgence from neceſſity, and obtained it, the Engliſh, thoſe of them eſpecially who write in rhyme, may claim it with better reaſon; as the words of their language are leſs muſical and far leſs ſuſceptible of variety in arrangement and ſyntax.

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* Dryden in one place (Æneid ix. verſ. 1095.) uſes *falſified* to denote *pierced through and through.* He acknowledges, that this uſe of the word is an innovation; and has nothing to plead for it but his own authority, and that *falſare* in Italian ſometimes means the ſame thing.

Secondly, Such poetical words as are known to be ancient have ſomething venerable in their appearance, and impart a ſolemnity to all around them. This remark is from Quintilian; who adds, that they give to a compoſition that caſt and colour of antiquity which in painting is ſo highly valued, but which art can never effectually imitate. Poetical words that are either not ancient, or not known to be ſuch, have, however, a pleaſing effect from aſſociation. We are accuſtomed to meet with them in ſublime and elegant writing; and hence they come to acquire ſublimity and elegance: even as the words we hear on familiar occaſions come to be accounted familiar; and as thoſe that take their riſe among pick-pockets, gamblers, and gipſies, are thought too indelicate to be uſed by any perſon of taſte or good manners. When one hears the following lines, which abound in poetical words,

> The breezy call of incenſe-breathing morn,
> The ſwallow twittering from the ſtraw-built ſhed,
> The cock's ſhrill clarion, or the echoing horn,
> No more ſhall rouſe them from their lowly bed:

—one is as ſenſible of the dignity of the language, as one would be of the vileneſs or vulgarity of that man's ſpeech, who ſhould prove his acquaintance with Bridewell, by interlarding his diſcourſe with ſuch terms as *mill-doll*, *queer cull*, or *nubbing cheat*; or who, in imitation of fops and gamblers, ſhould, on the common occaſions of life, talk of being *beat hollow*, or *ſaving his diſtance*. What gives dignity to perſons gives dignity to language. A man of this character is one who has borne important employments, been connected with honourable aſſociates, and never degraded himſelf by levity or immorality of conduct. Dignified phraſes are thoſe which have been uſed to expreſs elevated ſentiments, have always made their appearance in elegant compoſition, and have never been profaned by giving permanency or utterance to the paſſions of the vile, the giddy, or the worthleſs. And as, by an active old age, the dignity of ſuch men is confirmed and heightened; ſo the dignity of ſuch words, if they be not ſuffered to fall into diſuſe, ſeldom fails to improve by length of time.

Art. II. Of Tropes and Figures.

If it appear that, by means of figures, language may be made more *pleaſing* and more natural than it would be without them; it will follow, that to poetic language, whoſe end is to *pleaſe* by imitating *nature*, figures muſt be not only ornamental, but neceſſary. It will here be proper, therefore, firſt to point out the importance and utility of figurative language; ſecondly, to ſhow that figures are more neceſſary to poetry in general than to any other mode of writing.

I. *As to the importance and utility of figurative expreſſion*, in making language more pleaſing and more natural; it may be remarked,

(1.) That tropes and figures are often neceſſary to ſupply the unavoidable defects of language. When *proper* words are wanting, or not recollected, or when we do not chooſe to be always repeating them, we muſt have recourſe to tropes and figures. When philoſophers began to explain the operations of the mind, they found that moſt of the words in common uſe, being framed to anſwer the more obvious exigencies of life, were in their proper ſignification applicable to matter only and its qualities. What was to be done in this caſe? Would they think of making a new language to expreſs the qualities of mind? No: that would have been difficult or impracticable; and, granting it both practicable and eaſy, they muſt have foreſeen, that nobody would read or liſten to what was thus ſpoken or written in a new and conſequently in an unknown tongue. They therefore took the language as they found it; and, wherever they thought there was a ſimilarity or analogy between the qualities of the mind and the qualities of matter, ſcrupled not to uſe the names of the material qualities tropically, by applying them to the mental qualities. Hence came the phraſes *ſolidity* of judgment, *warmth* of imagination, *enlargement* of underſtanding, and many others; which, though figurative, expreſs the meaning juſt as well as proper words would have done. In fact, numerous as the words in every language are, they muſt always fall ſhort of the unbounded variety of human thoughts and perceptions. Taſtes and ſmells are almoſt as numerous as the ſpecies of bodies. Sounds admit of perceptible varieties that ſurpaſs all computation, and the ſeven primary colours may be diverſified without end. If each variety of external perception were to have a name, language would be inſurmountably difficult; nay, if men were to appropriate a claſs of names to each particular ſenſe, they would multiply words exceedingly, without adding any thing to the clearneſs of ſpeech. Thoſe words, therefore, that in their proper ſignification denote the objects of one ſenſe, we often apply tropically to the objects of another, and ſay, Sweet taſte, ſweet ſmell, ſweet ſound; ſharp point, ſharp taſte, ſharp ſound; harmony of ſounds, harmony of colours, harmony of parts; ſoft ſilk, ſoft colour, ſoft ſound, ſoft temper; and ſo in a thouſand inſtances: and yet theſe words, in their tropical ſignification, are not leſs intelligible than in their proper one; for ſharp taſte and ſharp ſound are as expreſſive as ſharp ſword; and harmony of tones is not better underſtood by the muſician, than harmony of parts by the architect, and harmony of colours by the painter.

Savages, illiterate perſons, and children, have comparatively but few words in proportion to the things they may have occaſion to ſpeak of; and muſt therefore recur to tropes and figures more frequently than perſons of copious elocution. A ſeaman, or mechanic, even when he talks of that which does not belong to his art, borrows his language from that which does; and this makes his diction figurative to a degree that is ſometimes entertaining enough. "Death (ſays a ſeaman in one of Smollet's novels) has not yet *boarded* my comrade; but they have been *yard-arm and yard-arm* theſe *three glaſſes*. His *ſtarboard* eye is open, but faſt *jammed* in his head; and the *haulyards* of his under jaw have given way." Theſe phraſes are exaggerated; but we allow them to be natural, becauſe we know that illiterate people are apt to make uſe of tropes and figures taken from their own trade, even when they ſpeak of things that are very remote and incongruous. In thoſe poems, therefore, that imitate the converſation of illiterate perſons, as in comedy, farce, and paſtoral, ſuch figures judiciouſly applied may render the imitation more pleaſing, becauſe more exact and natural.

Words that are untuneable and harſh, the poet is often obliged to avoid, when perhaps he has no other way to expreſs their meaning than by tropes and figures; and ſometimes the meaſure of his verſe may oblige him to reject a proper word that is not harſh, merely on account of its being too long, or too ſhort, or in any other way unſuitable to the rhythm, or to the rhyme. And hence another uſe of figurative language, that it contributes to poetical harmony. Thus, *to preſs the plain* is frequently uſed to ſignify *to be ſlain in battle*; *liquid plain* is put for *ocean*, *blue ſerene* for *ſky*, and *ſylvan reign* for *country life*.

(2.) Tropes and figures are favourable to delicacy. When the proper name of a thing is in any reſpect unpleaſant, a well-choſen trope will convey the idea in ſuch a way as to give no offence. This is agreeable, and even neceſſary, in polite converſation, and cannot be diſpenſed with in elegant writing of any kind. Many words, from their being often applied to vulgar uſe, acquire a meanneſs that diſqualifies them for a place in ſerious poetry; while perhaps, under the influence of a different ſyſtem of manners, the correſponding words in another language may be elegant, or at leaſt not vulgar. When one reads Homer in the Greek, one takes no offence at his calling Eumeus by a name which, literally rendered, ſignifies *ſwine-herd*; firſt, becauſe the Greek word is well-ſounding in itſelf; ſecondly, becauſe we have never heard it pronounced in converſation, nor conſequently debaſed by vulgar uſe; and, thirdly, becauſe we know, that the office denoted by it was, in the age of Eumeus, both important and honourable. But Pope would have been blamed if a name ſo indelicate as *ſwine-herd* had in his tranſlation been applied to ſo eminent a perſonage; and therefore he judiciouſly makes uſe of the trope *ſynecdoche*, and calls him *ſwain*; a word both elegant and poetical, and not likely to lead the reader into any miſtake about the perſon ſpoken of, as his employment had been deſcribed in a preceding paſſage. The ſame Eumeus is ſaid, in the ſimple but melodious language of the original, to have been making his own ſhoes when Ulyſſes came to his door; a work which in thoſe days the greateſt heroes would often find neceſſary. This, too, the tranſlator ſoftens by a tropical expreſſion:

> Here ſat Eumeus, and his cares applied
> To form ſtrong *buſkins* of well-ſeaſon'd hide.

A hundred other examples might be quoted from this tranſlation; but theſe will explain our meaning.

There are other occaſions on which the delicacy of figurative language is ſtill more needful; as in Virgil's account of the effects of animal love, and of the plague among the beaſts, in the third Georgic; where Dryden's ſtyle, by being leſs figurative than the original, is in one place exceedingly filthy, and in another ſhockingly obſcene.

Hobbes could conſtrue a Greek author; but his ſkill in words muſt have been all derived from the dictionary: for he ſeems not to have known that any one articulate ſound could be more agreeable, or any one phraſe more dignified, than another. In his Iliad and Odyſſey, even when he hits the author's ſenſe (which is not always the caſe), he proves, by his choice of words, that of harmony, elegance, or energy of ſtyle, he had no manner of conception. And hence that work, though called a *Tranſlation of Homer*, does not even deſerve the name of *poem*; becauſe it is in every reſpect unpleaſing, being nothing more than a fictitious narrative delivered in a mean proſe, with the additional meanneſs of harſh rhyme, and untuneable meaſure.—Trapp underſtood Virgil well enough as a grammarian, and had a taſte for his beauties: yet his tranſlation bears no reſemblance to Virgil; which is owing to the ſame cauſe, an imprudent choice of words and figures, and a total want of harmony.

The delicacy we here contend for may, indeed, both in converſation and in writing, be carried too far. To call *killing an innocent man in a duel* an affair of honour, and *a violation of the rights of wedlock* an affair of gallantry, is a proſtitution of figurative language. Nor is it any credit to us, that we are ſaid to have upwards of 40 figurative phraſes to denote exceſſive drinking. Language of this ſort generally implies, that the public abhorrence of ſuch crimes is not ſo ſtrong as it ought to be; and it is a queſtion, whether even our morals might not be improved, if we were to call theſe and ſuch like crimes by their proper names, *murder*, *adultery*, *drunkenneſs*, *gluttony*; names that not only expreſs our meaning, but alſo betoken our diſapprobation.—As to writing, it cannot be denied, that even Pope himſelf, in the excellent verſion juſt now quoted, has ſometimes, for the ſake of his numbers, or for fear of giving offence by too cloſe an imitation of Homer's ſimplicity, employed tropes and figures too quaint or too ſolemn for the occaſion. And the finical ſtyle is in part characteriſed by the writer's diſlike to literal expreſſions, and affectedly ſubſtituting in their ſtead unneceſſary tropes and figures. With theſe authors, a man's only child muſt always be his *only hope*; a country-maid becomes *a rural beauty*, or perhaps a *nymph of the groves*; if flattery ſing at all, it muſt be a *ſyren ſong*; the ſhepherd's flute dwindles into an *oaten reed*, and his crook is exalted into a *ſceptre*; the *ſilver lilies* riſe from their *golden beds*, and *languiſh* to the *complaining* gale. A young woman, though a good Chriſtian, cannot make herſelf agreeable without *ſacrificing to the Graces*: nor hope to do any execution among the *gentle ſwains*, till a whole legion of *Cupids*, armed with *flames* and *darts*, and other weapons, begin to diſcharge from her eyes their formidable artillery. For the ſake of variety, or of the verſe, ſome of theſe figures may now and then find a place in a poem; but in proſe, unleſs very ſparingly uſed, they ſavour of affectation.

(3.) Tropes and figures promote brevity; and brevity, united with perſpicuity, is always agreeable. An example or two will be given in the next paragraph. Sentiments thus delivered, and imagery thus painted, are readily apprehended by the mind, make a ſtrong impreſſion upon the fancy, and remain long in the memory; whereas too many words, even when the meaning is good, never fail to bring diſguſt and wearineſs. They argue a debility of mind which hinders the author from ſeeing his thoughts in one diſtinct point of view; and they alſo encourage a ſuſpicion that there is ſomething faulty or defective in the matter. In the poetic ſtyle, therefore, which is addreſſed to the fancy and paſſions, and intended to make a vivid, a pleaſing, and a permanent impreſſion, brevity, and conſequently tropes and figures, are indiſpenſable. And a language will always be the better ſuited to poetical purpoſes, the more it admits of this brevity;—a character which is more conſpicuous in the Greek and Latin than in any modern tongue, and much leſs in the French than in the Italian or Engliſh.

(4.) Tropes and figures contribute to ſtrength or energy of language, not only by their conciſeneſs, but alſo by conveying to the fancy ideas that are eaſily comprehended, and make a ſtrong impreſſion. We are powerfully affected with what we ſee, or feel, or hear. When a ſentiment comes enforced or illuſtrated by figures taken from objects of ſight, or touch, or hearing, one thinks, as it were, that one ſees, or ſeels, or hears, the thing ſpoken of; and thus, what in itſelf would perhaps be obſcure, or is merely intellectual, may be made to ſeize our attention and intereſt our paſſions almoſt as effectually as if it were an object of outward ſenſe. When Virgil calls the Scipios *thunderbolts of war*, he very ſtrongly expreſſes in one word, and by one image, the rapidity of their victories, the noiſe their achievements made in the world, and the ruin and conſternation that attended their irreſiſtible career. When Homer calls Ajax *the bulwark of the Greeks*, he paints with equal brevity his vaſt ſize and ſtrength, the difficulty of prevailing againſt him, and the confidence wherewith his countrymen repoſed on his valour. When Solomon ſays of the ſtrange woman, or harlot, that " her feet go *down* to death," he lets us know, not only that her path ends in deſtruction, but alſo, that they who accompany her will find it eaſy to go forwards to ruin, and difficult to return to their duty. Satan's enormous magnitude, and refulgent appearance, his perpendicular aſcent through a region of darkneſs, and the inconceivable rapidity of his motion, are all painted out to our fancy by Milton, in one very ſhort ſimilitude;

> Sprung upward, like—a pyramid of fire.
> *Par. Loſt*, b. 4. v. 1013.

To take in the full meaning of which figure, we muſt imagine ourſelves in chaos, and a vaſt luminous body riſing upward, near the place where we are, ſo ſwiftly as to appear a continued track of light, and leſſening to the view according to the increaſe of diſtance, till it end in a point, and then diſappear; and all this muſt be ſuppoſed to ſtrike our eye at one inſtant.—Equal to this in propriety, though not in magnificence, is that allegory of Gray, "*The paths of glory lead but to the grave*:" which preſents to the imagination a wide plain, where ſeveral roads appear, crowded with glittering multitudes, and iſſuing from different quarters, but drawing nearer and nearer as they advance, till they terminate in the dark and narrow houſe, where all their glories enter in ſucceſſion, and diſappear for ever. When it is ſaid in Scripture, of a good man who died, that he *fell aſleep*, what a number of ideas are at once conveyed to our imagination by this beautiful and expreſſive figure! As a labourer, at the cloſe of day, goes to ſleep, with the ſatisfaction of having performed his work, and with the agreeable hope of awaking in the morning of a new day, refreſhed and cheerful; ſo a good man, at the end of life, reſigns himſelf calm and contented to the will of his Maker, with the ſweet reflection of having endeavoured to do his duty, and with the tranſporting hope of ſoon awaking, in the regions of light, to life and happineſs eternal. The figure alſo ſuggeſts, that to a good man the tranſition from life to death is, even in the ſenſation, no more painful, than when our faculties melt away into the pleaſing inſenſibility of ſleep.—Satan, flying among the ſtars, is ſaid by Milton to "*ſail* between worlds and worlds;" which has an elegance and force far ſuperior to the proper word *fly*. For, by this alluſion to a ſhip, we are made to form a lively idea of his great ſize, and to conceive of his motion, that it was equable and majeſtic.—Virgil uſes a happy figure to expreſs the ſize of the great wooden horſe by means of which the Greeks were conveyed into Troy: "Equum divina Palladis arte *ædificant*."——Milton is ſtill bolder when he ſays,

> Who would not ſing for Lycidas? He knew
> Himſelf to ſing, and *build the lofty rhyme*.

The phraſe, however, though bold, is emphatical; and gives a noble idea of the durability of poetry, as well as of the art and attention requiſite to form a good poem. There are hundreds of tropical expreſſions in common uſe, incomparably more energetic than any proper words of equal brevity that could be put in their place. A cheek *burning* with bluſhes, is a trope which at once deſcribes the colour as it appears to the beholder, and the glowing heat as it is felt by the perſon bluſhing. *Chilled* with deſpondence, *petrified* with aſtoniſhment, *thunderſtruck* with diſagreeable and unexpected intelligence, *melted* with love or pity, *diſſolved* in luxury, *hardened* in wickedneſs, *ſoftening* into remorſe, *inflamed* with deſire, *toſſed* with uncertainty, &c. every one is ſenſible of the force of theſe and the like phraſes, and that they muſt contribute to the energy of compoſition.

(5.) Tropes and figures promote ſtrength of expreſſion; and are in poetry peculiarly requiſite, becauſe they are often more *natural*, and more *imitative*, than proper words. In fact, this is ſo much the caſe, that it would be impoſſible to imitate the language of paſſion without them. It is true, that when the mind is agitated, one does not run out into allegories, or long-winded ſimilitudes, or any of the figures that require much attention and many words, or that tend to withdraw the fancy from the object of the paſſion. Yet the language of many paſſions muſt be figurative notwithſtanding; becauſe they rouſe the fancy, and direct it to objects congenial to their own nature, which diverſify the language of the ſpeaker with a multitude of alluſions. The fancy of a very angry man, for example, preſents to his view a train of diſagreeable ideas connected with the paſſion of anger, and tending to encourage it; and if he ſpeak without reſtraint during the paroxyſm of his rage, thoſe ideas will force themſelves upon him, and compel him to give them utterance. "Infernal monſter! (he will ſay,)—my blood boils at him; he has uſed me like a dog; never was man ſo injured as I have been by this barbarian. He has no more ſenſe of propriety than a ſtone. His countenance is diabolical, and his ſoul as ugly as his countenance. His heart is cold and hard, and his reſolutions dark and bloody," &c. This ſpeech is wholly figurative. It is made up of *metaphors* and *hyperboles*, which, with the *proſopopeia* and *apoſtrophe*, are the moſt paſſionate of all the figures. Lear, driven out of doors by his unnatural daughters, in the midſt of darkneſs, thunder, and tempeſt, naturally breaks forth (for his indignation is juſt now raiſed to the very higheſt pitch) into the following violent exclamation againſt the crimes of mankind, in which almoſt every word is figurative.

> Tremble, thou wretch,
> That haſt within thee undivulged crimes
> Unwhipt of juſtice. Hide thee, thou bloody hand,
> Thou perjur'd, and thou ſimular of virtue,
> That art inceſtuous. Caitiff, to pieces ſhake,
> That under covert, and convenient ſeeming,
> Haſt practis'd on man's life. Cloſe pent-up guilts,
> Rive your concealing continents, and cry
> Theſe dreadful ſummoners grace. *King Lear.*

——The vehemence of maternal love, and ſorrow from the apprehenſion of loſing her child, make the lady Conſtance utter a language that is ſtrongly figurative, though quite ſuitable to the condition and character of the ſpeaker. The paſſage is too long for a quotation, but concludes thus:

> O Lord! my boy, my Arthur, my fair ſon,
> My life, my joy, my food, my all-the-world,
> My widow-comfort, and my ſorrow's cure. *King John.*

——Similar to this, and equally expreſſive of conjugal love, is that beautiful hyperbole in Homer, where Andromache, to diſſuade her huſband from going out to the battle, tells him that ſhe had now no mother, father, or brethren, all her kindred being dead, and her native country deſolate; and then tenderly adds,

> But while my Hector yet ſurvives, I ſee
> My father, mother, brethren, all in thee. *Iliad*, b. 6.

As the paſſions that agitate the ſoul, and rouſe the fancy, are apt to vent themſelves in tropes and figures, ſo thoſe that depreſs the mind adopt for the moſt part a plain diction without any ornament: for to a dejected mind, wherein the imagination is generally inactive, it is not probable that any great variety of ideas will preſent themſelves; and when theſe are few and familiar, the words that expreſs them muſt be ſimple. As no author equals Shakeſpeare in boldneſs or variety of figures when he copies the ſtyle of thoſe violent paſſions that ſtimulate the fancy; ſo, when he would exhibit the human mind in a dejected ſtate, no uninſpired writer excels him in ſimplicity. The ſame Lear whoſe reſentment had impaired his underſtanding, while it broke out in the moſt boiſterous language, when, after ſome medical applications, he recovers his reaſon, his rage being now exhauſted, his pride humbled, and his ſpirits totally depreſſed, ſpeaks in a ſtyle than which nothing can be imagined more ſimple or more affecting :

> Pray, do not mock me :
> I am a very fooliſh fond old man,
> Fourſcore and upward ; and, to deal plainly with you,
> I fear I am not in my perfect mind.
> Methinks I ſhould know you, and know this man ;
> Yet I am doubtful : for I am mainly ignorant
> What place this is ; and all the ſkill I have
> Remembers not theſe garments : nor I know not
> Where I did lodge laſt night. *Lear*, act 4. ſc. 7.

——Deſdemona, ever gentle, artleſs, and ſincere, ſhocked at the unkindneſs of her huſband, and overcome with melancholy, ſpeaks in a ſtyle ſo beautifully ſimple, and ſo perfectly natural, that one knows not what to ſay in commendation of it :

> My mother had a maid call'd Barbara ;
> She was in love, and he ſhe lov'd prov'd mad,
> And did forſake her. She had a ſong of willow ;
> An old thing it was, but it expreſs'd her fortune,
> And ſhe died ſinging it. That ſong to-night
> Will not go from my mind : I have much to do,
> But to go hang my head all at one ſide,
> And ſing it like poor Barbara. *Othello*, act 4. ſc. 3.

Sometimes the imagination, even when exerted to the utmoſt, takes in but few ideas. This happens when the attention is totally engroſſed by ſome very great object ; admiration being one of thoſe emotions that rather ſuſpend the exerciſe of the faculties than puſh them into action. And here, too, the ſimpleſt language is the moſt natural ; as when Milton ſays of the Deity, that he ſits " high-throned above all height." And as this ſimplicity is more ſuitable to that one great exertion which occupies the ſpeaker's mind than a more elaborate imagery or language would have been, ſo has it alſo a more powerful effect in fixing and elevating the imagination of the hearer ; for to introduce other thoughts, for the ſake of illuſtrating what cannot be illuſtrated, could anſwer no other purpoſe than to draw off the attention from the principal idea. In theſe and the like caſes, the fancy, left to itſelf, will have more ſatisfaction in purſuing at leiſure its own ſpeculations than in attending to thoſe of others ; as they who ſee for the firſt time ſome admirable object would chooſe rather to feaſt upon it in ſilence than to have their thoughts interrupted by a long deſcription from another perſon, informing them of nothing but what they ſee before them, are already acquainted with, or may eaſily conceive.

It was remarked above, that the *hyperbole*, *proſopopeia*, and *apoſtrophe*, are among the moſt paſſionate figures. This deſerves illuſtration.

1ſt, A very angry man is apt to think the injury he has juſt received greater than it really is; and if he proceed immediately to retaliate by word or deed, ſeldom fails to exceed the due bounds, and to become injurious in his turn. The fond parent looks upon his child as a prodigy of genius and beauty ; and the romantic lover will not be perſuaded that his miſtreſs has nothing ſupernatural either in her mind or perſon. Fear, in like manner, not only magnifies its object when real, but even forms an object out of nothing, and miſtakes the fictions of fancy for the intimations of ſenſe. No wonder, then, that they who ſpeak according to the impulſe of paſſion ſhould ſpeak *hyperbolically* ; that the angry man ſhould exaggerate the injury he has received, and the vengeance he is going to inflict ; that the ſorrowful ſhould magnify what they have loſt, and the joyful what they have obtained ; that the lover ſhould ſpeak extravagantly of the beauty of his miſtreſs, the coward of the dangers he has encountered, and the credulous clown of the miracles performed by the juggler. In fact, theſe people would not do juſtice to what they feel if they did not ſay more than the truth. The valiant man, on the other hand, as naturally adopts the diminiſhing hyperbole when he ſpeaks of danger ; and the man of ſenſe, when he is obliged to mention his own virtue or ability ; becauſe it appears to him, or he is willing to conſider it, as leſs than the truth, or at beſt as inconſiderable. Contempt uſes the ſame figure ; and therefore Petruchio, affecting that paſſion, affects alſo the language of it :

> Thou lieſt, thou thread, thou thimble,
> Thou yard, three-quarters, half-yard, quarter, nail,
> Thou flea, thou nit, thou winter-cricket, thou !
> Brav'd in mine own houſe with a ſkein of thread !
> Away, thou rag, thou quantity, thou remnant !
> *Taming of the Shrew*, act 4. ſc. 1.

For ſome paſſions conſider their objects as important, and others as unimportant. Of the former ſort are anger, love, fear, admiration, joy, ſorrow, pride ; of the latter are contempt and courage. Thoſe may be ſaid to ſubdue the mind to the object, and theſe to ſubdue the object to the mind. And the former, when violent, always magnify their objects ; whence the hyperbole called amplification, or *auxeſis* : and the latter as conſtantly diminiſh theirs ; and give riſe to the hyperbole called *meioſis*, or diminution. Even when the mind cannot be ſaid to be under the influence of any violent paſſion, we naturally employ the ſame figure when we would impreſs another very ſtrongly with any idea. " He is a walking ſhadow ; he is worn to ſkin and bone ; he has one foot in the grave and the other following :"—theſe, and the like phraſes, are proved to be natural by their frequency. By introducing great ideas, the hyperbole is further uſeful in poetry as a ſource of the ſublime ; but when employed injudiciouſly is very apt to become ridiculous. Cowley makes Goliah as big as the hill down which he was marching ; and tells us, that when he came into the valley he ſeemed to fill it, and to overtop the neighbouring mountains (which, by the by, ſeems rather to leſſen the mountains and valleys than to magnify the giant) ; nay, he adds, that the ſun ſtarted back when he ſaw the ſplendour of his arms. This poet ſeems to have thought that the figure in queſtion could never be ſufficiently enormous ; but Quintilian would have taught him, " Quamvis omnis hyperbole ultra fidem, non tamen eſſe debet ultra modum." The reaſon is, that this figure, when exceſſive, betokens rather abſolute infatuation than intenſe emotion ; and reſembles the efforts of a ranting tragedian, or the ravings of an enthuſiaſtic declaimer, who, by putting on the geſtures and looks of a lunatic, ſatisfy the diſcerning part of their audience, that, inſtead of feeling ſtrongly, they have no rational feelings at all. In the wildeſt energies of nature there is a modeſty which the imitative artiſt will be careful never to overſtep.

2dly, That figure, by which things are ſpoken of as if they were perſons, is called *proſopopeia*, or *perſonification*. It is a bold figure, and yet is often natural. Long acquaintance recommends to ſome ſhare in our affection even things inanimate, as a houſe, a tree, a rock, a mountain, a country ; and were we to leave ſuch a thing, without hope of return, we ſhould be inclined to addreſs it with a farewell, as if it were a percipient creature. Hence it was that Mary queen of Scotland, when on her return to her own kingdom, ſo affectionately bade adieu to the country which ſhe had left. " Farewell, France," ſaid ſhe ; " farewell, beloved country, which I ſhall never more behold !" Nay, we find that ignorant nations have actually worſhipped ſuch things, or conſidered them as the haunt of certain powerful beings. Dryads and hamadryads were by the Greeks and Romans ſuppoſed to preſide over trees and groves ; river gods and nymphs, over ſtreams and fountains; little deities, called *Lares* and *Penates*, were believed to be the guardians of hearths and houſes. In Scotland there is hardly a hill remarkable for the beauty of its ſhape that was not in former times thought to be the habitation of fairies. Nay, modern as well as ancient ſuperſtition has appropriated the waters to a peculiar ſort of demon or goblin, and peopled the very regions of death, the tombs and charnel-houſes, with multitudes of ghoſts and phantoms.—Beſides, when things inanimate make a ſtrong impreſſion upon us, whether agreeable or otherwiſe, we are apt to addreſs them in terms of affection or diſlike. The ſailor bleſſes the plank that brought him aſhore from the ſhipwreck; and the paſſionate man, and ſometimes even the philoſopher, will ſay bitter words to the ſtumbling-block that gave him a fall.—Moreover, a man agitated with any intereſting paſſion, eſpecially of long continuance, is apt to fancy that all nature ſympathiſes with him. If he has loſt a beloved friend, he thinks the ſun leſs bright than at other times; and in the ſighing of the winds and groves, in the lowings of the herd, and in the murmurs of the ſtream, he ſeems to hear the voice of lamentation. But when joy or hope predominate, the whole world aſſumes a gay appearance. In the contemplation of every part of nature, of every condition of mankind, of every form of human ſociety, the benevolent and the pious man, the moroſe and the cheerful, the miſer and the miſanthrope, finds occaſion to indulge his favourite paſſion, and ſees, or thinks he ſees, his own temper reflected back in the actions, ſympathies, and tendencies of other things and perſons. Our affections are indeed the medium through which we may be ſaid to ſurvey ourſelves, and every thing elſe; and whatever be our inward frame, we are apt to perceive a wonderful congeniality in the world without us. And hence the fancy, when rouſed by real emotions, or by the pathos of compoſition, is eaſily reconciled to thoſe figures of ſpeech that aſcribe ſympathy, perception, and the other attributes of animal life, to things inanimate, or even to notions merely intellectual.—Motion, too, bears a cloſe affinity to action, and affects our imagination nearly in the ſame manner; and we ſee a great part of nature in motion, and by its ſenſible effects are led to contemplate energies innumerable. Theſe conduct the rational mind to the Great Firſt Cauſe; and theſe, in times of ignorance, diſpoſed the vulgar to believe in a variety of ſubordinate agents employed in producing thoſe appearances that could not otherwiſe be accounted for. Hence an endleſs train of fabulous deities, and of witches, demons, fairies, genii; which, if they prove our reaſon weak and our fancy ſtrong, prove alſo that perſonification is natural to the human mind; and that a right uſe of this figure may have a powerful effect, in fabulous writing eſpecially, to engage our ſympathy in behalf of things as well as perſons: for nothing can give laſting delight to a moral being, but that which awakens ſympathy, and touches the heart; and though it be true that we ſympathiſe in ſome degree even with inanimate things, yet what has, or is ſuppoſed to have, life, calls forth a more ſincere and more permanent fellow-feeling.—Let it be obſerved further, that, to awaken our ſympathetic feelings, a lively conception of their object is neceſſary. This indeed is true of almoſt all our emotions; their keenneſs is in proportion to the vivacity of the perceptions that excite them. Diſtreſs that we ſee is more affecting than what we only hear of; a peruſal of the gayeſt ſcenes in a comedy does not rouſe the mind ſo effectually as the preſence of a cheerful companion; and the death of a friend is of greater energy in producing ſeriouſneſs, and the conſideration of our latter end, than all the pathos of Young. Of deſcriptions addreſſed to the fancy, thoſe that are moſt vivid and pictureſque will generally be found to have the moſt powerful influence over our affections; and thoſe that exhibit perſons engaged in action, and adorned with viſible inſignia, give a briſker impulſe to the faculties than ſuch as convey intellectual ideas only, or images taken from ſtill life. No abſtract notion of time, or of love, can be ſo ſtriking to the fancy as the image of an old man accoutred with a ſcythe, or of a beautiful boy with wings and a bow and arrows: and no phyſiological account of phrenſy could ſuggeſt ſo vivid an idea as the poet has given us in that exquiſite portrait, "*And moody madneſs laughing wild amid ſevereſt wo.*" And for this reaſon partly it is that the epic poet, in order to work the more effectually upon our paſſions and imagination, refers the ſecret ſprings of human conduct, and the viciſſitudes of human affairs, to the agency of perſonified cauſes; that is, to the machinery of gods and goddeſſes, angels, demons, magicians, and other powerful beings. And hence, in all ſublime poetry, life and motion, with their ſeveral modes and attributes, are liberally beſtowed on thoſe objects wherewith the author intends that we ſhould be ſtrongly impreſſed: ſcenes perfectly inanimate and ſtill, tending rather to diffuſe a languor over the mind than to communicate to our internal powers thoſe lively energies without which a being eſſentially active can never receive complete gratification.—Laſtly, ſome violent paſſions are peculiarly inclined to change things into perſons. The horrors of his mind haunted Oreſtes in the ſhape of furies. Conſcience, in the form of the murdered perſon, ſtares the murderer in the face, and often terrifies him to diſtraction. The ſuperſtitious man, travelling alone in the dark, miſtakes a white ſtone for a ghoſt, a buſh for a demon, a tree waving with the wind for an enormous giant brandiſhing a hundred arms. The lunatic and enthuſiaſt converſe with perſons who exiſt only in their own diſtempered fancy; and the glutton and the miſer, if they were to give utterance to all their thoughts, would often, it is preſumable, ſpeak, the one of his gold, the other of his belly, not only as a perſon, but as a god,—the object of his warmeſt love and moſt devout regard.—More need not be ſaid to prove that perſonification is natural, and may frequently contribute to the pathos, energy, and beauty, of poetic language.

3dly, *Apoſtrophe*, or a ſudden diverſion of ſpeech from one perſon to another perſon or thing, is a figure nearly related to the former. Poets ſometimes make uſe of it in order to help out their verſe, or merely to give variety to their ſtyle: but on theſe occaſions it is to be conſidered as rather a trick of art than an effort of nature. It is moſt natural, and moſt pathetic, when the perſon or thing to whom the apoſtrophe is made, and for whoſe ſake we give a new direction to our ſpeech, is in our eyes eminently diſtinguiſhed for good or evil, or raiſes within us ſome ſudden and powerful emotion, ſuch as the hearer would acquieſce in, or at leaſt acknowledge to be reaſonable. But this, like the other pathetic figures, muſt be uſed with great prudence. For if, inſtead of calling forth the hearer's ſympathy, it ſhould only betray the levity of the ſpeaker, or ſuch wanderings of his mind as neither the ſubject nor the occaſion would lead one to expect, it will then create diſguſt inſtead of approbation. The orator, therefore, muſt not attempt the paſſionate apoſtrophe, till the minds of the hearers be prepared to join in it. And every audience is not equally obſequious in this reſpect. In the forum of ancient Rome that would have paſſed for ſublime and pathetic, which in the moſt reſpectable Britiſh auditories would appear ridiculous. For our ſtyle of public ſpeaking is cool and argumentative; and partakes leſs of enthuſiaſm than the Roman did, and much leſs than the modern French or Italian. Of Britiſh eloquence, particularly that of the pulpit, the chief recommendations are gravity and ſimplicity. And it is vain to ſay, that our oratory *ought* to be more vehement: for that matter depends on cauſes, which it is not only inexpedient, but impoſſible, to alter; namely, on the character and ſpirit of the people, and their rational notions in regard to religion, policy, and literature. The exclamations of

Cicero would weigh but little in our parliament; and many of thoſe which we meet with in French ſermons would not be more effectual if attempted in our pulpit. To ſee one of our preachers, who the moment before was a cool reaſoner, a temperate ſpeaker, a humble Chriſtian, and an orthodox divine, break out into a ſudden apoſtrophe to the immortal powers, or to the walls of the church, tends to force a ſmile, rather than a tear, from thoſe among us who reflect, that there is nothing in the ſubject, and ſhould be nothing in the orator, to warrant ſuch wanderings of fancy or vehemence of emotion. If he be careful to cultivate a pure ſtyle, and a grave and graceful utterance, a Britiſh clergyman, who ſpeaks from conviction the plain unaffected words of truth and ſoberneſs, of benevolence and piety, will, it is believed, convey more pathetic, as well as more permanent, impreſſions to the heart, and be more uſeful as a Chriſtian teacher, than if he were to put in practice all the attitudes of Roſcius, and all the tropes and figures of Cicero.

But where the language of paſſion and enthuſiaſm is permitted to diſplay itſelf, whatever raiſes any ſtrong emotion, whether it be animated or inanimate, abſent or preſent, ſenſible or intellectual, may give riſe to the apoſtrophe. A man in a diſtant country, ſpeaking of the place of his birth, might naturally exclaim, "O my dear native land, ſhall I never ſee thee more!" Or, when ſome great misfortune befals him, "Happy are ye, O my parents, that ye are not alive to ſee this!" We have a beautiful apoſtrophe in the third book of the Æneid, where Æneas, who is telling his ſtory to Dido, happening to mention the death of his father, makes a ſudden addreſs to him as follows:

> ——— hic, pelagi tot tempeſtatibus actus,
> Heu, genitorem, omnis curæ caſuſque levamen,
> Amitto Anchiſen:—hic me, pater optime, feſſum
> Deſeris, heu, tantis nequicquam erepte periclis!

This apoſtrophe has a pleaſing effect. It ſeems to intimate, that the love which the hero bore his father was ſo great, that when he mentioned him he forgot every thing elſe; and, without minding his company, one of whom was a queen, ſuddenly addreſſed himſelf to that which, though preſent only in idea, was ſtill a principal object of his affection. An emotion ſo warm and ſo reaſonable cannot fail to command the ſympathy of the reader.——When Michael, in the eleventh book of Paradiſe Loſt, announces to Adam and Eve the neceſſity of their immediate departure from the garden of Eden, the poet's art in preſerving the decorum of the two characters is very remarkable. Pierced to the heart at the thought of leaving that happy place, Eve, in all the violence of ungovernable ſorrow, breaks forth into a pathetic apoſtrophe to Paradiſe, to the flowers ſhe had reared, and to the nuptial bower ſhe had adorned. Adam makes no addreſs to the walks, the trees, or the flowers of the garden, the loſs whereof did not ſo much afflict him; but, in his reply to the Archangel, expreſſes without a figure his regret for being baniſhed from a place where he had been ſo oft honoured with a ſenſible manifeſtation of the divine preſence. The uſe of the apoſtrophe in the one caſe, and the omiſſion of it in the other, not only gives a beautiful variety to the ſtyle, but alſo marks that ſuperior elevation and compoſure of mind, by which the poet had all along diſtinguiſhed the character of Adam.—One of the fineſt applications of this figure that is anywhere to be ſeen is in the fourth book of the ſame poem; where the author, catching by ſympathy the devotion of our firſt parents, ſuddenly drops his narrative, and joins his voice to theirs in adoring the Father of the univerſe.

> Thus at their ſhady lodge arriv'd, both ſtood,
> Both turn'd, and under open ſky ador'd
> The God that made both ſky, air, earth, and heav'n,
> Which they beheld, the moon's reſplendent globe,
> And ſtarry pole:—Thou alſo mad'ſt the night,
> Maker omnipotent! and thou the day,
> Which we in our appointed work employ'd
> Have finiſh'd.———

Milton took the hint of this fine contrivance from a well-known paſſage of Virgil:

> Hic juvenum chorus, ille ſenum; qui carmine laudes
> Herculeas et facta ferant;———
> ——— ut duros mille labores
> Rege ſub Euryſtheo, fatis Junonis iniquæ,
> Pertulerit:—Tu nubigenas, invicte, bimembres,
> Hylæum Pholoumque, manu; tu Creſia mactas
> Prodigia.———

The beauty ariſing from diverſified compoſition is the ſame in both, and very great in each. But every reader muſt *feel*, that the figure is incomparably more affecting to the mind in the imitation than in the original. So true it is, that the moſt rational emotions raiſe the moſt intenſe fellow-feeling; and that the apoſtrophe is then the moſt emphatical, when it diſplays thoſe workings of human affection which are at once ardent and well-founded.

To conclude this head: Tropes and figures, particularly the *metaphor*, *ſimilitude*, and *allegory*, are further uſeful in beautifying language, by ſuggeſting, together with the thoughts eſſential to the ſubject, an endleſs variety of agreeable images, for which there would be no place, if writers were always to confine themſelves to the *proper* names of things. And this beauty and variety, judiciouſly applied, is ſo far from diſtracting, that it tends rather to fix, the attention, and captivate the heart of the readers, by giving light, and life, and pathos, to the whole compoſition.

II. That tropes and figures are more neceſſary to poetry, than to any other mode of writing, was the ſecond point propoſed to be illuſtrated in this ſection.

Language, as already obſerved, is then natural, when it is ſuitable to the ſuppoſed condition of the ſpeaker. Figurative language is peculiarly ſuitable to the ſuppoſed condition of the poet; becauſe figures are ſuggeſted by the fancy; and the fancy of him who compoſes poetry is more employed than that of any other author. Of all hiſtorical, philoſophical, and theological reſearches, the object is *real* truth, which is fixed and permanent. The aim of rhetorical declamation (according to Cicero) is *apparent* truth; which, being leſs determinate, leaves the fancy of the ſpeaker more free, gives greater ſcope to the inventive powers, and ſupplies the materials of a more figurative phraſeology. But the poet is ſubject to no reſtraints but thoſe of veriſimilitude, which is ſtill leſs determinate than rhetorical truth. He ſeeks not to convince the judgment of his reader by arguments of either real or apparent cogency; he means only to pleaſe and intereſt him, by an appeal to his ſenſibility and imagination. His own imagination is therefore continually at work, ranging through the whole of real and probable exiſtence, "glancing from heaven to earth, from earth to heaven," in queſt of images and ideas ſuited to the emotions he himſelf feels, and to the ſympathies he would communicate to others. And, conſequently, figures of ſpeech, the offspring of excurſive fancy, muſt (if he ſpeak according to what he is ſuppoſed to think and feel, that is, according to his ſuppoſed condition) tincture the language of the poet more than that of any other compoſer. So that, if figurative diction be unnatural in geometry, becauſe all wanderings of fancy are unſuitable, and even impoſſible, to the geometrician, while intent upon his argument; it is, upon the ſame principle, perfectly natural, and even unavoidable, in poetry; becauſe the more a poet attends to his ſubject, and the better qualified he is to do it juſtice, the more active will his imagination be, and the more diverſified the ideas that preſent themſelves to his mind.—— Beſides, the true poet addreſſes himſelf to the paſſions and ſympathies of mankind; which, till his own be raiſed, he cannot hope to do with ſucceſs. And it is the nature of many paſſions, though not of all, to increaſe the activity of imagination: and an active imagination naturally vents itſelf in figurative language; nay, unleſs reſtrained by a correct taſte, has a tendency to exceed in it; of which biſhop Taylor and lord Verulam, two geniuſes different in kind, but of the higheſt order, are memorable examples.

We ſaid, that "the poet ſeeks not to convince the judgment of his reader by arguments of either real or apparent cogency." ——We do not mean, that in poetry argument has no place. The moſt legitimate reaſoning, the ſoundeſt philoſophy, and narratives purely hiſtorical, may appear in a poem, and contribute greatly to the honour of the author, and to the importance of his work. All this we have in Paradiſe Loſt. We mean, that what diſtinguiſhes *pure* poetry from other writing is its aptitude, not to ſway the judgment by reaſoning, but to pleaſe the fancy, and move the paſſions, by a lively imitation of nature. Nor would we exclude poetical embelliſhment from hiſtory, or even from philoſophy. Plato's Dialogues and the Moral Eſſays of Addiſon and Johnſon abound in poetic imagery; and Livy and Tacitus often amuſe their readers with poetical deſcription. In like manner, though geometry and phyſics be different ſciences; though abſtract ideas be the ſubject, and pure demonſtration or intuition the evidence, of the former; and though the material univerſe, and the informations of ſenſe, be the ſubject and the evidence of the latter; yet have theſe ſciences been united by the beſt philoſophers, and very happy effects reſulted from the union.——In one and the ſame work, poetry, hiſtory, philoſophy, and oratory, may doubtleſs be blended; nay, theſe arts have all been actually blended in one and the ſame work, not by Milton only, but alſo by Homer, Virgil, Lucan, and Shakeſpeare. Yet ſtill theſe arts are different; different in their ends and principles, and in the faculties of the mind to which they are reſpectively addreſſed: and it is eaſy to perceive when a writer employs one and when another.

§ 2. *Of the* SOUND *of Poetical Language.*

As the ear, like every other perceptive faculty, is capable of gratification, regard is to be had to the ſound of words, even in proſe. But to the harmony of language, it behoves the poet, more than any other writer, to attend; as it is more eſpecially his concern to render his work pleaſurable. In fact, we find that no poet was ever popular who did not poſſeſs the art of harmonious compoſition.

What belongs to the ſubject of Poetical Harmony may be referred to one or other of theſe heads, *Sweetneſs*, *Meaſure*, and *Imitation*.

I. In order to give *ſweetneſs* to language, either in verſe or proſe, all words of harſh ſound, difficult pronunciation, or unwieldy magnitude, are to be avoided as much as poſſible, unleſs when they have in the ſound ſomething peculiarly emphatical; and words are to be ſo placed in reſpect of one another, as that diſcordant combinations may not reſult from their union. But in poetry this is more neceſſary than in proſe; poetical language being underſtood to be an imitation of natural language improved to that perfection which is conſiſtent with probability. To poetry, therefore, a greater latitude muſt be allowed than to proſe, in expreſſing, by tropes and figures of pleaſing ſound, thoſe ideas whereof the proper names are in any reſpect offenſive, either to the ear or to the fancy.

II. How far verſification or *regular meaſure* may be eſſential to this art, has been diſputed by critical writers; ſome holding it to be indiſpenſably neceſſary, and ſome not neceſſary at all.

The fact ſeems to be, as already hinted, that to poetry verſe is not eſſential. In a proſe work, we may have the fable, the arrangement, and a great deal of the pathos and language, of poetry; and ſuch a work is certainly a poem, though perhaps not a perfect one. For how abſurd would it be to ſay, that by changing the poſition only of a word or two in each line, one might diveſt Homer's Iliad of the poetical character! At this rate, the arts of poetry and verſification would be the ſame; and the rules in Deſpauter's Grammar, and the moral diſtichs aſcribed to Cato, would be as real poetry as any part of Virgil. In fact, ſome very ancient poems, when tranſlated into a modern tongue, are far leſs poetical in verſe than in proſe; the alterations neceſſary to adapt them to our numbers being detrimental to their ſublime ſimplicity; of which any perſon of taſte will be ſenſible, who compares our common proſe-verſion of Job, the Pſalms, and the Song of Solomon, with the beſt metrical paraphraſe of thoſe books that has yet appeared. Nay, in many caſes, Comedy will be more poetical, becauſe more pleaſing and natural, in proſe than in verſe. By verſifying Tom Jones, and The Merry Wives of Windſor, we ſhould ſpoil the two fineſt comic poems, the one epic, the other dramatical, now in the world.

But, ſecondly, though verſe be not eſſential to poetry, it is neceſſary to the perfection of all poetry that admits of it. Verſe is to poetry what colours are to painting *. A painter might diſplay great genius, and draw maſterly figures, with chalk or ink; but if he intend a perfect picture, he muſt employ in his work as many colours as are ſeen in the object he imitates. Or, to adopt a beautiful compariſon of Demoſthenes, quoted by Ariſtotle, "Verſification is to poetry what bloom is to the human countenance." A good face is agreeable when the bloom is gone, and good poetry may pleaſe without verſification; harmonious numbers may ſet off an indifferent poem, and a fine bloom indifferent features; but, without verſe, poetry is incomplete; and beauty is not perfect, unleſs to ſweetneſs and regularity of feature there be ſuperadded, "*The bloom of young deſire, and purple light of love.*" If numbers are neceſſary to the perfection of the higher poetry, they are no leſs ſo to that of the lower kinds, to Paſtoral, Song, and Satire, which have little beſides the language and verſification to diſtinguiſh them from proſe; and which ſome ancient authors are unwilling to admit to the rank of poems: though it ſeems too nice a ſcruple, both becauſe ſuch writings are commonly termed *poetical*; and alſo becauſe there is, even in them, ſomething that may not improperly be conſidered as an imitation of nature.

That the rhythm and meaſures of verſe are naturally agreeable, and therefore that by theſe poetry may be made more pleaſing than it would be without them, is evident from this, that children and illiterate people, whoſe admiration we cannot ſuppoſe to be the effect of habit or prejudice, are exceedingly delighted with them. In many proverbial ſayings, where there is neither rhime nor alliteration, rhythm is obviouſly ſtudied. Nay, the uſe of rhythm in poetry is univerſal; whereas alliteration and rhime, though reliſhed by ſome nations, are not much ſought after by others. And we need not be at a loſs to account for the agreeableneſs of proportion and order, if we reflect that they ſuggeſt the agreeable ideas of contrivance and ſkill, at the ſame time that they render the connection of things obvious to the underſtanding, and imprint it deeply on the memory. Verſe, by promoting diſtinct and eaſy remembrance, conveys ideas to the mind with energy, and enlivens every emotion the poet intends to raiſe in the reader or hearer. Beſides, when we attend to verſes, after hearing one or two we become acquainted with the meaſure, which therefore we always look for in the ſequel. This perpetual interchange of hope and gratification is a ſource of delight ; and to this in part is owing the pleaſure we take in the rhimes of modern poetry. And hence we ſee, that though an incorrect rhime or untuneable verſe be in itſelf, and compared with an important ſentiment, a very trifling matter ; yet it is no trifle in regard to its effects on the hearer, becauſe it brings diſappointment, and ſo gives a temporary ſhock to the mind, and interrupts the current of the affections ; and becauſe it ſuggeſts the diſagreeable ideas of negligence or want of ſkill on the part of the author. And therefore, as the public ear becomes more delicate, the negligence will be more glaring, and the diſappointment more intenſely felt ; and correctneſs of rhime and of meaſure will of courſe be the more indiſpenſable. In our tongue, rhime is more neceſſary to Lyric than to Heroic poetry. The reaſon ſeems to be, that in the latter the ear can of itſelf perceive the boundary of the meaſure, becauſe the lines are all of equal length nearly, and every good reader makes a ſhort pauſe at the end of each ; whereas, in the former, the lines vary in length ; and therefore the rhime is requiſite to make the meaſure and rhythm ſufficiently perceptible. Cuſtom too may have ſome influence. Engliſh Odes without rhime are uncommon ; and therefore have ſomething aukward about them, or ſomething at leaſt to which the public ear is not yet thoroughly reconciled. Indeed, when the drama is excepted, we do not think that rhime can be ſafely ſpared from Engliſh poetry of any kind, but when the ſubject is able to ſupport itſelf. "He that thinks himſelf capable of aſtoniſhing (ſays Johnſon) may write blank verſe ; but thoſe that hope only to pleaſe muſt condeſcend to rhime."

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* Horace ſeems to hint at the ſame compariſon, when, after ſpecifying the ſeveral ſorts of verſe ſuitable to Epic, Elegiac, Lyric, and Dramatic Poetry, he adds,

Deſcriptas ſervare vices, *operumque colores*.
Cur ego, ſi nequeo ignoroque, Poeta ſalutor? *Art. Poet.* ver. 8.

Rhime, however, is of leſs importance by far than rhythm, which in poetry as well as in muſic is the ſource of much pleaſing variety ; of variety tempered with uniformity, and regulated by art ; inſomuch that, notwithſtanding the likeneſs of one hexameter verſe to another, it is not common, either in Virgil or in Homer, to meet with two contiguous hexameters whoſe rhythm is exactly the ſame. And though all Engliſh heroic verſes conſiſt of five feet, among which the iambic predominates ; yet this meaſure, in reſpect of rhythm alone, is ſuſceptible of more than 30 varieties. And let it be remarked further, that different kinds of verſe, by being adapted to different ſubjects and modes of writing, give variety to the poetic language, and multiply the charms of this pleaſing art.

What has formerly been ſhown to be true in regard to ſtyle, will alſo in many caſes hold true of verſification, "that it is then *natural*, when it is adapted to the *ſuppoſed condition* of the ſpeaker."—In the epopee, the poet aſſumes the character of calm inſpiration ; and therefore his language muſt be elevated, and his numbers majeſtic and uniform. A peaſant ſpeaking in heroic or hexameter verſe is no improbability here ; becauſe his words are ſuppoſed to be tranſmitted by one who will of his own accord give them every ornament neceſſary to reduce them into dignified meaſure ; as an eloquent man, in a ſolemn aſſembly, recapitulating the ſpeech of a clown, would naturally expreſs it in pure and perſpicuous language. The uniform heroic meaſure will ſuit any ſubject of dignity, whether narrative or didactic, that admits or requires uniformity of ſtyle. In tragedy, where the imitation of real life is more perfect than in epic poetry, the uniform magnificence of epic numbers might be improper ; becauſe the heroes and heroines are ſuppoſed to ſpeak in their own perſons, and according to the immediate impulſe of paſſion and ſentiment. Yet, even in tragedy, the verſification may be both harmonious and dignified ; becauſe the characters are taken chiefly from high life, and the events from a remote period ; and becauſe the higher poetry is permitted to imitate nature, not as it is, but in that ſtate of perfection in which it might be. The Greeks and Romans conſidered their hexameter as too artificial for dramatic poetry ; and therefore in tragedy, and even in comedy, made uſe of the iambic, and ſome other meaſures that came near the cadence of converſation : we uſe the iambic both in the epic and dramatic poem ; but for the moſt part it is, or ought to be, much more elaborate in the former than in the latter. In dramatic comedy, where the manners and concerns of familiar life are exhibited, verſe would ſeem to be unnatural, except it be ſo like the ſound of common diſcourſe as to hardly diſtinguiſhable from it. Cuſtom, however, may in ſome countries determine otherwiſe ; and againſt cuſtom, in theſe matters, it is vain to argue. The profeſſed enthuſiaſm of the dithyrambic poet renders wildneſs, variety, and a ſonorous harmony of numbers, peculiarly ſuitable to his odes. The love-ſonnet, and Anacreontic ſong, will be leſs various, more regular, and of a ſofter harmony ; becauſe the ſtate of mind expreſſed in it has more compoſure. Philoſophy can ſcarce go further in this inveſtigation, without deviating into whim and hypotheſis. The particular ſorts of verſe to be adopted in the lower ſpecies of poetry are determined by faſhion chiefly, and the practice of approved authors.

III. The origin and principles of *imitative harmony*, or of that artifice by which the ſound is made, as Pope ſays, "an echo to the ſenſe," may be explained in the following manner.

It is pleaſing to obſerve the uniformity of nature in all her operations. Between moral and material beauty and harmony, between moral and material deformity and diſſonance, there obtains a very ſtriking analogy. The viſible and audible expreſſions of almoſt every virtuous emotion are agreeable to the eye and the ear, and thoſe of almoſt every criminal paſſion diſagreeable. The looks, the attitudes, and the vocal ſounds, natural to benevolence, to gratitude, to compaſſion, to piety, are in themſelves graceful and pleaſing ; while anger, diſcontent, deſpair, and cruelty, bring diſcord to the voice, deformity to the features, and diſtortion to the limbs. That flowing curve, which painters know to be eſſential to the beauty of animal ſhape, gives place to a multiplicity of right lines and ſharp angles in the countenance and geſture of him who knits his brows, ſtretches his noſtrils, grinds his teeth, and clenches his fiſt ; whereas devotion, magnanimity, benevolence, contentment, and good humour, ſoften the attitude, and give a more graceful ſwell to the outline of every feature. Certain vocal tones accompany certain mental emotions. The voice of ſorrow is feeble and broken, that of deſpair boiſterous and incoherent ; joy aſſumes a ſweet and ſprightly note, fear a weak and tremulous cadence ; the tones of love and benevolence are muſical and uniform, thoſe of rage loud and diſſonant ; the voice of the ſedate reaſoner is equable and grave, but not unpleaſant ; and he who declaims with energy employs many varieties of modulation ſuited to the various emotions that predominate in his diſcourſe.

But it is not in the language of paſſion only that the human voice varies its tone, or the human face its features. Every ſtriking ſentiment, and every intereſting idea, has an effect upon it. One would eſteem that perſon no adept in narrative eloquence who ſhould deſcribe with the very ſame accent ſwift and ſlow motion, extreme labour and eaſy performance, agreeable ſenſation and excruciating pain; who ſhould talk of the tumult of a tempeſtuous ocean, the roar of thunder, the devaſtations of an earthquake, or an Egyptian pyramid tumbling into ruins, in the ſame tone of voice wherewith he deſcribes the murmur of a rill, the warbling of the harp of Æolus, the ſwinging of a cradle, or the deſcent of an angel. Elevation of mind gives dignity to the voice. From Achilles, Sarpedon, and Othello, we ſhould as naturally expect a manly and ſonorous accent as a nervous ſtyle and majeſtic attitude. Coxcombs and bullies, while they aſſume airs of importance and valour, affect alſo a dignified articulation.

Since the notes of natural language are ſo various, poetry, which imitates the language of nature, muſt alſo vary its tones; and, in reſpect of ſound as well as of meaning, be framed after that model of ideal perfection which the variety and energy of the human articulate voice render probable. This is the more eaſily accompliſhed, becauſe in every language there is between the ſound and ſenſe of certain words a perceptible analogy; which, though not ſo accurate as to lead a foreigner from the ſound to the ſignification, is yet accurate enough to ſhow, that, in forming ſuch words, regard has been had to the imitative qualities of vocal ſound. Such, in Engliſh, are the words *yell*, *craſh*, *crack*, *hiſs*, *roar*, *murmur*, and many others.

All the particular laws that regulate this ſort of imitation, as far as they are founded in nature, and liable to the cognizance of philoſophy, depend on the general law of ſtyle above mentioned. Together with the other circumſtances of the ſuppoſed ſpeaker, the poet takes into conſideration the tone of voice ſuitable to the ideas that occupy his mind, and thereto adapts the ſound of his language, if it can be done conſiſtently with eaſe and elegance of expreſſion. But when this imitative harmony is too much ſought after, or words appear to be choſen for ſound rather than ſenſe, the verſe becomes finical and ridiculous. Such is Ronſard's affected imitation of the ſong of the ſky-lark:

> Elle quindée du zephire
> Sublime en l'air vire et revire,
> Et y declique un joli cris,
> Qui rit, guérit, et tire l'ire
> Des eſprits mieux que je n'écris.

This is as ridiculous as that line of Ennius,

> Tum tuba terribili ſonitu taratantara dixit:

Or as the following verſes of Swift;

> The man with the kettle-drum enters the gate,
> Dub dub a dub dub: the trumpeters follow,
> Tantara tantara; while all the boys hollow.

Words by their ſound may imitate ſound; and quick or ſlow articulation may imitate quick or ſlow motion. Hence, by a proper choice and arrangement of words, the poet may imitate *Sounds* that are ſweet with dignity [*],—ſweet and tender [†].—loud [‡],—and harſh [§];—and *Motions* that are ſlow, in conſequence of dignity [‖],—ſlow in conſequence of difficulty [¶],—ſwift and noiſy [**],—ſwift and ſmooth [††],—uneven and abrupt [‡‡], quick and joyous [§§]. An unexpected pauſe in the verſe may alſo imitate a ſudden failure of ſtrength [‖‖], or interruption of motion[*], or give vivacity to an image or thought, by fixing our attention longer than uſual upon the word that precedes it[†].—Moreover, when we deſcribe great bulk, it is natural for us to articulate ſlowly, even in common diſcourſe; and therefore a line of poetry that requires a ſlow pronunciation, or ſeems longer than it ſhould be, may be uſed with good effect in deſcribing vaſtneſs of ſize[‡].—Sweet and ſmooth numbers are moſt proper when the poet paints agreeable objects or gentle energy[§], and harſher ſounds when he ſpeaks of what is ugly, violent, or diſagreeable[‖]. This, too, is according to the nature of common language; for we generally employ harſher tones of voice to expreſs what we diſlike, and more melodious notes to deſcribe the objects of love, complacency, or admiration. Harſh numbers, however, ſhould not be frequent in poetry: for in this art, as in muſic, concord and melody ought always to predominate. And we find, in fact, that good poets can occaſionally expreſs themſelves ſomewhat harſhly when the ſubject requires it, and yet preſerve the ſweetneſs and majeſty of poetical diction. Further, the voice of complaint, pity, love, and all the gentler affections, is mild and muſical, and ſhould therefore be imitated in muſical numbers; while deſpair, defiance, revenge, and turbulent emotions in general, aſſume an abrupt and ſonorous cadence. Dignity of deſcription[¶], ſolemn vows[**], and all ſentiments that proceed from a mind elevated with great ideas[††], require a correſpondent pomp of language and verſification.—Laſtly, an irregular or uncommon movement in the verſe may ſometimes be of uſe, to make the reader conceive an image in a particular manner. Virgil, deſcribing horſes running over rocky heights at full ſpeed, begins the line with two dactyls, to imitate rapidity, and concludes it with eight long ſyllables:

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[*] No ſooner had th' Almighty ceas'd, than all
The multitude of angels, with a ſhout
Loud as from numbers without number, ſweet
As from bleſt voices utt'ring joy, heav'n rung
With jubilee, and loud hoſannas fill'd
Th' eternal regions.—— *Par. Loſt*, b. iii.

See alſo the night-ſtorm of thunder, lightning, wind, and rain, in Virg. Georg. lib. i. ver. 328—334.

[†] Et longum, formoſe, vale, vale, inquit, Iola.
Virg. Ecl. 3.

Formoſam reſonare doces Amaryllida ſilvas.
Virg. Ecl. 1.

See alſo the ſimile of the nightingale, Geor. lib. iv. verſ. 511. And ſee that wonderful couplet deſcribing the wailings of the owl, Æneid iv. 462.

[‡] ——————— vibratus ab æthere fulgor
Cum ſonitu venit, et ruere omnia viſa repente,
Tyrrhenuſque tubæ mugire per æthera clangor,
Suſpiciunt: iterum atque iterum fragor intonat ingens.
Æneid. 8.

See alſo the ſtorm in the firſt book of the Æneid, and in the fifth of the Odyſſey.

[§] The hoarſe rough verſe ſhall like the torrent roar. *Pope*.

———— On a ſudden open fly,
With impetuous recoil and jarring ſound,
Th' infernal doors, and on their hinges grate
Harſh thunder.—— *Par. Loſt*, ii. 879.

See alſo Homer's Iliad, lib. ii. ver. 363. and Clarke's Annotation.

[‖] See an exquiſite example in Gray's Progreſs of Poeſy; the concluſion of the third ſtanza.

[¶] And when up ten ſteep ſlopes you've dragg'd your thighs.
Pope.

Juſt brought out this when ſcarce his tongue could ſtir.
Pope.

———— ———— The huge leviathan,
Wallowing unwieldy, enormous in their gait,
Tempeſt the ocean. *Par. Loſt*, vii. 411.

See the famous deſcription of Siſyphus rolling the ſtone, Odyſſ. lib. xi. ver. 592. See Quintil. Inſt. Orat. lib. ix. cap. 4. ſect. 4. compared with Paradiſe Loſt, book ii. ver. 1022.

[**] Quadrupedante putrem ſonitu quatit ungula campum.
Æneid.

Αυταρ επειτα πεδονδε κυλινδετο λαας αναιδης. *Odyſſ* 11.

See alſo Virg. Æneid. lib. i. ver. 83—87.

[††] See wild as the winds o'er the deſert he flies. *Pope*.
Ille volat, ſimul arva fuga, ſimul æquora verrens. *Virg*.
Ρηιδιη τ' επειτα πελει, χαλεπη περ εουσα. *Heſiod*.

[‡‡] *Πολλα δ' αναντα καταντα παραντα τε δοχμια τ' ηλθον.*
Hom.

The laſs ſhriek'd, ſtarted up, and ſhriek'd again. *Anonym*.

[§§] Let the merry bells ring round,
And the jocund rebecks ſound,
To many a youth, and many a maid,
Dancing in the chequer'd ſhade. *Milt. Allegro*.

See alſo Gray's Progreſs of Poeſy, ſtanza 3.

[‖‖] Ac velut in ſomnis oculos ubi languida preſſit
Nocte quies, nequicquam avidos extendere curſus
Velle videmur:—et in mediis conatibus ægri
Succidimus.——— *Æneid*.

See alſo Virg. Georg. lib. iii. ver. 515, 516.

> Saxa per, et ſcopulos, et depreſſas convalles.
>
> *Geor.* iii. 276.

which is a very unuſual meaſure, but ſeems well adapted to the thing expreſſed, namely, to the deſcent of the animal from the hills to the low ground. At any rate, this extraordinary change of the rhythm may be allowed to bear ſome reſemblance to the animal's change of motion, as it would be felt by a rider, and as we may ſuppoſe it is felt by the animal itſelf.

Other forms of imitative harmony, and many other examples, beſides thoſe referred to in the margin, will readily occur to all who are converſant in the writings of the beſt verſifiers, particularly Homer, Virgil, Milton, Lucretius, Spenſer, Dryden, Shakeſpeare, Pope, and Gray.

PART II. OF THE DIFFERENT SPECIES OF POETRY, with their PARTICULAR PRINCIPLES.

SECT. I. *Of Epic and Dramatic Compoſitions.*

§ 1. *The Epopee and Drama compared.*

TRAGEDY and the epic differ not in ſubſtantials: in both the ſame ends are propoſed, viz. inſtruction and amuſement; and in both the ſame mean is employed, viz. imitation of human actions. They differ only in the manner of imitating: epic poetry employs narration; tragedy repreſents its facts as paſſing in our ſight: in the former, the poet introduces himſelf as an hiſtorian; in the latter, he preſents his actors, and never himſelf.

This difference, regarding form only, may be thought ſlight: but the effects it occaſions are by no means ſo; for what we ſee makes a deeper impreſſion than what we learn from others. A narrative poem is a ſtory told by another; facts and incidents paſſing upon the ſtage, come under our own obſervation; and are beſide much enlivened by action and geſture, expreſſive of many ſentiments beyond the reach of language. A dramatic compoſition has another property, independent altogether of action; which, is, that it makes a deeper impreſſion than narration: in the former, perſons expreſs their own ſentiments; in the latter, ſentiments are related at ſecond-hand. For that reaſon, Ariſtotle, the father of critics, lays it down as a rule, That in an epic poem the author ought to take every opportunity of introducing his actors, and of confining the narrative part within the narroweſt bounds. Homer underſtood perfectly the advantage of this method; and his poems are both of them in a great meaſure dramatic. Lucan runs to the oppoſite extreme: and is guilty of a ſtill greater fault, in ſtuffing his *Pharſalia* with cold and languid reflections, the merit of which he aſſumes to himſelf, and deigns not to ſhare with his actors. Nothing can be more injudiciouſly timed, than a chain of ſuch reflections, which ſuſpend the battle of Pharſalia after the leaders had made their ſpeeches, and the two armies are ready to engage.

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[*] For this, be ſure to-night thou ſhalt have cramps,
Side-ſtitches that ſhall pen thy breath up. Urchins
Shall exerciſe upon thee.———
Proſpero to Calyban in *the Tempeſt.*

See Pope's Iliad, xiii. 199.

[†] ———How often, from the ſteep
Of echoing hill or thicket, have we heard
Celeſtial voices, to the midnight air,
Sole, or reſponſive to each other's note,
Singing their great Creator!——— *Par. Loſt,* b. iv.

And over them triumphant Death his dart
Shook; but delay'd to ſtrike. *Id.*

See alſo Hom. Odyſſ. l. ix. ver. 290.

[‡] Thus ſtretch'd out, huge in length, the arch-fiend lay.
Par. Loſt.

Monſtrum horrendum, informe, ingens, cui lumen ademptum. *Æneid.* 3.

Et magnos membrorum artus, magna oſſa, lacertoſque
Exuit, atque ingens media conſiſtit arena.
Æneid. v. 422.

[§] Hic gelidi fontes, hic mollia prata, Lycori,
Hic nemus, hic ipſo tecum conſumerer ævo.
Virg. Ecl. 10.

The dumb ſhall ſing; the lame his crutch forego,
And leap, exulting, like the bounding roe.
Pope's Meſſiah.

See Milton's deſcription of the evening, Par. Loſt, book iv. ver. 598—609.

Ye gentle gales, beneath my body blow,
And ſoftly lay me on the waves below. *Pope's Sappho.*

[‖] Stridenti ſtipula miſerum diſperdere carmen.
Virg. Ecl. 3.

Immo ego Sardois videar tibi amarior herbis,
Horridior ruſco, projecta vilior alga. *Virg. Ecl.* 7.

Neu patriæ validas in viſcera vertite vires. *Virg. Æneid.* 6.

See alſo Milton's deſcription of the Lazar-houſe in Paradiſe Loſt, b. xi. v. 477—492.

[¶] See Virg. Georg. l. 328. and Homer, Virgil, and Milton, *paſſim.* See alſo Dryden's Alexander's Feaſt, and Gray's Odes.

[**] See Virg. Æneid. iv. 24.

[††] Examples are frequent in the great authors. See Othello's exclamation:

——— ——— O now for ever
Farewell the tranquil mind! &c. *Act* 3. *ſc.* 3.

Ariſtotle, from the nature of the fable, divides tragedy into ſimple and complex; but it is of greater moment, with reſpect to dramatic as well as epic poetry, to found a diſtinction upon the different ends attained by ſuch compoſitions. A poem, whether dramatic or epic, that has nothing in view but to move the paſſions and to exhibit pictures of virtue and vice, may be diſtinguiſhed by the name of *pathetic*: but where a ſtory is purpoſely contrived to illuſtrate ſome moral truth, by ſhowing that diſorderly paſſions naturally lead to external miſfortunes, ſuch compoſition may be denominated *moral*. Beſide making a deeper impreſſion than can be done by cool reaſoning, a moral poem does not fall ſhort of reaſoning in affording conviction: the natural connection of vice with miſery, and of virtue with happineſs, may be illuſtrated by ſtating a fact as well as by urging an argument. Let us aſſume, for example, the following moral truths: That diſcord among the chiefs renders ineffectual all common meaſures; and that the conſequences of a ſlightly-founded quarrel, foſtered by pride and arrogance, are not leſs fatal than thoſe of the groſſeſt injury: theſe truths may be inculcated by the quarrel between Agamemnon and Achilles at the ſiege of Troy. If facts or circumſtances be wanting, ſuch as tend to rouſe the turbulent paſſions, they muſt be invented; but no accidental nor unaccountable event ought to be admitted; for the neceſſary or probable connection between vice and miſery is not learned from any events but what are naturally occaſioned by the characters and paſſions of the perſons repreſented, acting in ſuch circumſtances. A real event, of which we ſee not the cauſe, may afford a leſſon, upon the preſumption that what hath happened may again happen: but this cannot be inferred from a ſtory that is known to be a fiction.

Many are the good effects of ſuch compoſitions. A pathetic compoſition, whether epic or dramatic, tends to a habit of virtue, by exciting us to do what is right, and reſtraining us from what is wrong. Its frequent pictures of human woes produce, beſide, two effects extremely ſalutary: they improve our ſympathy, and fortify us to bear our own miſfortunes. A moral compoſition muſt obviouſly produce the ſame good effects, becauſe by being moral it ceaſeth not to be pathetic: it enjoys beſides an excellence peculiar to itſelf; for it not only improves the heart, as above mentioned, but inſtructs the head by the moral it contains. It ſeems impoſſible to imagine any entertainment more ſuited to a rational being, than a work thus happily illuſtrating ſome moral truth; where a number of perſons of different characters are engaged in an important action, ſome retarding, others promoting, the great cataſtrophe; and where there is dignity of ſtyle as well as of matter. A work of this kind has our ſympathy at command, and can put in motion the whole train of the ſocial affections: our curioſity in ſome ſcenes is excited, in others gratified; and our delight is conſummated at the cloſe, upon finding, from the characters and ſituations exhibited at the commencement, that every incident down to the final cataſtrophe is natural, and that the whole in conjunction make a regular chain of cauſes and effects.

Conſidering that an epic and a dramatic poem are the ſame in ſubſtance, and have the ſame aim or end, one will readily imagine, that ſubjects proper for the one muſt be equally proper for the other. But conſidering their difference as to form, there will be found reaſon to correct that conjecture, at leaſt in ſome degree. Many ſubjects may indeed be treated with equal advantage in either form: but the ſubjects are ſtill more numerous for which they are not equally qualified; and there are ſubjects proper for the one and not at all for the other. To give ſome ſlight notion of the difference, as there is no room here for enlarging upon every article, we obſerve, that dialogue is better qualified for expreſſing ſentiments, and narrative for diſplaying facts. Heroiſm, magnanimity, undaunted courage, and other elevated virtues, figure beſt in action: tender paſſions, and the whole tribe of ſympathetic affections, figure beſt in ſentiment. It clearly follows, that tender paſſions are more peculiarly the province of tragedy, grand and heroic actions of epic poetry.

"The epic poem (ſays Blair in his Lectures) is univerſally allowed to be, of all poetical works, the moſt dignified, and, at the ſame time, the moſt difficult in execution. To contrive a ſtory which ſhall pleaſe and intereſt all readers, by being at once entertaining, important, and inſtructive; to fill it with ſuitable incidents; to enliven it with a variety of characters and of deſcriptions; and, throughout a long work, to maintain that propriety of ſentiment, and that elevation of ſtyle, which the epic character requires, is unqueſtionably the higheſt effort of poetical genius.

"The action or ſubject of the epic poem muſt be great and intereſting. Without greatneſs it would not have ſufficient importance either to fix our attention or to juſtify the magnificent apparatus which the poet beſtows on it. This is ſo evidently requiſite as not to require illuſtration; and, indeed, hardly any who have attempted epic poetry have failed in chooſing ſome ſubject ſufficiently important, either by the nature of the action or by the fame of the perſonages concerned in it. The fame of Homer's heroes, and the conſequences of diſſenſion between the greateſt of them, is a ſubject important in itſelf, and muſt have appeared particularly ſo to his countrymen, who boaſted their deſcent from thoſe heroes. The ſubject of the Æneid is ſtill greater than that of the Iliad, as it is the foundation of the moſt powerful empire that ever was eſtabliſhed upon this globe; an event of much greater importance than the deſtruction of a city, or the anger of a ſemibarbarous warrior. But the poems of Homer and Virgil fall in this reſpect infinitely ſhort of that of Milton. "Before the greatneſs diſplayed in Paradiſe Loſt, Johnſon has well obſerved that all other greatneſs ſhrinks away. The ſubject of the Engliſh poet is not the deſtruction of a city, the conduct of a colony, or the foundation of an empire: it is the fate of worlds, the revolutions of heaven and earth; rebellion againſt the Supreme King, raiſed by the higheſt order of created beings; the overthrow of their hoſt, and the puniſhment of their crime; the creation of a new race of reaſonable creatures; their original happineſs and innocence, their forfeiture of immortality, and their reſtoration to hope and peace."

An epic poem, however, is defective if its action be not intereſting as well as great; for a narrative of mere valour may be ſo conſtructed as to prove cold and tireſome. "Much (ſays Blair) will depend on the happy choice of ſome ſubject, which ſhall by its nature intereſt the public; as when the poet ſelects for his hero one who is the founder, or the deliverer, or the favourite of his nation; or when he writes achievements that have been highly celebrated, or have been connected with important conſequences to any public cauſe. Moſt of the great epic poems are abundantly fortunate in this reſpect, and muſt have been very intereſting to thoſe ages in which they were compoſed." The ſubject of the Paradiſe Loſt, as it is infinitely greater, muſt likewiſe be conſidered as more univerſally intereſting than that of any other poem. "We all feel the effects of Adam's tranſgreſſion; we all ſin like him, and like him muſt all bewail our offences. We have reſtleſs and inſidious enemies in the fallen angels, and in the bleſſed ſpirits we have guardians and friends; in the redemption of mankind we hope to be included; in the deſcription of heaven and hell we are ſurely intereſted, as we are all to reſide hereafter either in the regions of horror or bliſs.”

“ The chief circumſtance which renders an epic poem intereſting, and which tends to intereſt not one age or country alone, but all readers, is the ſkilful conduct of the author in the management of his ſubject. His plan muſt comprehend many affecting incidents. He may ſometimes be awful and auguſt; he muſt often be tender and pathetic; he muſt give us gentle and pleaſing ſcenes of love, friendſhip, and affection. The more that an epic poem abounds with ſituations which awaken the feelings of humanity, it is the more intereſting. In this reſpect perhaps no epic poets have been ſo happy as Virgil and Taſſo. The plan of the *Paradiſe Loſt* compriſes neither human actions nor human manners. The man and woman who act and ſuffer, are in a ſtate which no man or woman can ever know. The reader finds no tranſaction in which he can be engaged; beholds no condition in which he can by any effort of imagination place himſelf; he has therefore little natural curioſity or ſympathy.”

A queſtion has been moved, Whether the nature of the epic poem does not require that the hero ſhould be ultimately ſucceſsful? To this queſtion Johnſon replies, that “ there is no reaſon why the hero ſhould not be unfortunate, except eſtabliſhed practice, ſince ſucceſs and virtue do not neceſſarily go together.” Moſt critics, however, are of a different opinion, and hold ſucceſs to be, if not the neceſſary, at leaſt the moſt proper iſſue of an epic poem. An unhappy concluſion depreſſes the mind, and is oppoſite to the elevating emotions which belong to this ſpecies of poetry. Terror and compaſſion are the proper ſubjects of tragedy; but as the epic is of larger extent, it were too much, if, after the difficulties and troubles which commonly abound in the progreſs of the poem, the author ſhould bring them all at laſt to an unfortunate concluſion. We know not that any author of name has held this courſe except *Lucan*; for in the *Paradiſe Loſt*, as Adam's deceiver is at laſt cruſhed, and he himſelf reſtored to the favour of his maker, Milton's hero muſt be conſidered as finally ſucceſsful.

We have no occaſion to ſay more of the epic, conſidered as peculiarly adapted to certain ſubjects, and to be conducted according to a certain plan. But as dramatic ſubjects are more complex, it is neceſſary to take a narrower view of them. They are either the light and the gay, or the grave and affecting, incidents of human life. The former conſtitute the ſubject of comedy, and the latter of tragedy.

As great and ſerious objects command more attention than little and ludicrous ones; as the fall of a hero intereſts the public more than the marriage of a private perſon; tragedy has been always held a more dignified entertainment than comedy. The firſt thing required of the tragic poet is, that he pitch upon ſome moving and intereſting ſtory, and that he conduct it in a natural and probable manner. For we muſt obſerve, that the natural and probable are more eſſential to tragic than even to epic poetry. Admiration is excited by the wonderful; but paſſion can be raiſed only by the impreſſions of nature and truth upon the mind.

The ſubject beſt fitted for tragedy is where a man has himſelf been the cauſe of his misfortune; not ſo as to be deeply guilty, nor altogether innocent: the misfortune muſt be occaſioned by a fault incident to human nature, and therefore in ſome degree venial. Such misfortunes call forth the ſocial affections, and warmly intereſt the ſpectator. An accidental misfortune, if not extremely ſingular, doth not greatly move our pity: the perſon who ſuffers, being innocent, is freed from the greateſt of all torments, that anguiſh of mind which is occaſioned by remorſe. An atrocious criminal, on the other hand, who brings misfortunes upon himſelf, excites little pity, for a different reaſon: his remorſe, it is true, aggravates his diſtreſs, and ſwells the firſt emotions of pity; but then our hatred of him as a criminal blending with pity, blunts its edge conſiderably. Misfortunes that are not innocent, nor highly criminal, partake the advantages of each extreme: they are attended with remorſe to embitter the diſtreſs, which raiſes our pity to a great height; and the ſlight indignation we have at a venial fault detracts not ſenſibly from our pity. The happieſt of all ſubjects accordingly for raiſing pity, is where a man of integrity falls into a great misfortune by doing an action that is innocent, but which, by ſome ſingular means, is conceived by him to be criminal: his remorſe aggravates his diſtreſs; and our compaſſion, unreſtrained by indignation, knows no bounds. Pity comes thus to be the ruling paſſion of a pathetic tragedy; and, by proper repreſentation, may be raiſed to a height ſcarce exceeded by any thing felt in real life. A moral tragedy takes in a larger field; as it not only exerciſes our pity, but raiſes another paſſion, which, though ſelfiſh, deſerves to be cheriſhed equally with the ſocial affection. The paſſion we have in view is fear or terror; for, when a misfortune is the conſequence of ſome wrong bias in the temper, every ſpectator who is conſcious of ſuch a bias in himſelf takes the alarm, and dreads his falling into the ſame misfortune: and by the emotion of fear or terror, frequently reiterated in a variety of moral tragedies, the ſpectators are put upon their guard againſt the diſorders of paſſion.

The commentators upon Ariſtotle, and other critics, have been much gravelled about the account given of tragedy by that author: “ That by means of pity and terror, it refines or purifies in us all ſorts of paſſion.” But no one who has a clear conception of the end and effects of a good tragedy, can have any difficulty about Ariſtotle's meaning: Our pity is engaged for the perſons repreſented; and our terror is upon our own account. Pity indeed is here made to ſtand for all the ſympathetic emotions, becauſe of theſe it is the capital. There can be no doubt, that our ſympathetic emotions are refined or improved by daily exerciſe; and in what manner our other paſſions are refined by terror, has juſt now been ſaid. One thing is certain, that no other meaning can juſtly be given to the foregoing doctrine than that now mentioned; and that it was really Ariſtotle's meaning, appears from his 13th chapter, where he delivers ſeveral propoſitions conformable to the doctrine as here explained. Theſe, at the ſame time, we take the liberty to mention; becauſe, ſo far as authority can go, they confirm the foregoing reaſoning about ſubjects proper for tragedy. The firſt propoſition is, That it being the province of tragedy to excite pity and terror, an innocent perſon falling into adverſity ought never to be the ſubject. This propoſition is a neceſſary conſequence of his doctrine as explained: a ſubject of that nature may indeed excite pity and terror; but the former in an inferior degree, and the latter in no degree for moral inſtruction. The ſecond propoſition is, That the hiſtory of a wicked perſon in a change from miſery to happineſs ought not to be repreſented; which excites neither terror nor compaſſion, nor is agreeable in any reſpect. The third is, That the misfortunes of a wicked perſon ought not to be repreſented: ſuch repreſentation may be agreeable in ſome meaſure upon a principle of juſtice; but it will not move our pity; nor any degree of terror, except in thoſe of the ſame vicious diſpoſition with the perſon repreſented. The laſt propoſition is, That the only character fit for repreſentation lies in the middle, neither eminently good nor eminently bad; where the misfortune is not the effect of deliberate vice, but of ſome involuntary fault, as our author expreſſes it. The only objection we find to Ariſtotle's account of tragedy, is, that he confines it within too narrow bounds, by refuſing admittance to the pathetic kind: for, if terror be eſſential to tragedy, no repreſentation deſerves that name but the moral kind, where the misfortunes exhibited are cauſed by a wrong balance of mind, or ſome diſorder in the internal conſtitution: ſuch misfortunes always ſuggeſt moral inſtruction; and by ſuch misfortunes only can terror be excited for our improvement.

Thus, Ariſtotle's four propoſitions above mentioned relate ſolely to tragedies of the moral kind. Thoſe of the pathetic kind are not confined within ſo narrow limits: ſubjects fitted for the theatre are not in ſuch plenty as to make us reject innocent misfortunes which rouſe our ſympathy, though they inculcate no moral. With reſpect indeed to the ſubjects of that kind, it may be doubted, whether the concluſion ought not always to be fortunate. Where a perſon of integrity is repreſented as ſuffering to the end under misfortunes purely accidental, we depart diſcontented, and with ſome obſcure ſenſe of injuſtice: for ſeldom is man ſo ſubmiſſive to Providence, as not to revolt againſt the tyranny and vexations of blind chance; he will be tempted to ſay, This ought not to be. We give for an example the *Romeo and Juliet* of Shakeſpeare, where the fatal cataſtrophe is occaſioned by Friar Laurence's coming to the monument a minute too late; we are vexed at the unlucky chance, and go away diſſatisfied." Such impreſſions, which ought not to be cheriſhed, are a ſufficient reaſon for excluding ſtories of this kind from the theatre.

The misfortunes of a virtuous perſon, ariſing from neceſſary cauſes, or a chain of unavoidable circumſtances, as they excite a notion of deſtiny, are equally unſatisfactory to the human mind. A metaphyſician in his cloſet may reaſon himſelf into the belief of fate, or what in modern language is called *philoſophical neceſſity*; but the feelings of the heart revolt againſt that doctrine; and we have the confeſſion of the two ableſt philoſophers by whom it was ever maintained, that men conduct themſelves through life as if their will were abſolutely free, and their actions no part of a chain of neceſſary cauſes and effects. As no man goes to the theatre to ſtudy metaphyſics, or to diveſt himſelf of the common feelings of humanity, it is impoſſible, whatever be his philoſophical creed, that he ſhould contemplate without horror and diſguſt an innocent perſon ſuffering by mere deſtiny. A tragedy of uncommon merit in every other reſpect may indeed be endured, nay perhaps admired, though ſuch be its cataſtrophe; becauſe no work of man was ever perfect; and becauſe, where imperfections are unavoidable, a multitude of excellencies may be allowed to cover one fault: but we believe the miſery of an innocent perſon reſulting from a chain of unavoidable circumſtances has never been conſidered as a beauty by minds unperverted by a falſe philoſophy. "It muſt be acknowledged (ſays Blair) that the ſubjects of the ancient Greek tragedies were frequently founded on mere deſtiny and inevitable misfortunes. In the courſe of the drama many moral ſentiments occurred; but the only inſtruction which the fable conveyed was, that reverence was due to the gods, and ſubmiſſion to the decrees of fate. Modern tragedy has aimed at a higher object, by becoming more the theatre of paſſion; pointing out to men the conſequences of their own miſconduct, ſhowing the direful effects which ambition, jealouſy, love, reſentment, and other ſuch ſtrong emotions, when miſguided or left unreſtrained, produce upon human life. An Othello, hurried by jealouſy to murder his innocent wife; a Jaffier enſnared by reſentment and want to engage in a conſpiracy, and then ſtung with remorſe and involved in ruin; a Siffredi, through the deceit which he employs for public-ſpirited ends, bringing deſtruction on all whom he loved: theſe, and ſuch as theſe, are the examples which Tragedy now diſplays to public view; and by means of which it inculcates on men the proper government of their paſſions."

There is indeed one ſingular drama, in which deſtiny is employed in a manner very different from that in which it was uſed by the poets of Greece and Rome. It is Schiller's Tragedy of the Robbers, of which "the hero, endowed by nature (as the tranſlator of the piece obſerves) with the moſt generous feelings, animated by the higheſt ſenſe of honour, and ſuſceptible of the warmeſt affections of the heart, is driven by the perfidy of a brother, and the ſuppoſed inhumanity of his father, into a ſtate of confirmed miſanthropy and deſpair." He wiſhes that he "could blow the trumpet of rebellion through all nature; that he could extinguiſh with one mortal blow the viperous race of men; and that he could ſo ſtrike as to deſtroy the germ of exiſtence." In this ſituation he is hurried on to the perpetration of a ſeries of crimes, which find from their very magnitude and atrocity a recommendation to his diſtempered mind. Senſible all the while of his own guilt, and ſuffering for that guilt the ſevereſt pangs of remorſe, he yet believes himſelf an inſtrument of vengeance in the hand of the Almighty for the puniſhment of the crimes of others. In thus accompliſhing the dreadful deſtiny which is preſcribed for him, he feels a ſpecies of gloomy ſatisfaction, at the ſame time that he conſiders himſelf as doomed to the performance of that part in life which is to conſign his memory to infamy and his ſoul to perdition. After burning a town, he exclaims, "O God of vengeance! am I to blame for this? Art thou to blame, O Father of Heaven! when the inſtruments of thy wrath, the peſtilence, flood, and famine overwhelm at once the righteous and the guilty? Who can command the flames to ſtay their courſe, to deſtroy only the noxious vermin, and ſpare the fertile field?" Yet with the ſame breath he accuſes himſelf of extreme criminality, for "preſumptuouſly wielding the ſword of the Moſt High!" He frequently laments in the moſt affecting manner the loſs of his innocence, wiſhes that "he could return into the womb that bare him, that he hung an infant at the breaſt, that he were born a beggar, the meaneſt hind, a peaſant of the field." He conſiders himſelf as the outcaſt of Heaven, and finally rejected by the Father of mercy: yet he tells the band of robbers whom he commanded, that the "Almighty honoured them as agents in his hands to execute his wondrous purpoſes; employed them as his angels to execute his ſtern decrees, and pour the vials of his wrath;" and, in a very ſolemn prayer, he ſuppoſes that "the God who ruleth over all had *decreed* that he ſhould become the chief of theſe foul murderers."

"It will be allowed, ſays the tranſlator, that the imagination could not have conceived a ſpectacle more deeply intereſting, more powerfully affecting to the mind of man, than that of a human being thus characteriſed and acting under ſuch impreſſions. The compaſſionate intereſt which the mind feels in the emotions or ſufferings of the guilty perſon, is not diminiſhed by the obſervation, that he acts under an impreſſion of inevitable deſtiny; on the contrary, there is ſomething in our nature which leads us the more to compaſſionate the inſtrument of thoſe crimes, that we ſee him conſider himſelf as bound to guilt by fetters, which he has the conſtant wiſh, but not the ſtrength, to break."

This is indeed true: we ſympathiſe with the hero of the Robbers, not only on account of his exalted ſentiments and his inflexible regard to the abſtract principles of honour and juſtice, but much more for that diſorder of intellect which makes him *ſuppoſe* "his deſtiny fixed and unalterable," at the very time that he is torn with remorſe for the perpetration of thoſe crimes by which he believed it to be fulfilling. Deſtiny, however, is not in this tragedy exhibited as real, but merely as the phantom of a diſtempered though noble mind. Had the poet repreſented his hero as in *fact decreed by God*, or *bound by fate*, to head a band of foul murderers, and to commit a ſeries of the moſt atrocious crimes; though our pity for him might not have been leſſened, the impreſſions of the whole piece on the mind could have been only thoſe of horror and diſguſt at what would have appeared to us the unequal ways of providence.

The Tragedy of the Robbers is a ſtriking inſtance of the juſtneſs of Dr. Blair's criticiſm, in oppoſition to that of Lord Kames. His lordſhip holds that it is eſſential to a good Tragedy, that its principal facts be borrowed from hiſtory; becauſe a mixture of known truth with the fable tends to delude us into a conviction of the reality of the whole. The Doctor conſiders this as a matter of no great conſequence; for "it is proved by experience, that a fictitious tale, if properly conducted, will melt the heart as much as any real hiſtory:" this obſervation is verified in the Robbers. It is indeed a very irregular drama, and perhaps could not be acted on a Britiſh theatre. But although the whole is known to be a fiction, we believe there are few effuſions of human genius which more powerfully excite the emotions of terror and pity. Truth is indeed congenial to the mind; and when a ſubject proper for tragedy occurs in hiſtory or tradition, it is perhaps better to adopt it than to invent one which has no ſuch foundation. But in chooſing a ſubject which makes a figure in hiſtory, greater precaution is neceſſary than where the whole is a fiction. In the latter caſe, the author is under no reſtraint other than that the characters and incidents be juſt copies of nature. But where the ſtory is founded on truth, no circumſtances muſt be added, but ſuch as connect naturally with what are known to be true; hiſtory may be ſupplied, but muſt not be contradicted. Further, the ſubject choſen muſt be diſtant in time, or at leaſt in place; for the familiarity of recent perſons and events ought to be avoided. Familiarity ought more eſpecially to be avoided in an epic poem, the peculiar character of which is dignity and elevation: modern manners make but a poor figure in ſuch a poem. Their familiarity unqualifies them for a lofty ſubject. Their dignity will be better underſtood in future ages, when they are no longer familiar.

After Voltaire, no writer, it is probable, will think of rearing an epic poem upon a recent event in the hiſtory of his own country. But an event of that kind is perhaps not altogether unqualified for tragedy: it was admitted in Greece; and Shakeſpeare has employed it ſucceſsfully in ſeveral of his pieces. One advantage it poſſeſſes above fiction, that of more readily engaging our belief, which tends above any other particular to raiſe our ſympathy. The ſcene of comedy is generally laid at home: familiarity is no objection; and we are peculiarly ſenſible of the ridicule of our own manners.

After a proper ſubject is choſen, the dividing it into parts requires ſome art. The concluſion of a book in an epic poem, or of an act in a play, cannot be altogether arbitrary; nor be intended for ſo ſlight a purpoſe as to make the parts of equal length. The ſuppoſed pauſe at the end of every book, and the real pauſe at the end of every act, ought always to coincide with ſome pauſe in the action. In this reſpect, a dramatic or epic poem ought to reſemble a ſentence or period in language, divided into members that are diſtinguiſhed from each other by proper pauſes; or it ought to reſemble a piece of muſic, having a full cloſe at the end, preceded by imperfect cloſes that contribute to the melody. The diviſion of every play into *five* acts has no other foundation than common practice, and the authority of Horace *. It is a diviſion purely arbitrary; there is nothing in the nature of the compoſition which fixes this number rather than any other; and it had been much better if no ſuch number had been aſcertained. But, ſince it is aſcertained, every act in a dramatic poem ought to cloſe with ſome incident that makes a pauſe in the action; for otherwiſe there can be no pretext for interrupting the repreſentation. It would be abſurd to break off in the very heat of action; againſt which every one would exclaim: the abſurdity ſtill remains where the action relents, if it be not actually ſuſpended for ſome time. This rule is alſo applicable to an epic poem; though in it a deviation from the rule is leſs remarkable; becauſe it is in the reader's power to hide the abſurdity, by proceeding inſtantly to another book. The firſt book of Paradiſe Loſt ends without any cloſe, perfect or imperfect: it breaks off abruptly, where Satan, ſeated on his throne, is prepared to harangue the convocated hoſt of the fallen angels; and the ſecond book begins with the ſpeech. Milton ſeems to have copied the Æneid, of which the two firſt books are divided much in the ſame manner. Neither is there any proper pauſe at the end of the ſeventh book of Paradiſe Loſt, nor at the end of the eleventh. In the Iliad little attention is given to this rule.

Beſides tragedy, dramatic poetry comprehends comedy and farce. Theſe are ſufficiently diſtinguiſhed from tragedy by their general ſpirit and ſtrain. "While pity and terror, and the other ſtrong paſſions, form the province of the tragic muſe, the chief or rather ſole inſtrument of comedy and farce is ridicule." Theſe two ſpecies of compoſition are ſo perpetually running into each other, that we ſhall not treat of them ſeparately; ſince what is now known by the name of *farce* differs in nothing eſſential from what was called the *old comedy* among the Greeks. "Comedy (ſays Blair) propoſes for its object neither the great ſufferings nor the great crimes of men; but their follies and ſlighter vices, thoſe parts of their character which raiſe in beholders a ſenſe of impropriety, which expoſe them to be cenſured and laughed at by others, or which render them troubleſome in civil ſociety.

"The ſubjects of tragedy are not limited to any age or country; but the ſcene and ſubject of comedy ſhould always be laid in our own country, and in our own times. The reaſon is obvious; thoſe decorums of behaviour, thoſe leſſer diſcriminations of character, which afford ſubject for comedy, change with the differences of countries and times; and can never be ſo well underſtood by foreigners as by natives. The comic poet, who aims at correcting improprieties and follies of behaviour, ſhould 'catch the manners living as they riſe.' It is not his buſineſs to amuſe us with a tale of other times; but to give us pictures taken from among ourſelves; to ſatirize reigning and preſent vices; to exhibit to the age a faithful copy of itſelf, with its humours, its follies, and its extravagancies.

"Comedy may be divided into two kinds: comedy of *character*, and comedy of *intrigue*. The former is the more valuable ſpecies; becauſe it is the buſineſs of comedy to exhibit the prevailing manners which mark the character of the age in which the ſcene is laid: yet there ſhould be always as much intrigue as to give us ſomething to wiſh and ſomething to fear. The incidents ſhould ſo ſucceed one another, as to produce ſtriking ſituations, and to fix our attention; while they afford at the ſame time a proper field for the exhibition of character. The action in comedy, though it demands the poet's care in order to render it animated and natural, is a leſs ſignificant and important part of the performance than the action in tragedy: as in comedy it is what men ſay, and how they behave, that draws our attention, rather than what they perform or what they ſuffer.

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* *Neve minor, neu ſit quinto productior actu*
Fabula. De Arte Poetica.

If you would have your play deſerve ſucceſs,
Give it five acts complete, nor more nor leſs. *Francis.*

“ In the management of characters, one of the moſt common faults of comic writers is the carrying of them too far beyond life. Wherever ridicule is concerned, it is indeed extremely difficult to hit the preciſe point where true wit ends and buffoonery begins. When the miſer in Plautus, ſearching the perſon whom he ſuſpects of having ſtolen his caſket, after examining firſt his right hand and then his left, cries out, *Oſtende etiam tertiam*—‘ Show me your third hand,’ there is no one but muſt be ſenſible of the extravagance. Certain degrees of exaggeration are allowed to the comedian, but there are limits ſet to it by nature and good taſte; and ſuppoſing the miſer to be ever ſo much engroſſed by his jealouſy and his ſuſpicions, it is impoſſible to conceive any man in his wits ſuſpecting another of having more than two hands.”

It appears from the plays of Ariſtophanes, which remain, that the characters in the old comedy of Athens were almoſt always overcharged. They were likewiſe directed and avowed ſatires againſt particular perſons, who were brought upon the ſtage by name. “ The ridicule employed in them is extravagant, the wit for the moſt part buffooniſh and farcical, the raillery biting and cruel, and the obſcenity that reigns in them is groſs and intolerable. They ſeem to have been compoſed merely for the mob.” Yet of theſe abominable dramas, Hurd has affirmed, with too much truth, that what is now called *farce* is nothing more than the ſhadow. The characters in genuine comedy are not thoſe of particular and known perſons, but the general characters of the age and nation; which it requires no ſmall ſkill to diſtinguiſh clearly and naturally from each other. In attempting this, poets are too apt to contraſt characters and introduce them always in pairs; which gives an affected air to the whole piece. The perfection of art is to conceal art. A maſterly writer will give us his characters diſtinguiſhed rather by ſuch ſhades of diverſity as are commonly found in ſociety, than marked with ſuch ſtrong oppoſitions as are rarely brought into actual contraſt in any of the circumſtances of real life.”

The ſtyle of comedy ought to be pure, elegant, and lively, very ſeldom riſing higher than the ordinary tone of polite converſation; and upon no occaſion deſcending into vulgar, mean, and groſs expreſſions; and in one word, action and character being the fundamental parts of every epic and dramatic compoſition, the ſentiments and tone of language ought to be ſubſervient to theſe, ſo as to appear natural and proper for the occaſion.

§ 2. *Reſpective Peculiarities of the Epopee and Drama.*

In a theatrical entertainment, which employs both the eye and the ear, it would be a groſs abſurdity to introduce upon the ſtage ſuperior beings in a viſible ſhape. There is no place for ſuch objection in an *epic poem*; and Boileau, with many other critics, declares ſtrongly for that ſort of machinery in an epic poem. But waving authority, which is apt to impoſe upon the judgment, let us draw what light we can from reaſon. We may in the firſt place obſerve, that this matter is but indiſtinctly handled by critics: the poetical privilege of animating inſenſible objects for enlivening a deſcription, is very different from what is termed *machinery*, where deities, angels, devils, or other ſupernatural powers, are introduced as real perſonages, mixing in the action, and contributing to the cataſtrophe; and yet theſe two things are conſtantly jumbled together in reaſoning. The former is founded on a natural principle: but nothing is more unnatural than the latter. Its effects, at the ſame time, are deplorable. Firſt, it gives an air of fiction to the whole; and prevents that impreſſion of reality which is requiſite to intereſt our affections, and to move our paſſions; which of itſelf is ſufficient to explode machinery, whatever entertainment it may afford to readers of a fantaſtic taſte or irregular imagination. And, next, were it poſſible, by diſguiſing the fiction, to delude us into a notion of reality, an inſuperable objection would ſtill remain, which is, that the aim or end of an epic poem can never be attained in any perfection where machinery is introduced; for an evident reaſon, that virtuous emotions cannot be raiſed ſucceſsfully but by the actions of thoſe who are endued with paſſions and affections like our own, that is, by human actions; and as for moral inſtruction, it is clear, that none can be drawn from beings who act not upon the ſame principles with us. A fable in Æſop's manner is no objection to this reaſoning: his lions, bulls, and goats, are truly men under diſguiſe; they act and feel in every reſpect as human beings; and the moral we draw is founded on that ſuppoſition. Homer, it is true, introduces the gods into his fable: but the religion of his country authoriſed that liberty; it being an article in the Grecian creed, that the gods often interpoſe viſibly and bodily in human affairs. It muſt however be obſerved, that Homer's deities do no honour to his poems; fictions that tranſgreſs the bounds of nature, ſeldom have a good effect; they may inflame the imagination for a moment, but will not be reliſhed by any perſon of a correct taſte. They may be of ſome uſe to the lower rank of writers; but an author of genius has much finer materials, of Nature's production, for elevating his ſubject, and making it intereſting.

One would be apt to think, that Boileau, declaring for the Heathen deities, intended them only for embelliſhing the diction: but unluckily he baniſhes angels and devils, who undoubtedly make a figure in poetic language, equal to the Heathen deities. Boileau, therefore, by pleading for the latter in oppoſition to the former, certainly meant, if he had any diſtinct meaning, that the Heathen deities may be introduced as actors. And, in fact, he himſelf is guilty of that glaring abſurdity, where it is not ſo pardonable as in an epic poem: In his ode upon the taking of Namur, he demands with a moſt ſerious countenance, whether the walls were built by Apollo or Neptune: and in relating the paſſage of the Rhine, *anno* 1672, he deſcribes the god of that river as fighting with all his might to oppoſe the French monarch; which is confounding fiction with reality at a ſtrange rate. The French writers in general run into this error: wonderful the effect of cuſtom, entirely to hide from them how ridiculous ſuch fictions are!

That this is a capital error in *Gieruſalemme Liberata*, Taſſo's greateſt admirers muſt acknowledge: a ſituation can never be intricate, nor the reader ever in pain about the cataſtrophe, ſo long as there is an angel, devil, or magician, to lend a helping hand. Voltaire, in his eſſay upon epic poetry, talking of the *Pharſalia*, obſerves judiciouſly, “ That the proximity of time, the notoriety of events, the character of the age, enlightened and political, joined with the ſolidity of Lucan's ſubject, deprived him of poetical fiction.” Is it not amazing, that a critic who reaſons ſo juſtly with reſpect to others, can be ſo blind with reſpect to himſelf? Voltaire, not ſatiſfied to enrich his language with images drawn from inviſible and ſuperior beings, introduces them into the action: in the ſixth canto of the *Henriade*, St. Louis appears in perſon, and terrifies the ſoldiers; in the ſeventh canto, St. Louis ſends the god of Sleep to Henry; and, in the tenth, the demons of Diſcord, Fanaticiſm, War, &c. aſſiſt Aumale in a ſingle combat with Turenne, and are driven away by a good angel brandiſhing the ſword of God. To blend ſuch fictitious perſonages in the ſame action with mortals, makes a bad figure at any rate; and is intolerable in a hiſtory ſo recent as that of Henry IV. But perfection is not the lot of man.

But perhaps the moſt ſucceſsful weapon that can be employed upon this ſubject is ridicule. Addiſon has applied this in an elegant manner: “ Whereas the time of general peace is, in all appearance, drawing near; being informed that there are ſeveral ingenious perſons who intend to ſhow their talents on ſo happy an occaſion, and being willing, as much as in me lies, to prevent that effuſion of nonſenſe which we have good cauſe to apprehend; I do hereby ſtrictly require every perſon who ſhall write on this ſubject, to remember that he is a Chriſtian, and not to ſacrifice his catechiſm to his poetry. In order to it, I do expect of him, in the firſt place, to make his own poem, without depending upon Phœbus for any part of it, or calling out for aid upon any of the muſes by name. I do likewiſe poſitively forbid the ſending of Mercury with any particular meſſage or diſpatch relating to the peace; and ſhall by no means ſuffer Minerva to take upon her the ſhape of any plenipotentiary concerned in this great work. I do further declare, that I ſhall not allow the Deſtinies to have had a hand in the deaths of the ſeveral thouſands who have been ſlain in the late war; being of opinion that all ſuch deaths may be well accounted for by the Chriſtian ſyſtem of powder and ball. I do therefore ſtrictly forbid the Fates to cut the thread of man's life upon any pretence whatſoever, unleſs it be for the ſake of rhyme. And whereas I have good reaſon to fear, that Neptune will have a great deal of buſineſs on his hands in ſeveral poems which we may now ſuppoſe are upon the anvil, I do alſo prohibit his appearance, unleſs it be done in metaphor, ſimile, or any very ſhort alluſion; and that even here he may not be permitted to enter, but with great caution and circumſpection. I deſire that the ſame rule may be extended to his whole fraternity of Heathen gods; it being my deſign to condemn every poem to the flames in which Jupiter thunders, or exerciſes any other act of authority which does not belong to him. In ſhort, I expect that no Pagan agent ſhall be introduced, or any fact related which a man cannot give credit to with a good conſcience. Provided always, that nothing herein contained ſhall extend, or be conſtrued to extend, to ſeveral of the female poets in this nation, who ſhall ſtill be left in full poſſeſſion of their gods and goddeſſes, in the ſame manner as if this paper had never been written." *Spect.* No. 523.

The marvellous is indeed ſo much promoted by machinery, that it is not wonderful to find it embraced by the bulk of writers, and perhaps of readers. If indulged at all, it is generally indulged to exceſs. Homer introduceth his deities with no greater ceremony than his mortals; and Virgil has ſtill leſs moderation: a pilot ſpent with watching cannot fall aſleep and drop into the ſea by natural means: one bed cannot receive the two lovers Æneas and Dido, without the immediate interpoſition of ſuperior powers. The ridiculous in ſuch fictions muſt appear even through the thickeſt veil of gravity and ſolemnity.

Angels and devils ſerve equally with Heathen deities as materials for figurative language; perhaps better among Chriſtians, becauſe we believe in them, and not in Heathen deities. But every one is ſenſible, as well as Boileau, that the inviſible powers in our creed make a much worſe figure as actors in a modern poem than the inviſible powers in the Heathen creed did in ancient poems; the cauſe of which is not far to ſeek. The Heathen deities, in the opinion of their votaries, were beings elevated one ſtep only above mankind, ſubject to the ſame paſſions, and directed by the ſame motives; therefore not altogether improper to mix with men in an important action. In our creed, ſuperior beings are placed at ſuch a mighty diſtance from us, and are of a nature ſo different, that with no propriety can we appear with them upon the ſame ſtage: man, a creature much inferior, loſes all dignity in the compariſon.

There can be no doubt that a hiſtorical poem admits the embelliſhment of allegory as well as of metaphor, ſimile or other figure. Moral truth, in particular, is finely illuſtrated in the allegorical manner: it amuſes the fancy to find abſtract terms, by a ſort of magic, metamorphoſed into active beings; and it is delightful to trace a general propoſition in a pictured event. But allegorical beings ſhould be confined within their own ſphere, and never be admitted to mix in the principal action, nor to co-operate in retarding or advancing the cataſtrophe; which would have a ſtill worſe effect than inviſible powers: for the impreſſion of real exiſtence, eſſential to an epic poem, is inconſiſtent with that figurative exiſtence which is eſſential to an allegory; and therefore no method can more effectually prevent the impreſſion of reality than the introduction of allegorical beings co-operating with thoſe whom we conceive to be really exiſting. The lôve-epiſode in the Henriade (canto 9.), inſufferable by the diſcordant mixture of allegory with real life, is copied from that of Rinaldo and Armida in the *Gieruſalemme Liberata*, which hath no merit to entitle it to be copied. An allegorical object, ſuch as Fame in the Æneid, and the Temple of Love in the Henriade, may find place in a deſcription: but to introduce Diſcord as a real perſonage, imploring the aſſiſtance of Love as another real perſonage, to enervate the courage of the hero, is making theſe figurative beings act beyond their ſphere, and creating a ſtrange jumble of truth and fiction. The allegory of Sin and Death in the Paradiſe Loſt is poſſibly not generally reliſhed, though it is not entirely of the ſame nature with what we have been condemning; in a work comprehending the achievements of ſuperior beings there is more room for fancy than where it is confined to human actions.

What is the true notion of an epiſode? or how is it to be diſtinguiſhed from the principal action? Every incident that promotes or retards the cataſtrophe muſt be part of the principal action. This clears the nature of an epiſode; which may be defined, "An incident connected with the principal action, but contributing neither to advance nor retard it." The deſcent of Æneas into hell does not advance nor retard the cataſtrophe, and therefore is an epiſode. The ſtory of Niſus and Euryalus, producing an alteration in the affairs of the contending parties, is a part of the principal action. The family-ſcene in the ſixth book of the Iliad is of the ſame nature; for, by Hector's retiring from the field of battle to viſit his wife, the Grecians had opportunity to breathe, and even to turn upon the Trojans. The unavoidable effect of an epiſode according to this definition muſt be, to break the unity of action; and therefore it ought never to be indulged unleſs to unbend the mind after the fatigue of a long narration. An epiſode, when ſuch is its purpoſe, requires the following conditions: it ought to be well connected with the principal action; it ought to be lively and intereſting; it ought to be ſhort; and a time ought to be choſen when the principal action relents *.

In the following beautiful epiſode, which cloſes the ſecond book of Fingal, all theſe conditions are united.

"Comal was a ſon of Albion; the chief of a hundred hills. His deer drunk of a thouſand ſtreams; and a thouſand rocks replied to the voice of his dogs. His face was the mildneſs of youth; but his hand the death of heroes. One was his love, and fair was ſhe! the daughter of mighty Conloch. She appeared like a ſun-beam among women, and her hair was like the wing of the raven. Her ſoul was fixed on Comal, and ſhe was his companion in the chace. Often met their eyes of love, and happy were their words in ſecret. But Gormal loved the maid, the chief of gloomy Ardven. He watched her lone ſteps on the heath, the foe of unhappy Comal.

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* Homer's deſcription of the ſhield of Achilles is properly introduced at a time when the action relents, and the reader can bear an interruption. But the author of Telemachus deſcribes the ſhield of that young hero in the heat of battle; a very improper time for an interruption.

"One day, tired of the chace, when the miſt had concealed their friends, Comal and the daughter of Conloch met in the cave of Ronan. It was the wonted haunt of Comal. Its ſides were hung with his arms; a hundred ſhields of thongs were there, a hundred helms of ſounding ſteel. Reſt here, ſaid he, my love Galvina, thou light of the cave of Ronan! A deer appears on Mora's brow; I go, but ſoon will return. I fear, ſaid ſhe, dark Gormal my foe: I will reſt here; but ſoon return, my love.

"He went to the deer of Mora. The daughter of Conloch, to try his love, clothed her white ſide with his armour, and ſtrode from the cave of Ronan. Thinking her his foe, his heart beat high, and his colour changed. He drew the bow: the arrow flew: Galvina fell in blood. He ran to the cave with haſty ſteps, and called the daughter of Conloch. Where art thou, my love? but no anſwer.——He marked, at length, her heaving heart beating againſt the mortal arrow. O Conloch's daughter, is it thou!—He ſunk upon her breaſt.

"The hunters found the hapleſs pair. Many and ſilent were his ſteps round the dark dwellings of his love. The fleet of the ocean came: he fought, and the ſtrangers fell: he ſearched for death over the field; but who could kill the mighty Comal? Throwing away his ſhield, an arrow found his manly breaſt. He ſleeps with his Galvina: their green tombs are ſeen by the mariner when he bounds on the waves of the north."

Next, upon the peculiarities of a *dramatic poem*. And the firſt we ſhall mention is a double plot: one of which muſt reſemble an epiſode in an epic poem; for it would diſtract the ſpectator, inſtead of entertaining him, if he were forced to attend at the ſame time to two capital plots equally intereſting. And even ſuppoſing it an under-plot like an epiſode, it ſeldom hath a good effect in tragedy, of which ſimplicity is a chief property; for an intereſting ſubject that engages our affections, occupies our whole attention, and leaves no room for any ſeparate concern. Variety is more tolerable in comedy; which pretends only to amuſe, without totally occupying, the mind. But even there, to make a double plot agreeable, is no ſlight effort of art: the under-plot ought not to vary greatly in its tone from the principal; for diſcordant emotions are unpleaſant when jumbled together; which, by the way, is an inſuperable objection to tragi-comedy. Upon that account the Provok'd Huſband deſerves cenſure; all the ſcenes that bring the family of the Wrongheads into action, being ludicrous and farcical, are in a very different tone from the principal ſcenes, diſplaying ſevere and bitter expoſtulations between Lord Townley and his lady. The ſame objection touches not the double plot of the Careleſs Huſband; the different ſubjects being ſweetly connected, and having only ſo much variety as to reſemble ſhades of colours harmoniouſly mixed. But this is not all. The under-plot ought to be connected with that which is principal, ſo much at leaſt as to employ the ſame perſons: the under-plot ought to occupy the intervals or pauſes of the principal action; and both ought to be concluded together. This is the caſe of the Merry Wives of Windſor.

Violent action ought never to be repreſented on the ſtage. While the dialogue goes on, a thouſand particulars concur to delude us into an impreſſion of reality; genuine ſentiments, paſſionate language, and perſuaſive geſture: the ſpectator, once engaged, is willing to be deceived, loſes ſight of himſelf, and without ſcruple enjoys the ſpectacle as a reality. From this abſent ſtate he is rouſed by violent action; he wakes as from a pleaſing dream; and, gathering his ſenſes about him, finds all to be a fiction. Horace delivers the ſame rule; and founds it upon the ſame reaſon:

> Ne pueros coram populo Medea trucidet;
> Aut humana palam coquat exta nefarius Atreus;
> Aut in avem Progne vertatur, Cadmus in anguem:
> Quodcumque oſtendis mihi ſic, incredulus odi.

The French critics join with Horace in excluding blood from the ſtage; but, overlooking the moſt ſubſtantial objection, they urge only that it is barbarous and ſhocking to a polite audience. The Greeks had no notion of ſuch delicacy, or rather effeminacy; witneſs the murder of Clytemneſtra by her ſon Oreſtes, paſſing behind the ſcene, as repreſented by Sophocles: her voice is heard calling out for mercy, bitter expoſtulations on his part, loud ſhrieks upon her being ſtabbed, and then a deep ſilence. An appeal may be made to every perſon of feeling, whether this ſcene be not more horrible than if the deed had been committed in ſight of the ſpectators upon a ſudden guſt of paſſion. If Corneille, in repreſenting the affair between Horatius and his ſiſter, upon which the murder enſues behind the ſcene, had no other view but to remove from the ſpectators a ſhocking action, he was guilty of a capital miſtake: for murder in cold blood, which in ſome meaſure was the caſe as repreſented, is more ſhocking to a polite audience, even where the concluſive ſtab is not ſeen, than the ſame act performed in their preſence by violent and unpremeditated paſſion, as ſuddenly repented of as committed. Addiſon's obſervation is juſt; that no part of this incident ought to have been repreſented, but reſerved for a narrative, with every alleviating circumſtance in favour of the hero.

A few words upon the dialogue, which ought to be ſo conducted as to be a true repreſentation of nature. We talk not here of the ſentiments nor of the language (which are treated elſewhere): but of what properly belongs to dialogue-writing; where every ſingle ſpeech, ſhort or long, ought to ariſe from what is ſaid by the former ſpeaker, and furniſh matter for what comes after till the end of the ſcene. In this view, all the ſpeeches from firſt to laſt repreſent ſo many links of one regular chain. No author, ancient or modern, poſſeſſes the art of dialogue equal to Shakeſpeare. Dryden, in that particular, may juſtly be placed as his oppoſite. He frequently introduces three or four perſons ſpeaking upon the ſame ſubject, each throwing out his own notions ſeparately, without regarding what is ſaid by the reſt: take for an example the firſt ſcene of Aurengzebe. Sometimes he makes a number club in relating an event, not to a ſtranger ſuppoſed ignorant of it, but to one another, for the ſake merely of ſpeaking: of which notable ſort of dialogue we have a ſpecimen in the firſt ſcene of the firſt part of the Conqueſt of Granada. In the ſecond part of the ſame tragedy, ſcene ſecond, the King, Abenamar, and Zulema, make their ſeparate obſervations, like ſo many ſoliloquies, upon the fluctuating temper of the mob: a dialogue ſo uncouth puts one in mind of two ſhepherds in a paſtoral excited by a prize to pronounce verſes alternately, each in praiſe of his own miſtreſs.

This manner of dialogue-writing, beſide an unnatural air, has another bad effect: it ſtays the courſe of the action, becauſe it is not productive of any conſequence. In Congreve's comedies, the action is often ſuſpended to make way for a play of wit.

No fault is more common among writers than to prolong a ſpeech after the impatience of the perſon to whom it is addreſſed ought to prompt him or her to break in. Conſider only how the impatient actor is to behave in the mean time. To expreſs his impatience in violent action without interrupting would be unnatural; and yet to diſſemble his impatience, by appearing cool where he ought to be highly inflamed, would be no leſs ſo.

Rhyme being unnatural and diſguſtful in dialogue, is happily baniſhed from our theatre: the only wonder is that it ever found admittance, eſpecially among a people accuſtomed to the more manly freedom of Shakeſpeare's dialogue. By baniſhing rhyme, we have gained ſo much as never once to dream that there can be any further improvement. And yet, however ſuitable blank verſe may be to elevated characters and warm paſſions, it muſt appear improper and affected in the mouths of the lower ſort. Why then ſhould it be a rule, That every ſcene in tragedy muſt be in blank verſe? Shakeſpeare, with great judgment, has followed a different rule; which is, to intermix proſe with verſe, and only to employ the latter where it is required by the importance or dignity of the ſubject. Familiar thoughts and ordinary facts ought to be expreſſed in plain language: to hear, for example, a footman deliver a ſimple meſſage in blank verſe muſt appear ridiculous to every one who is not biaſſed by cuſtom. In ſhort, that variety of characters and of ſituations, which is the life of a play, requires not only a ſuitable variety in the ſentiments, but alſo in the diction.

§ 3. *The Three Unities.*

WHEN we conſider the chain of cauſes and effects in the material world, independent of purpoſe, deſign, or thought, we find a number of incidents in ſucceſſion, without beginning, middle, or end: every thing that happens is both a cauſe and an effect; being the effect of what goes before, and the cauſe of what follows: one incident may affect us more, another leſs; but all of them are links in the univerſal chain: the mind, in viewing theſe incidents, cannot reſt or ſettle ultimately upon any one; but is carried along in the train without any cloſe.

But when the intellectual world is taken under view, in conjunction with the material, the ſcene is varied. Man acts with deliberation, will, and choice: he aims at ſome end; glory, for example, or riches, or conqueſt, the procuring happineſs to individuals, or to his country in general: he propoſes means, and lays plans to attain the end propoſed. Here are a number of facts or incidents leading to the end in view, the whole compoſing one chain by the relation of cauſe and effect. In running over a ſeries of ſuch facts or incidents, we cannot reſt upon any one; becauſe they are preſented to us as means only, leading to ſome end: but we reſt with ſatisfaction upon the end or ultimate event; becauſe there the purpoſe or aim of the chief perſon or perſons is accompliſhed. This indicates the beginning, the middle, and the end, of what Ariſtotle calls *an entire action*. The ſtory naturally begins with deſcribing thoſe circumſtances which move the perſon who acts the principal part to form a plan, in order to compaſs ſome deſired event; the proſecution of that plan, and the obſtructions, carry the reader into the heat of action; the middle is properly where the action is the moſt involved; and the end is where the event is brought about, and the plan accompliſhed.

We have given the foregoing example of a plan crowned with ſucceſs, becauſe it affords the cleareſt conception of a beginning, a middle, and an end, in which conſiſts *unity* of action; and indeed ſtricter unity cannot be imagined than in that caſe. But an action may have unity, or a beginning, middle, and an end, without ſo intimate a relation of parts; as where the cataſtrophe is different from what is intended or deſired, which frequently happens in our beſt tragedies. In the Æneid, the hero, after many obſtructions, makes his plan effectual. The Iliad is formed upon a different model: it begins with the quarrel between Achilles and Agamemnon; goes on to deſcribe the ſeveral effects produced by that cauſe; and ends in a reconciliation. Here is unity of action, no doubt, a beginning, a middle, and an end; but inferior to that of the Æneid, which will thus appear. The mind hath a propenſity to go forward in the chain of hiſtory; it keeps always in view the expected event; and when the incidents or underparts are connected by their relation to the event, the mind runs ſweetly and eaſily along them. This pleaſure we have in the Æneid. It is not altogether ſo pleaſant to connect, as in the Iliad, effects by their common cauſe; for ſuch connection forces the mind to a continual retroſpect: looking backward is like walking backward.

If unity of action be a capital beauty in fable imitative of human affairs, a plurality of unconnected fables muſt be a capital deformity. For the ſake of variety, we indulge an underplot that is connected with the principal: but two unconnected events are extremely unpleaſant, even where the ſame actors are engaged in both. Arioſto is quite licentious in that particular: he carries on at the ſame time a plurality of unconnected ſtories. His only excuſe is, that his plan is perfectly well adjuſted to his ſubject; for every thing in the *Orlando Furioſo* is wild and extravagant.

Though to ſtate facts in the order of time is natural, yet that order may be varied for the ſake of conſpicuous beauties. If, for example, a noted ſtory, cold and ſimple in its firſt movements, be made the ſubject of an epic poem, the reader may be hurried into the heat of action; reſerving the preliminaries for a converſation-piece, if thought neceſſary: and that method, at the ſame time, hath a peculiar beauty from being dramatic. But a privilege that deviates from nature ought to be ſparingly indulged; and yet romance-writers make no difficulty of preſenting to the reader, without the leaſt preparation, unknown perſons engaged in ſome arduous adventure equally unknown. In Caſſandra, two perſonages, who afterwards are diſcovered to be the heroes of the fable, ſtart up completely armed upon the banks of the Euphrates, and engage in a ſingle combat.

A play analyſed is a chain of connected facts, of which each ſcene makes a link. Each ſcene, accordingly, ought to produce ſome incident relative to the cataſtrophe or ultimate event, by advancing or retarding it. A ſcene that produceth no incident, and for that reaſon may be termed *barren*, ought not to be indulged, becauſe it breaks the unity of action: a barren ſcene can never be entitled to a place, becauſe the chain is complete without it. In the Old Bachelor, the 3d ſcene of act 2. and all that follow to the end of that act, are mere converſation-pieces, productive of no conſequence. The 10th and 11th ſcenes, act 3. Double Dealer, and the 10th, 11th, 12th, 13th, and 14th ſcenes, act 1 Love for Love, are of the ſame kind. Neither is The Way of the World entirely guiltleſs of ſuch ſcenes. It will be no juſtification that they help to diſplay characters: it were better, like Dryden in his *dramatis perſonæ*, to deſcribe characters beforehand; which would not break the chain of action. But a writer of genius has no occaſion for ſuch artifice: he can diſplay the characters of his perſonages much more to the life in ſentiment and action. How ſucceſsfully is this done by Shakeſpeare! in whoſe works there is not to be found a ſingle barren ſcene.

Upon the whole, it appears, that all the facts in an hiſtorical fable ought to have a mutual connection, by their common relation to the grand event or cataſtrophe. And this relation, in which the *unity* of action conſiſts, is equally eſſential to epic and dramatic compoſitions.

How far the unities of time and of place are eſſential, is a queſtion of greater intricacy. Theſe unities were ſtrictly obſerved in the Greek and Roman theatres; and they are inculcated by the French and Engliſh critics as eſſential to every dramatic compoſition. In theory theſe unities are alſo acknowledged by our beſt poets, though their practice ſeldom correſponds: they are often forced to take liberties, which they pretend not to juſtify, againſt the practice of the Greeks and Romans, and againſt the ſolemn deciſion of their own countrymen. But in the courſe of this inquiry it will be made evident, that in this article we are under no neceſſity to copy the ancients; and that our critics are guilty of a miſtake, in admitting no greater latitude of place and time than was admitted in Greece and Rome.

Indeed the unities of place and time are not, by the moſt rigid critics, required in a narrative poem. In ſuch compoſition, if it pretend to copy nature, theſe unities would be abſurd; becauſe real events are ſeldom confined within narrow limits either of place or of time: and yet we can follow hiſtory, or an hiſtorical fable, through all its changes, with the greateſt facility: we never once think of meaſuring the real time by what is taken in reading; nor of forming any connection between the place of action and that which we occupy.

We are aware, that the drama differs ſo far from the epic as to admit different rules. It will be obſerved, "That an hiſtorical fable, intended for reading ſolely, is under no limitation of time or of place more than a genuine hiſtory; but that a dramatic compoſition cannot be accurately repreſented unleſs it be limited, as its repreſentation is, to one place and to a few hours; and therefore that no fable can be admitted but what has theſe properties, becauſe it would be abſurd to compoſe a piece for repreſentation that cannot be juſtly repreſented." This argument has at leaſt a plauſible appearance; and yet one is apt to ſuſpect ſome fallacy, conſidering that no critic, however ſtrict, has ventured to confine the unities of place and of time within ſo narrow bounds.

A view of the Grecian drama, compared with our own, may perhaps relieve us from this dilemma: if they be differently conſtructed, as ſhall be made evident, it is poſſible that the foregoing reaſoning may not be equally applicable to both.

All authors agree, that tragedy in Greece was derived from the hymns in praiſe of Bacchus, which were ſung in parts by a chorus. Theſpis, to relieve the ſingers, and for the ſake of variety, introduced one actor, whoſe province it was to explain hiſtorically the ſubject of the ſong, and who occaſionally repreſented one or other perſonage. Eſchylus, introducing a ſecond actor, formed the dialogue; by which the performance became dramatic; and the actors were multiplied when the ſubject repreſented made it neceſſary. But ſtill the chorus, which gave a beginning to tragedy, was conſidered as an eſſential part. The firſt ſcene, generally, unfolds the preliminary circumſtances that lead to the grand event; and this ſcene is by Ariſtotle termed the *prologue*. In the ſecond ſcene, where the action properly begins, the chorus is introduced, which, as originally, continues upon the ſtage during the whole performance: the chorus frequently makes one in the dialogue; and when the dialogue happens to be ſuſpended, the chorus, during the interval, is employed in ſinging. Sophocles adheres to this plan religiouſly. Euripides is not altogether ſo correct. In ſome of his pieces it becomes neceſſary to remove the chorus for a little time: but when that unuſual ſtep is riſked, matters are ſo ordered as not to interrupt the repreſentation: the chorus never leave the ſtage of their own accord, but at the command of ſome principal perſonage, who conſtantly waits their return.

Thus, the Grecian drama is a continued repreſentation without any interruption; a circumſtance that merits attention. A continued repreſentation without a pauſe affords not opportunity to vary the place of action, nor to prolong the time of the action beyond that of the repreſentation. To a repreſentation ſo confined in place and time the foregoing reaſoning is ſtrictly applicable: a real or feigned action that is brought to a concluſion after conſiderable intervals of time and frequent changes of place cannot accurately be copied in a repreſentation that admits no latitude in either. Hence it is, that the unities of place and of time were, or ought to have been, ſtrictly obſerved in the Greek tragedies; which is made neceſſary by the very conſtitution of their drama, for it is abſurd to compoſe a tragedy that cannot be juſtly repreſented.

Modern critics, who for our drama pretend to eſtabliſh rules founded on the practice of the Greeks, are guilty of an egregious blunder. The unities of place and of time were in Greece, as we ſee, a matter of neceſſity, not of choice; and it is eaſy to ſhow, that, if we ſubmit to ſuch fetters, it muſt be from choice, not neceſſity. This will be evident upon taking a view of the conſtitution of our drama, which differs widely from that of Greece; whether more or leſs perfect, is a different point, to be handled afterward. By dropping the chorus, opportunity is afforded to divide the repreſentation by intervals of time, during which the ſtage is evacuated and the ſpectacle ſuſpended. This qualifies our drama for ſubjects ſpread through a wide ſpace both of time and of place. the time ſuppoſed to paſs during the ſuſpenſion of the repreſentation is not meaſured by the time of the ſuſpenſion; and any place may be ſuppoſed, as it is not in ſight: by which means, many ſubjects can juſtly be repreſented in our theatres, that were excluded from thoſe of ancient Greece. This doctrine may be illuſtrated, by comparing a modern play to a ſet of hiſtorical pictures; let us ſuppoſe them five in number, and the reſemblance will be complete: each of the pictures reſembles an act in one of our plays: there muſt neceſſarily be the ſtricteſt unity of place and of time in each picture; and the ſame neceſſity requires theſe two unities during each act of a play, becauſe during an act there is no interruption in the ſpectacle. Now, when we view in ſucceſſion a number of ſuch hiſtorical pictures, let it be, for example, the Hiſtory of Alexander by Le Brun, we have no difficulty to conceive, that months or years have paſſed between the events exhibited in two different pictures, though the interruption is imperceptible in paſſing our eye from the one to the other; and we have as little difficulty to conceive a change of place, however great: in which view, there is truly no difference between five acts of a modern play and five ſuch pictures. Where the repreſentation is ſuſpended, we can with the greateſt facility ſuppoſe any length of time or any change of place: the ſpectator, it is true, may be conſcious, that the real time and place are not the ſame with what are employed in the repreſentation; but this is a work of reflection; and by the ſame reflection he may alſo be conſcious, that Garrick is not King Lear, that the playhouſe is not Dover cliffs, nor the noiſe he hears thunder and lightning. In a word, after an interruption of the repreſentation, it is not more difficult for a ſpectator to imagine a new place, or a different time, than, at the commencement of the play, to imagine himſelf at Rome, or in a period of time two thouſand years back. And indeed it is abundantly ridiculous that a critic, who is willing to hold candle-light for ſun-ſhine, and ſome painted canvaſſes for a palace or a priſon, ſhould affect ſo much difficulty in imagining a latitude of place or of time in the fable, beyond what is neceſſary in the repreſentation.

There are, it muſt be acknowledged, ſome effects of great latitude in time that ought never to be indulged in a compoſition for the theatre: nothing can be more abſurd, than at the cloſe to exhibit a full-grown perſon who appears a child at the beginning: the mind rejects, as contrary to all probability, ſuch latitude of time as is requiſite for a change ſo remarkable. The greateſt change from place to place hath not altogether the ſame bad effect: in the bulk of human affairs place is not material; and the mind, when occupied with an intereſting event, is little regardful of minute circumſtances: theſe may be varied at will, becauſe they ſcarce make any impreſſion.

At the ſame time, it is not here meant to juſtify liberty without any reſerve. An unbounded licence with relation to place and time is faulty, for a reaſon that ſeems to have been overlooked, which is, that it ſeldom fails to break the unity of action: in the ordinary courſe of human affairs, ſingle events, ſuch as are fit to be repreſented on the ſtage, are confined to a narrow ſpot, and generally employ no great extent of time: we accordingly ſeldom find ſtrict unity of action in a dramatic compoſition, where any remarkable latitude is indulged in theſe particulars. It may even be admitted, that a compoſition which employs but one place, and requires not a greater length of time than is neceſſary for the repreſentation, is ſo much the more perfect; becauſe the confining an event within ſo narrow bounds, contributes to the unity of action, and alſo prevents that labour, however ſlight, which the mind muſt undergo in imagining frequent changes of place, and many intervals of time. But ſtill we muſt inſiſt, that ſuch limitation of place and time as was neceſſary in the Grecian drama, is no rule to us; and therefore, that though ſuch limitation adds one beauty more to the compoſition, it is at beſt but a refinement, which may juſtly give place to a thouſand beauties more ſubſtantial. And we may add, that it is extremely difficult, if not impracticable, to contract within the Grecian limits any fable ſo fruitful of incidents in number and variety as to give full ſcope to the fluctuation of paſſion.

It may now appear, that critics who put the unities of place and of time upon the ſame footing with the unity of action, making them all equally eſſential, have not attended to the nature and conſtitution of the modern drama. If they admit an interrupted repreſentation, with which no writer finds fault, it is abſurd to reject its greateſt advantage, that of repreſenting many intereſting ſubjects excluded from the Grecian ſtage. If there needs muſt be a reformation, why not reſtore the ancient chorus and the ancient continuity of action? There is certainly no medium; for, to admit an interruption without relaxing from the ſtrict unities of place and of time, is in effect to load us with all the inconveniences of the ancient drama, and at the ſame time to withhold from us its advantages.

And therefore the only proper queſtion is, Whether our model be or be not a real improvement? This indeed may fairly be called in queſtion; and in order to a comparative trial, ſome particulars muſt be premiſed. When a play begins, we have no difficulty to adjuſt our imagination to the ſcene of action, however diſtant it be in time or in place; becauſe we know that the play is a repreſentation only. The caſe is very different after we are engaged: it is the perfection of repreſentation to hide itſelf, to impoſe on the ſpectator, and to produce in him an impreſſion of reality, as if he were ſpectator of a real event; but any interruption annihilates that impreſſion, by rouſing him out of his waking dream, and unhappily reſtoring him to his ſenſes. So difficult it is to ſupport the impreſſion of reality, that much ſlighter interruptions than the interval between two acts are ſufficient to diſſolve the charm: in the 5th act of the *Mourning Bride*, the three firſt ſcenes are in a room of ſtate, the fourth in a priſon; and the change is operated by ſhifting the ſcene, which is done in a trice: but however quick the tranſition may be, it is impracticable to impoſe upon the ſpectators ſo as to make them conceive that they are actually carried from the palace to the priſon; they immediately reflect, that the palace and priſon are imaginary, and that the whole is a fiction.

From theſe premiſes, one will naturally be led, at firſt view, to pronounce the frequent interruptions in the modern drama to be an imperfection. It will occur, "That every interruption muſt have the effect to baniſh the dream of reality, and with it to baniſh our concern, which cannot ſubſiſt while we are conſcious that all is a fiction; and therefore, that in the modern drama, ſufficient time is not afforded for fluctuation and ſwelling of paſſion, like what is afforded in that of Greece, where there is no interruption." This reaſoning, it muſt be owned, has a ſpecious appearance: but we muſt not become faint-hearted upon the firſt repulſe; let us rally our troops for a ſecond engagement.

On the Greek ſtage, whatever may have been the caſe on the Roman, the repreſentation was never interrupted, and the diviſion by acts was totally unknown. The word *act* never once occurs in Ariſtotle's Poetics, in which he defines exactly every part of the drama, and divides it into the beginning, the middle, and the end. At certain intervals, indeed, the actors retired; but the ſtage was not then left empty, nor the curtain let fall; for the chorus continued and ſung. Neither do theſe ſongs of the chorus divide the Greek tragedies into five portions, ſimilar to our acts; though ſome of the commentators have endeavoured to force them into this office. But it is plain, that the intervals at which the chorus ſung are extremely unequal and irregular, ſuited to the occaſion and the ſubject; and would divide the play ſometimes into three, ſometimes into ſeven or eight acts.

As practice has now eſtabliſhed a different plan on the modern ſtage, has divided every play into five acts, and made a total pauſe in the repreſentation at the end of each act, the queſtion to be conſidered is, Whether the plan of the ancient or of the modern drama is beſt qualified for making a deep impreſſion on the mind? That the preference is due to the plan of the modern drama, will be evident from the following conſiderations. If it be indeed true, as the advocates for the three unities allege, that the audience is deluded into the belief of the reality of a well-acted tragedy, it is certain that this deluſion cannot be long ſupported; for, when the ſpirits are exhauſted by cloſe attention, and by the agitation of paſſion, an uneaſineſs enſues, which never fails to baniſh the waking dream. Now, ſuppoſing the time that a man can employ with ſtrict attention without wandering to be no greater than is requiſite for a ſingle act (a ſuppoſition that cannot be far from truth), it follows, that a continued repreſentation of longer endurance than an act, inſtead of giving ſcope to fluctuation and ſwelling of paſſion, would overſtrain the attention, and produce a total abſence of mind. In this reſpect, the four pauſes have a fine effect: for, by affording to the audience a ſeaſonable reſpite when the impreſſion of reality is gone, and while nothing material is in agitation, they relieve the mind from its fatigue; and conſequently prevent a wandering of thought at the very time poſſibly of the moſt intereſting ſcenes.

In one article, indeed, the Grecian model has greatly the advantage: its chorus, during an interval, not only preſerves alive the impreſſions made upon the audience, but alſo prepares their hearts finely for new impreſſions. In our theatres, on the contrary, the audience, at the end of every act, being left to trifle time away, loſe every warm impreſſion; and they begin the next act cool and unconcerned, as at the commencement of the repreſentation. This is a groſs malady in our theatrical repreſentations; but a malady that luckily is not incurable: to revive the Grecian chorus, would be to revive the Grecian ſlavery of place and time; but we can figure a detached chorus coinciding with a pauſe in the repreſentation, as the ancient chorus did with a pauſe in the principal action. What objection, for example, can there lie againſt muſic between the acts, vocal and inſtrumental, adapted to the ſubject? Such detached chorus, without putting us under any limitation of time or place, would recruit the ſpirits, and would preſerve entire the tone, if not the tide, of paſſion: the muſic, after an act, ſhould commence in the tone of the preceding paſſion, and be gradually varied till it accord with the tone of the paſſion that is to ſucceed in the next act. The muſic and the repreſentation would both of them be gainers by their conjunction; which will thus appear. Muſic that accords with the preſent tone of mind is, on that account, doubly agreeable; and accordingly, though muſic ſingly hath not power to raiſe a paſſion, it tends greatly to ſupport a paſſion already raiſed. Further, muſic prepares us for the paſſion that follows, by making cheerful, tender, melancholy, or animated impreſſions, as the ſubject requires. Take for an example the firſt ſcene of the *Mourning Bride*, where ſoft muſic, in a melancholy ſtrain, prepares us for Almeria's deep diſtreſs. In this manner, muſic and repreſentation ſupport each other delightfully: the impreſſion made upon the audience by the repreſentation, is a fine preparation for the muſic that ſucceeds; and the impreſſion made by the muſic is a fine preparation for the repreſentation that ſucceeds. It appears evident, that by ſome ſuch contrivance the modern drama may be improved, ſo as to enjoy the advantage of the ancient chorus without its ſlaviſh limitation of place and time. But to return to the compariſon between the ancient and the modern drama.

The numberleſs improprieties forced upon the Greek dramatic poets by the conſtitution of their drama, may be ſufficient, one ſhould think, to make us prefer the modern drama, even abſtracting from the improvement propoſed. To prepare the reader for this article, it muſt be premiſed, that as in the ancient drama the place of action never varies, a place neceſſarily muſt be choſen to which every perſon may have acceſs without any improbability. This confines the ſcene to ſome open place, generally the court or area before a palace; which excludes from the Grecian theatre tranſactions within doors, though theſe commonly are the moſt important. Such cruel reſtraint is of itſelf ſufficient to cramp the moſt pregnant invention; and accordingly the Greek writers, in order to preſerve unity of place, are reduced to woful improprieties. In the *Hippolytus* of Euripides (act. 1. ſc. 6.), Phædra, diſtreſſed in mind and body, is carried without any pretext from her palace to the place of action; is there laid upon a couch, unable to ſupport herſelf upon her limbs; and made to utter many things improper to be heard by a number of women who form the chorus: and what is ſtill more improper, her female attendant uſes the ſtrongeſt entreaties to make her reveal the ſecret cauſe of her anguiſh; which at laſt Phædra, contrary to decency and probability, is prevailed upon to do in preſence of that very chorus (act 2. ſc. 2.) Alceſtes, in Euripides, at the point of death, is brought from the palace to the place of action, groaning, and lamenting her untimely fate (act 2. ſc. 1.) In the *Trachiniæ* of Sophocles (act 2.), a ſecret is imparted to Dejanira, the wife of Hercules, in preſence of the chorus. In the tragedy of *Iphigenia*, the meſſenger employed to inform Clytemneſtra that Iphigenia was ſacrificed, ſtops ſhort at the place of action, and with a loud voice calls the queen from her palace to hear the news. Again, in the *Iphigenia in Tauris* (act 4.), the neceſſary preſence of the chorus forces Euripides into a groſs abſurdity, which is, to form a ſecret in their hearing; and, to diſguiſe the abſurdity, much court is paid to the chorus, not one woman but a number, to engage them to ſecrecy. In the *Medea* of Euripides, that princeſs makes no difficulty, in preſence of the chorus, to plot the death of her huſband, of his miſtreſs, and of her father the king of Corinth, all by poiſon: it was neceſſary to bring Medea upon the ſtage; and there is but one place of action, which is always occupied by the chorus. This ſcene cloſes the ſecond act; and in the end of the third, ſhe frankly makes the chorus her confidents in plotting the murder of her own children. Terence, by identity of place, is often forced to make a converſation within doors be heard on the open ſtreet: the cries of a woman in labour are there heard diſtinctly.

The Greek poets are not leſs hampered by unity of time than by that of place. In the *Hippolytus* of Euripides, that prince is baniſhed at the end of the 4th act; and in the firſt ſcene of the following act, a meſſenger relates to Theſeus the whole particulars of the death of Hippolytus by the ſea-monſter: that remarkable event muſt have occupied many hours; and yet in the repreſentation it is confined to the time employed by the chorus upon the ſong at the end of the 4th act. The inconſiſtency is ſtill greater in the *Iphigenia in Tauris* (act 5. ſc. 4.): the ſong could not exhauſt half an hour; and yet the incidents ſuppoſed to have happened during that time could not naturally have been tranſacted in leſs than half a day.

The Greek artiſts are forced, not leſs frequently, to tranſgreſs another rule derived alſo from a continued repreſentation. The rule is, that as a vacuity, however momentary, interrupts the repreſentation, it is neceſſary that the place of action be conſtantly occupied. Sophocles, with regard to that rule as well as to others, is generally correct: but Euripides cannot bear ſuch reſtraint; he often evacuates the ſtage, and leaves it empty for others. Iphigenia in Tauris, after pronouncing a ſoliloquy in the firſt ſcene, leaves the place of action, and is ſucceeded by Oreſtes and Pylades: they, after ſome converſation, walk off; and Iphigenia re-enters, accompanied with the chorus. In the Alceſtes, which is of the ſame author, the place of action is void at the end of the third act. It is true, that to cover the irregularity, and to preſerve the repreſentation in motion, Euripides is careful to fill the ſtage without loſs of time: but this ſtill is an interruption, and a link of the chain broken: for, during the change of the actors, there muſt be a ſpace of time, during which the ſtage is occupied by neither ſet. It makes indeed a more remarkable interruption, to change the place of action as well as the actors; but that was not practicable upon the Grecian ſtage.

It is hard to ſay upon what model Terence has formed his plays. Having no chorus, there is a pauſe in the repreſentation at the end of every act: but advantage is not taken of the ceſſation, even to vary the place of action; for the ſtreet is always choſen, where every thing paſſing may be ſeen by every perſon; and by that choice, the moſt ſprightly and intereſting parts of the action, which commonly paſs within doors, are excluded; witneſs the laſt act of the *Eunuch*. He hath ſubmitted to the like ſlavery with reſpect to time. In a word, a play with a regular chorus, is not more confined in place and time than his plays are. Thus, a zealous ſectary follows implicitly ancient forms and ceremonies, without once conſidering whether their introductive cauſe be ſtill ſubſiſting. Plautus, of a bolder genius than Terence, makes good uſe of the liberty afforded by an interrupted repreſentation: he varies the place of action upon all occaſions, when the variation ſuits his purpoſe.

The intelligent reader will by this time underſtand, that we plead for no change of place in our plays but after an interval, nor for any latitude in point of time but what falls in with an interval. The unities of place and time ought to be ſtrictly obſerved during each act; for during the repreſentation there is no opportunity for the ſmalleſt deviation from either. Hence it is an eſſential requiſite, that during an act the ſtage be always occupied; for even a momentary vacuity makes an interval or interruption. Another rule is no leſs eſſential: it would be a groſs breach of the unity of action to exhibit upon the ſtage two ſeparate actions at the ſame time; and therefore, to preſerve that unity, it is neceſſary that each perſonage introduced during an act be linked to thoſe in poſſeſſion of the ſtage, ſo as to join all in one action. Theſe things follow from the very conception of an act, which admits not the ſlighteſt interruption: the moment the repreſentation is intermitted, there is an end of that act; and we have no other notion of a new act, but where, after a pauſe or interval, the repreſentation is again put in motion. French writers, generally ſpeaking, are correct in this particular. The Engliſh, on the contrary, are ſo irregular as ſcarce to deſerve a criticiſm; actors not only ſucceed each other in the ſame place without connection, but, what is ſtill leſs excuſable, they frequently ſucceed each other in different places. This change of place in the ſame act ought never to be indulged; for, beſide breaking the unity of the act, it has a diſagreeable effect: after an interval, the imagination adapts itſelf to any place that is neceſſary, as readily as at the commencement of the play; but during the repreſentation we reject change of place. From the foregoing cenſure muſt be excepted the *Mourning Bride* of Congreve, where regularity concurs with the beauty of ſentiment and of language, to make it one of the moſt complete pieces England has to boaſt of. It is to be acknowledged, however, that in point of regularity this elegant performance is not altogether unexceptionable. In the four firſt acts, the unities of place and time are ſtrictly obſerved: but in the laſt act, there is a capital error with reſpect to unity of place; for, in the three firſt ſcenes of that act, the place of action is a room of ſtate, which is changed to a priſon in the fourth ſcene: the chain alſo of the actors is broken; as the perſons introduced in the priſon are different from thoſe who made their appearance in the room of ſtate. This remarkable interruption of the repreſentation makes in effect two acts inſtead of one: and therefore, if it be a rule that a play ought not to conſiſt of more acts than five, this performance is ſo far defective in point of regularity. It may be added, that, even admitting ſix acts, the irregularity would not be altogether removed, without a longer pauſe in the repreſentation than is allowed in the acting; for more than a momentary interruption is requiſite for enabling the imagination readily to fall in with a new place, or with a wide ſpace of time. In *The Way of the World*, of the ſame author, unity of place is preſerved during every act, and a ſtricter unity of time during the whole play than is neceſſary.

§ 4. *Of the Opera.*

AN opera is a drama repreſented by muſic. This entertainment was invented at Venice. An exhibition of this ſort requires a moſt brilliant magnificence, and an expenſe truly royal. The drama muſt neceſſarily be compoſed in verſe; for, as operas are ſung, and accompanied with ſymphonies, they muſt be in verſe to be properly applicable to muſic. To render this entertainment ſtill more brilliant, it is ornamented with dances and ballettes, with ſuperb decorations, and ſurpriſing machinery. The dreſſes of the actors, of thoſe who aſſiſt in the chorus, and of the dancers, being all in the moſt ſplendid and elegant taſte, contribute to render the exhibition highly ſumptuous. But notwithſtanding this union of arts and pleaſures at an immenſe expenſe, and notwithſtanding a moſt dazzling pageantry, an opera appears, in the eyes of many people of taſte, but as a magnificent abſurdity, ſeeing that nature is never there from the beginning to the end. It is not our buſineſs here, however, to determine between the different taſtes of mankind.

The method of expreſſing our thoughts by ſinging and muſic is ſo little natural, and has ſomething in it ſo forced and affected, that it is not eaſy to conceive how it could come into the minds of men of genius to repreſent any human action, and, what is more, a ſerious or tragic action, any otherwiſe than by ſpeech. We have, it is true, operas in Engliſh by Addiſon, &c. in Italian by Metaſtaſio, in French by M. Quinault, Fontenelle, &c. the ſubjects of which are ſo grave and tragic, that one might call them muſical tragedies, and real *chefs d'œuvres* in their kind. But though we are highly ſatisfied and greatly affected on reading them, and are much pleaſed with ſeeing them repreſented, yet the ſpectator is, perhaps, more charmed with the magnificence of the ſight and the beauty of the muſic, than moved with the action and the tragical part of the performance. We are not, however, of that order of critics who ſtrive to prove, that mankind act wrong in finding pleaſure in an object with which they are really pleaſed; who blame a lover for thinking his miſtreſs charming, when her features are by no means regular; and who are perpetually applying the rules of logic to the works of genius: we make theſe obſervations merely in order to examine if it be not poſſible to augment the pleaſures of a polite people, by making the opera ſomething more natural, more probable, and more conſonant to reaſon.

We think, therefore, that the poet ſhould never, or at leaſt very rarely, chooſe a ſubject from hiſtory, but from fable or mythology, or from the regions of enchantment. Every rational mind is conſtantly ſhocked to hear a mutilated hero trill out, from the ſlender pipe of a chaffinch, *To arms! To arms!* and in the ſame tone animate his ſoldiers, and lead them to the aſſault; or harangue an aſſembly of grave ſenators, and ſometimes a whole body of people. Nothing can be more burleſque than ſuch exhibitions; and a man muſt be poſſeſſed of a very uncommon ſenſibility to be affected by them. But as we know not what was the language of the gods, and their manner of expreſſing themſelves, we are at liberty in that caſe to form what illuſions we pleaſe, and to ſuppoſe that they ſung to diſtinguiſh themſelves from mortals. Beſides, all the magic of decorations and machinery becomes natural, and even neceſſary, in theſe kinds of ſubjects; and therefore readily affords opportunity for all the pomp of theſe performances. The chorus, the dances, the ballettes, the ſymphonies and dreſſes, may likewiſe be all made to correſpond with ſuch ſubjects: nothing is here affected, abſurd, or unnatural. Whoever is poſſeſſed of genius, and is well acquainted with mythology, will there find an inexhauſtible ſource of ſubjects highly diverſified, and quite proper for the drama of an opera.

We ſhall not ſpeak here of that ſort of muſic which appears to us the moſt proper for ſuch a drama, and of the ſeveral alterations of which we think it ſuſceptible, in order to make it more complete, and to adapt it to a more pathetic, more noble, and more natural expreſſion, as well in the recitatives as in the airs and chorus. (See MUSIC.) We have only here to conſider the buſineſs of the poet. He ſhould never loſe ſight of nature, even in the midſt of the greateſt fiction. A god, a demi-god, a renowned hero, ſuch for example as Renaud in *Armida*, a fairy, a genie, a nymph, or fury, &c. ſhould conſtantly be repreſented according to the characters we give them, and never be made to talk the language of a fop or a *petite maitreſſe*. The recitative, which is the ground-work of the dialogue, requires verſes that are free and not regular, ſuch as with a ſimple cadence approach the neareſt to common language. The airs ſhould not be forced into the piece, nor improperly placed for the ſake of terminating a ſcene, or to diſplay the voice of a performer: they ſhould expreſs ſome ſentiment, or ſome precept, ſhort and ſtriking, or tender and affecting; or ſome ſimile lively and natural; and they ſhould ariſe of themſelves from a monologue, or from a ſcene between two perſons: prolixity ſhould here be particularly avoided, eſpecially when ſuch an air makes part of a dialogue; for nothing is more inſipid or diſguſtful than the countenances of the other actors who appear at the ſame time, whoſe ſilence is quite unmeaning, and who know not what to do with their hands and feet while the ſinger is ſtraining his throat. The verſe of all the airs ſhould be of the lyric kind, and ſhould contain ſome poetic image, or paint ſome noble paſſion, which may furniſh the compoſer with an opportunity of diſplaying his talents, and of giving a lively and affecting expreſſion to the muſic. A phraſe that is inanimated can never have a good effect in the performance, but muſt become inſipid and horribly tedious in the air. The trite ſimilies of the Italians, of a ſtream that flows, or a bird that flies, &c. are no longer ſufferable. The ſame thing may be ſaid with regard to the chorus, which ſhould be equally natural and well adapted: it is here ſometimes a whole people, ſometimes the inhabitants of a peculiar country, and ſometimes warriors, nymphs, or prieſts, &c. who raiſe their voice to demand juſtice, to implore favour, or render a general homage. The action itſelf will furniſh the poet of genius with ideas, words, and the manner of diſpoſing them.

Laſtly, the opera being a performance calculated leſs to ſatisfy the underſtanding than to charm the ear and affect the heart, and eſpecially to ſtrike the ſight, the poet ſhould have a particular attention to that object, ſhould be ſkilled in the arts of a theatre, ſhould know how to introduce combats, ballettes, feaſts, games, pompous entries, ſolemn proceſſions, and ſuch marvellous incidents as occur in the heavens, upon earth, in the ſea, and even in the infernal regions: but all theſe matters demand a ſtrong character, and the utmoſt preciſion in the execution: for, otherwiſe, the comic being a near neighbour to the ſublime, they will eaſily become ridiculous. The unity of action muſt certainly be obſerved in ſuch a poem, and all the incidental epiſodes muſt concur to the principal deſign; otherwiſe it would be a monſtrous chaos. It is impoſſible, however, ſcrupulouſly to obſerve the unity of time and place: though the liberty, which reaſon allows the poet in this reſpect, is not without bounds; and the leſs uſe he makes of it, the more perfect his poem will be. It is not perhaps impoſſible ſo to arrange the objects, that, in changing the decorations, the painter may conſtantly make appear ſome part of the principal decoration which characteriſes the ſituation of the ſcene, as the corner of a palace, at the end of a garden, or ſome avenue that leads to it, &c. But all this is liable to difficulties, and even to exceptions; and the art of the painter muſt concur in ſuch caſe with that of the poet. For the reſt, all the operas of Europe are at leaſt one third too long; eſpecially the Italian. The unity of action requires brevity; and ſatiety is inſeparable from a diverſion that laſts full four hours, and ſometimes longer.

They have indeed endeavoured to obviate this inconvenience by dividing an opera into three, and even into five acts; but experience proves, that this diviſion, though judicious, is ſtill not ſufficient to relieve the wearied attention.

Sect. II. *Of Lyric Poetry.*

The ode is very ancient, and was probably the firſt ſpecies of poetry. It had its ſource, we may ſuppoſe, from the heart, and was employed to expreſs, with becoming fervour and dignity, the grateful ſenſe man entertained of the bleſſings which daily flowed from God the fountain of all goodneſs: hence their harveſt hymns, and other devotional compoſitions of that kind.

But in proceſs of time it was employed, not only to praiſe the Almighty for bounties received, but to ſolicit his aid in time of trouble; as is plain from the odes written by king David and others, and collected by the Jewiſh Sanhedrim into the book of Pſalms, to be ſung at their faſts, feſtivals, and on other ſolemn occaſions. Nor was this practice confined to the Iſraelites only: other nations had their ſongs of praiſe and petitions of this ſort, which they preferred to their deities in time of public proſperity and public diſtreſs, as well as to thoſe heroes who diſtinguiſhed themſelves in arms. Even the American Indians, whoſe notions of religion are extremely confined, have their war-ſongs, which they ſing to this day.

It is reaſonable to ſuppoſe that the awful purpoſe to which the ode was applied, gave riſe among the ancients to the cuſtom of invoking the muſes; and that the poets, in order to raiſe their ſentiments and language, ſo as to be acceptable to their deities, thought it expedient to ſolicit ſome divine aſſiſtance. Hence poets are ſaid to have been inſpired, and hence an unbounded liberty has been given to the ode; for the lyric poet, fired, as it were, with his ſubject, and borne away on the wings of gratitude, diſdains grammatical niceties and common modes of ſpeech, and often ſoars above rule, though not above reaſon. This freedom, however, conſiſts chiefly in ſudden tranſitions, bold digreſſions, and lofty excurſions. For the ancient poets, and even Pindar, the moſt daring and lofty of them all, has in his ſublimeſt flights, and amidſt all his rapture, preſerved harmony, and often uniformity, in his verſification: but ſo great is the variety of his meaſures, that the traces of ſameneſs are in a manner loſt; and this is one of the excellencies for which that poet is admired, and which, though ſeemingly devoid of art, requires ſo much that he has ſeldom been imitated with ſucceſs.

The ancients in their odes indulged ſuch a liberty of fancy, that ſome of their beſt poets not only make bold excurſions and digreſſions, but, having in their flights ſtarted ſome new and noble thought, they frequently purſue it, and never more return to their ſubject. But this looſe kind of ode, which ſeems to reject all method, and in which the poet, having juſt touched upon his ſubject, immediately diverts to another, we ſhould think blameable, were it lawful to call in queſtion the authority of thoſe great men who were our preceptors in this art. We may venture to affirm, however, that theſe compoſitions ſtand in no degree of compariſon with other odes of theirs; in which, after wandering from the ſubject in purſuit of new ideas ariſing from ſome of its adjuncts, and ranging wantonly, as it were, through a variety of matter, the poet is from ſome other circumſtance led naturally to his ſubject again; and, like a bee, having collected the eſſence of many different flowers, returns home, and unites them all in one uniform pleaſing ſweet.

The ode among the ancients ſignified no more than a ſong; but, with the moderns, the ode and the ſong are conſidered as different compoſitions; the ode being uſually employed in grave and lofty ſubjects, and ſeldom ſung but on ſolemn occaſions.

The ſubjects moſt proper for the ode and ſong, Horace has pointed out in a few elegant lines:

> Gods, heroes, conquerors, Olympic crowns,
> Love's pleaſing cares, and the free joys of wine,
> Are proper ſubjects for the lyric ſong.

To which we may add, that happineſs, the pleaſures of a rural life, and ſuch parts of morality as afford leſſons for the promotion of our felicity, and reflections on the conduct of life, are equally ſuitable to the ode. This both *Pindar* and *Horace* were ſo ſenſible of, that many of their odes are ſeaſoned with theſe moral ſentences and reflections:

> But who can number ev'ry ſandy grain
> Waſh'd by *Sicilia's* hoarſe-reſounding main?
> Or who can *Theron's* gen'rous works expreſs,
> And tell how many hearts his bount'ous virtues bleſs?
>
> *Ode to* Theron.

And in another Olympic ode, inſcribed by the ſame poet to Diagoras of Rhodes (and in ſuch eſteem, that it was depoſited in the temple of Minerva, written in letters of gold), Pindar, after exalting them to the ſkies, concludes with this leſſon in life:

> Yet, as the gales of fortune various blow,
> To-day tempeſtuous, and to-morrow fair,
> Due bounds, ye Rhodians, let your tranſports know;
> Perhaps to-morrow comes a ſtorm of care.
>
> *Weſt's* Pindar.

The variety of ſubjects which are allowed the *lyric* poet makes it neceſſary to conſider this ſpecies of poetry under the following heads, viz. the *ſublime* ode, the *leſſer* ode, and the *ſong*.

We ſhall begin with the loweſt, and proceed to that which is more eminent.

I. *Songs* are little poetical compoſitions, uſually ſet to a tune, and frequently ſung in company by way of entertainment and diverſion. Of theſe we have in our language a great number; but, conſidering that number, not many which are excellent; for, as the duke of Buckingham obſerves,

> Though nothing ſeems more eaſy, yet no part
> Of poetry requires a nicer art.

The ſong admits of almoſt any ſubject; but the greateſt part of them turn either upon *love, contentment*, or the *pleaſures* of a *country life*, and *drinking*. Be the ſubject, however, what it will, the verſes ſhould be eaſy, natural, and flowing, and contain a certain harmony, ſo that poetry and muſic may be agreeably united. In theſe compoſitions, as in all others, obſcene and profane expreſſions ſhould be carefully avoided, and indeed every thing that tends to take off that reſpect which is due to religion and virtue, and to encourage vice and immorality. As the beſt ſongs in our language are already in every hand, it would ſeem ſuperfluous to inſert examples. For further precepts, however, as well as ſelect examples, in this ſpecies of compoſition, we may refer the reader to the elegant *Eſſay on Song-Writing*, by Mr. Aikin.

II. The *leſſer ode*. The diſtinguiſhing character of this is ſweetneſs; and as the pleaſure we receive from this ſort of poem ariſes principally from its ſoothing and affecting the paſſions, great regard ſhould be paid to the language as well as to the thoughts and numbers.

> Th' expreſſion ſhould be eaſy, fancy high;
> Yet that not ſeem to creep, nor this to fly:
> No words tranſpos'd, but in ſuch order all,
> As, though hard wrought, may ſeem by chance to fall.
> *D. Buckingham's Eſſay.*

The ſtyle, indeed, ſhould be eaſy; but it may be alſo florid and figurative. It ſolicits delicacy, but diſdains affectation. The thoughts ſhould be natural, chaſte, and elegant; and the numbers various, ſmooth, and harmonious. A few examples will ſufficiently explain what we mean.

Longinus has preſerved a fragment of Sappho, an ancient Greek poeteſs, which is well known and in great reputation amongſt the critics, having been happily tranſlated by Mr. Philips. "Bleſt as the immortal gods is he," &c.

After this account of the Sapphic ode, it may not be improper to mention that ſort of ode which is called *Anacreontic*; being written in the manner and taſte of Anacreon, a Greek poet, famous for the delicacy of his wit, and the exquiſite, yet eaſy and natural, turn of his poeſy. We have ſeveral of his odes ſtill extant, and many modern ones in imitation of him, which are moſtly compoſed in verſes of ſeven ſyllables, or three feet and a half. The young ſtudent is furniſhed with examples of his manner in Mr. Fawkes's excellent tranſlation.

Among the moſt ſucceſsful of Anacreon's Engliſh imitators may be reckoned Dr. Johnſon and Mr. Prior. The following ode on *Evening*, by the former of theſe writers, has, if we miſtake not, the very ſpirit and air of Anacreon.

> Evening now, from purple wings,
> Sheds the grateful gifts ſhe brings;
> Brilliant drops bedeck the mead;
> Cooling breezes ſhake the reed;
> Shake the reed, and curl the ſtream
> Silver'd o'er with Cynthia's beam;
> Near the chequer'd lonely grove
> Hears, and keeps thy ſecrets, Love.
> Stella, thither let us ſtray!
> Lightly o'er the dewy way.
> Phœbus drives his burning car
> Hence, my lovely Stella, far:
> In his ſtead the queen of night
> Round us pours a lambent light;
> Light that ſeems but juſt to ſhow
> Breaſts that beat, and cheeks that glow:
> Let us now, in whiſper'd joy,
> Evening's ſilent hours employ;
> Silence beſt, and conſcious ſhades,
> Pleaſe the hearts that love invades:
> Other pleaſures give them pain;
> Lovers all but love diſdain.

We come now to thoſe odes of the more *florid* and *figurative* kind, of which we have many in our language that deſerve particular commendation. Mr. Warton's Ode to Fancy, beginning "O parent of each lovely muſe," has been juſtly admired by the beſt judges; for, though it has a diſtant reſemblance of Milton's L'Allegro and Il Penſeroſo, yet the work is original; the thoughts are moſtly new and various, and the language and numbers elegant, expreſſive, and harmonious.

The well known ode, written by Mr. Collins on the death of Mr. Thomſon, is of the *paſtoral* and *elegiac* kind, and both pictureſque and pathetic. To perceive all the beauties of this little piece, which are indeed many, we muſt ſuppoſe them to have been delivered on the river Thames near Richmond.

Under this ſpecies of the ode, notice ought to be taken of thoſe written on divine ſubjects, and which are uſually called *hymns*. Of theſe we have many in our language, but none perhaps that are ſo much admired as Mr. Addiſon's, beginning "The ſpacious firmament on high," &c.—The beauties of this hymn are too well known, and too obvious, to need any commendation; we ſhall only obſerve, therefore, that in this hymn (intended to diſplay the power of the Almighty) he ſeems to have had a pſalm of David in his view, which ſays, that "the heavens declare the glory of God, and the firmament ſheweth his handywork."

The *paſtoral hymn*, which is a verſion of the 23d *Pſalm* by Mr. Addiſon, has peculiar beauties; and in juſtice to Dr. Boyce, we muſt obſerve that the muſic he has adapted to it is ſo ſweet and expreſſive, that we know not which is to be moſt admired, the poet or the muſician.—The hymn we allude to is that beginning "The Lord my paſture ſhall prepare," &c.

III. We are now to ſpeak of thoſe odes which are of the *ſublime* and *noble* kind, and diſtinguiſhed from others by their elevation of thought and diction, as well by the variety or irregularity of their numbers, as the frequent tranſitions and bold excurſions with which they are enriched.

To give the young ſtudent an idea of the ſudden and frequent tranſitions, digreſſions, and excurſions, which are admitted into the odes of the ancients, we cannot do better than refer him to the celebrated ſong or ode of Moſes; which is the oldeſt that we know of, and was penned by that divine author immediately after the children of Iſrael croſſed the Red-Sea.

At the end of this ſong, we are told that "Miriam the propheteſs, the ſiſter of Aaron, took a timbrel in her hand, and all the women went out after her with timbrels and with dances. And Miriam anſwered them, Sing ye to the Lord, for he hath triumphed gloriouſly; the horſe and his rider hath he thrown into the ſea."

From this laſt paſſage it is plain, that the ancients very early called in muſic to the aid of poetry; and that their odes were uſually ſung, and accompanied with their lutes, harps, lyres, timbrels, and other inſtruments: nay, ſo eſſential, and in ſuch reputation, was muſic held by the ancients, that we often find, in their lyric poets, addreſſes or invocations to the harp, the lute, or the lyre; and it was probably owing to the frequent uſe made of the laſt-mentioned inſtrument with the ode, that this ſpecies of writing obtained the name of *Lyric poetry*.

This ode, or hymn, which ſome believe was compoſed by Moſes in Hebrew verſe, is incomparably better than any thing the heathen poets have produced of the kind, and is by all good judges conſidered as a maſter-piece of ancient eloquence. The thoughts are noble and ſublime: the ſtyle is magnificent and expreſſive: the figures are bold and animated: the tranſitions and excurſions are ſudden and frequent: but they are ſhort; and the poet, having digreſſed for a moment, returns immediately to the great object that excited his wonder, and elevated his ſoul with joy and gratitude. The images fill the mind with their greatneſs, and ſtrike the imagination in a manner not to be expreſſed.

If there be any thing that in ſublimity approaches to it, we muſt look for it in the Eaſt, where perhaps we ſhall find nothing ſuperior to the Hindoo hymn to *Narrayna*, or "the ſpirit of God," taken, as Sir William Jones informs us, from the writings of the ancient Bramins.

We come now to the *Pindaric ode*, which (if we except the hymns in the Old Teſtament, the pſalms of king David, and ſuch hymns of the Hindoos as that juſt quoted) is the moſt exalted part of Lyric poetry; and was ſo called from *Pindar*, an ancient Greek poet, who is celebrated for the boldneſs of his flights, the impetuoſity of his ſtyle, and the ſeeming wildneſs and irregularity that runs through his compoſitions, and which are ſaid to be the effect of the greateſt art. See PINDAR.

The odes of Pindar were held in ſuch high eſtimation by the ancients, that it was fabled, in honour of their ſweetneſs, that the bees, while he was in the cradle, brought honey to his lips: nor did the victors at the Olympic and other games think the crown a ſufficient reward for their merit, unleſs their achievements were celebrated in Pindar's ſongs; moſt wiſely preſaging, that the firſt would decay, but the other endure for ever.

This poet did not always write his odes in the ſame meaſure, or with the ſame intention with regard to their being ſung. For the ode inſcribed to Diagoras (the concluding ſtanza of which we inſerted at the beginning of this ſection) is in heroic meaſure, and all the ſtanzas are equal: there are others alſo, as Mr. Weſt obſerves, made up of *ſtrophes* and *antiſtrophes*, without any *epode*; and ſome compoſed of *ſtrophes* only, of different lengths and meaſures: but the greateſt part of his odes are divided into *ſtrophe*, *antiſtrophe*, and *epode*; in order, as Mr. Congreve conjectures, to their being ſung, and addreſſed by the performers to different parts of the audience. "They were ſung (ſays he) by a chorus, and adapted to the lyre, and ſometimes to the lyre and pipe. They conſiſted ofteneſt of three ſtanzas. The firſt was called the *ſtrophe*, from the verſion or circular motion of the ſingers in that ſtanza from the right hand to the left. The ſecond ſtanza was called the *antiſtrophe*, from the contraverſion of the chorus; the ſingers in performing that, turning from the left hand to the right, contrary always to their motion in the *ſtrophe*. The third ſtanza was called the *epode* (it may be, as being the after-ſong), which they ſung in the middle, neither turning to one hand nor the other. But Dr. Weſt's friend (See preface to Weſt's Pindar) is of opinion, that the performers alſo danced one way while they were ſinging the *ſtrophe*, and danced back as they ſung the *antiſtrophe*, till they came to the ſame place again, and then ſtanding ſtill they ſung the *epode*. He has tranſlated a paſſage from the *Scholia* on *Hephæſtion*, in proof of his opinion; and obſerves, that the dancing the *ſtrophe* and *antiſtrophe* in the ſame ſpace of ground, and we may ſuppoſe the ſame ſpace of time alſo, ſhows why thoſe two parts conſiſted of the ſame length and meaſure.

As the various meaſures of Pindar's odes have been the means of ſo far miſleading ſome of our modern poets, as to induce them to call compoſitions Pindaric odes that were not written in the method of Pindar, it is neceſſary to be a little more particular on this head, and to give an example from that poet, the more effectually to explain his manner; which we ſhall take from the tranſlation of Dr. Weſt.

The eleventh NEMEAN ODE.

This ode is inſcribed to Ariſtagoras, upon occaſion of his entering on his office of preſident or governor of the iſland of Tenedos: ſo that, although it is placed among the Nemean odes, it has no ſort of relation to thoſe games, and is indeed properly an inauguration ode, compoſed to be ſung by a chorus at the ſacrifices and the feaſts made by Ariſtagoras and his colleagues in the town-hall, at the time of their being inveſted with the magiſtracy, as is evident from many expreſſions in the firſt *ſtrophe* and *antiſtrophe*.

ARGUMENT.

Pindar opens this ode with an invocation to Veſta (the goddeſs who preſided over the courts of juſtice, and whoſe ſtatue and altar were for that reaſon placed in the town-halls, or *Prytanæums*, as the Greeks called them), beſeeching her to receive favourably Ariſtagoras and his colleagues, who were then coming to offer ſacrifices to her, upon their entering on their office of Prytans or magiſtrates of Tenedos; which office continuing for a year, he begs the goddeſs to take Ariſtagoras under her protection during that time, and to conduct him to the end of it without trouble or diſgrace. From Ariſtagoras, Pindar turns himſelf in the next place to his father Arceſilas, whom he pronounces happy, as well upon account of his ſon's merit and honour, as upon his own great endowments and good fortune; ſuch as beauty, ſtrength, courage, riches, and glory, reſulting from his many victories in the games. But leſt he ſhould be too much puffed up with theſe praiſes, he reminds him at the ſame time of his mortality, and tells him that his clothing of fleſh is periſhable, that he muſt ere long be clothed with earth, the *end of all things*: and yet, continues he, it is but juſtice to praiſe and celebrate the worthy and deſerving, who from good citizens ought to receive all kinds of honour and commendation; as Ariſtagoras, for inſtance, who hath rendered both himſelf and his country illuſtrious by the many victories he hath obtained, to the number of ſixteen, over the neighbouring youth, in the games exhibited in and about his own country. From whence, ſays the poet, I conclude he would have come off victorious even in the Pythian and Olympic games, had he not been reſtrained from engaging in thoſe famous liſts by the too timid and cautious love of his parents. Upon which he falls into a moral reflection upon the vanity of man's hopes and fears; by the former of which they are oftentimes excited to attempts beyond their ſtrength, which accordingly iſſue in their diſgrace; as, on the other hand, they are frequently reſtrained, by unreaſonable and ill-grounded fears, from enterpriſes, in which they would in all probability have come off with honour. This reflection he applies to Ariſtagoras, by ſaying it was very eaſy to foreſee what ſucceeſs he was like to meet with, who both by father and mother was deſcended from a long train of great and valiant men. But here again, with a very artful turn of flattery to his father Arceſilas, whom he had before repreſented as ſtrong and valiant, and famous for his victories in the games, he obſerves that every generation, even of a great and glorious family, is not equally illuſtrious any more than the fields and trees are every year equally fruitful; that the gods had not given mortals any certain tokens by which they might foreknow when the *rich years of virtue ſhould ſucceed*: whence it comes to paſs, that men, out of ſelf-conceit and preſumption, are perpetually laying ſchemes, and forming enterpriſes, without previouſly conſulting prudence or wiſdom, whoſe *ſtreams*, ſays he, lie remote and out of the common road. From all which he infers, that it is better to moderate our deſires, and ſet bounds to our avarice and ambition; with which moral precept he concludes the ode.

STROPHE I.

Daughter of Rhea! thou, whoſe holy fire
Before the awful ſeat of juſtice flames!
Siſter of heav'n's almighty ſire!
Siſter of Juno, who coequal claims
With Jove to ſhare the empire of the gods!
O virgin Veſta! to thy dread abodes,
Lo! Ariſtagoras directs his pace!
Receive and near thy ſacred ſceptre place
Him, and his colleagues, who, with honeſt zeal,
O'er Tenedos preſide, and guard the public weal.

ANTISTROPHE I.

And lo! with frequent off'rings, they adore
Thee*, firſt invok'd in ev'ry ſolemn pray'r!
To thee unmix'd libations pour,
And fill with od'rous fumes the fragrant air.
Around in feſtive ſongs the hymning choir
Mix the melodious voice and ſounding lyre,
While ſtill, prolong'd with hoſpitable love,
Are ſolemniz'd the rites of genial Jove:
Then guard him, Veſta, through his long career,
And let him cloſe in joy his miniſterial year.

EPODE I.

But hail, Arceſilas! all hail
To thee, bleſs'd father of a ſon ſo great!
Thou whom on fortune's higheſt ſcale
The favourable hand of heav'n hath ſet,
Thy manly form with beauty hath refin'd,
And match'd that beauty with a valiant mind.
Yet let not man too much preſume,
Tho' grac'd with beauty's faireſt bloom;
Tho' for ſuperior ſtrength renown'd;
Tho' with triumphal chaplets crown'd:
Let him remember, that, in fleſh array'd,
Soon ſhall he ſee that mortal veſtment fade;
Till loſt, impriſon'd in the mould'ring urn,
To earth, the end of all things, he return.

STROPHE II.

Yet ſhould the worthy from the public tongue
Receive their recompenſe of virtuous praiſe;
By ev'ry zealous patriot ſung,
And deck'd with ev'ry flow'r of heav'nly lays.
Such retribution in return for fame,
Such, Ariſtagoras, thy virtues claim,
Claim from thy country; on whoſe glorious brows
The wreſtler's chaplet ſtill unfaded blows;
Mix'd with the great Pancratiaſtic crown,
Which from the neighb'ring youth thy early valour won.

ANTISTROPHE II.

And (but his timid parents' cautious love,
Diſturbing ever his too forward hand,
Forbad their tender ſon to prove
The toils of Pythia or Olympia's ſands),
Now, by the Gods I ſwear, his valorous might
Had 'ſcap'd victorious in each bloody fight;
And from Caſtalia†, or where dark with ſhade
The mount of Saturn‡ rears its olive head,
Great and illuſtrious home had he return'd;
While, by his fame eclips'd, his vanquiſh'd foes had mourn'd.

EPODE II.

Then, his triumphal treſſes bound
With the dark verdure of th' Olympic grove,
With joyous banquets had he crown'd
The great quinquennial feſtival of Jove;
And cheer'd the ſolemn pomp with choral lays,
Sweet tribute, which the muſe to virtue pays.
But, ſuch is man's prepoſt'rous fate!
Now, with o'er-weening pride elate,
Too far he aims his ſhaft to throw,
And ſtraining burſts his feeble bow:
Now puſillanimous depreſs'd with fear,
He checks his virtue in the mid career;
And, of his ſtrength diſtruſtful, coward flies
The conteſt, tho' empow'r'd to gain the prize.

STROPHE III.

But who could err in propheſying good
Of him, whoſe undegenerating breaſt
Swells with a tide of Spartan blood,
From ſire to ſire in long ſucceſſion trac'd
Up to Piſander; who in days of yore
From old Amyclæ to the Leſbian ſhore
And Tenedos, colleagu'd in high command
With great Oreſtes, led th' Æolian band?
Nor was his mother's race leſs ſtrong and brave,
Sprung from a ſtock that grew on fair Iſmenus' wave §.

ANTISTROPHE III.

Tho' for long intervals obſcur'd, again
Oft-times the ſeeds of lineal worth appear.
For neither can the furrow'd plain
Full harveſts yield with each returning year;
Nor in each period will the pregnant bloom
Inveſt the ſmiling tree with rich perfume.
So, barren often, and inglorious, paſs
The generations of a noble race;
While nature's vigour, working at the root,
In after-ages ſwells, and bloſſoms into fruit.

EPODE III.

Nor hath Jove giv'n us to foreknow
When the rich years of virtue ſhall ſucceed:
Yet bold and daring on we go,
Contriving ſchemes of many a mighty deed;
While hope, fond inmate of the human mind,
And ſelf-opinion, active, raſh, and blind,
Hold up a falſe illuſive ray,
That leads our dazzled feet aſtray
Far from the ſprings, where, calm and ſlow,
The ſecret ſtreams of wiſdom flow.
Hence ſhould we learn our ardour to reſtrain,
And limit to due bounds the thirſt of gain.
To rage and madneſs oft that paſſion turns,
Which with forbidden flames deſpairing burns.

From the above ſpecimen, and from what we have already ſaid on this ſubject, the reader will perceive, that odes of this ſort are diſtinguiſhed by the happy tranſitions and digreſſions which they admit, and the ſurpriſing yet natural returns to the ſubject. This requires great judgment and genius; and the poet who would excel in this kind of writing ſhould draw the plan of his poem in manner of the argument we have above inſerted, and mark out the places where thoſe elegant and beautiful ſallies and wanderings may be made, and where the returns will be eaſy and proper.

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* It was uſual, in all ſolemn ſacrifices and prayers, to begin with invoking Veſta.

† A river, upon whoſe banks the Pythian games were exhibited.

‡ A ſmall hill, planted with olives, that overlooked the Stadium at Olympia.

§ Iſmenus was a river of Bœotia, of which country was Menalippus, the anceſtor of Ariſtagoras by the mother's ſide.

Pindar, it is univerſally allowed, had a poetical and fertile imagination, a warm and enthuſiaſtic genius, a bold and figurative expreſſion, and a conciſe and ſententious ſtyle: but it is generally ſuppoſed that many of thoſe pieces which procured him ſuch extravagant praiſes and extraordinary teſtimonies of eſteem from the ancients are loſt; and if they were not, it would be perhaps impoſſible to convey them into our language; for beauties of this kind, like plants of an odoriferous and delicate nature, are not to be tranſplanted into another clime without loſing much of their fragrance or eſſential quality.

With regard to thoſe compoſitions which are uſually called *Pindaric odes* (but which ought rather to be diſtinguiſhed by the name of *irregular odes*), we have many in our language that deſerve particular commendation: and the criticiſm Mr. Congreve has given us on that ſubject has too much aſperity and too great latitude; for, if other writers have, by miſtaking Pindar's meaſures, given their odes an improper title, it is a crime, one would think, not ſo dangerous to the commonwealth of letters as to deſerve ſuch ſevere reproof. Beſide which, we may ſuppoſe that ſome of theſe writers did not deviate from Pindar's method through ignorance, but by choice; and that as their odes were not to be performed with both ſinging and dancing, in the manner of Pindar's, it ſeemed unneceſſary to confine the firſt and ſecond ſtanzas to the ſame exact numbers as was done in his ſtrophes and antiſtrophes. The poet therefore had a right to indulge himſelf with more liberty: and we cannot help thinking, that the ode which Mr. Dryden has given us, entitled *Alexander's Feaſt*, or *The Power of Muſic*, is altogether as valuable in looſe and wild numbers as it could have been if the ſtanzas were more regular, and written in the manner of Pindar. In this ode there is a wonderful ſublimity of thought, a loftineſs and ſweetneſs of expreſſion, and a moſt pleaſing variety of numbers.

There is another poem by Dryden, on the death of Mrs. Anne Killegrew, a young lady eminent for her ſkill in poetry and painting, which Dr. Johnſon has pronounced to be "undoubtedly the nobleſt ode that our language has ever produced." He owns, that as a whole it may perhaps be inferior to *Alexander's Feaſt*; but he affirms that the firſt ſtanza of it is ſuperior to any ſingle part of the other. This famous ſtanza, he ſays, flows with a torrent of enthuſiaſm: *Fervet immenſuſque ruit*. How far this criticiſm is juſt, the public muſt determine. The poem we allude to begins, "*Thou youngeſt virgin daughter of the ſkies*," &c.

That it is a fine ode, and not unworthy of the genius of Dryden, muſt be acknowledged; but that it is the nobleſt which the Engliſh language has produced, or that any part of it runs with the torrent of enthuſiaſm which characteriſes *Alexander's Feaſt*, are poſitions which we feel not ourſelves inclined to admit. Had the critic by whom it is ſo highly praiſed inſpected it with the eye which ſcanned the odes of Gray, we cannot help thinking that he would have perceived ſome parts of it to be tediouſly minute in deſcription, and others not very perſpicuous at the firſt peruſal. It may perhaps, upon the whole, rank as high as the Ode by Collins on the Popular Superſtitions of the Highlands of Scotland; but to a higher place it has ſurely no claim.

We cannot conclude this ſection, and theſe examples, without recommending to the reader's peruſal Gray's *Progreſs of Poeſy*, which, in ſpite of the ſeverity of Johnſon's criticiſm, certainly ranks high among the odes which pretend to ſublimity. The firſt ſtanza, when examined by the frigid rules of grammatical criticiſm, is certainly not faultleſs; but its faults will be overlooked by every reader who has any portion of the author's fervor. It begins, "Awake, Æolian lyre, awake," &c.

Sect. III. *Of the Elegy.*

The *Elegy* is a *mournful* and *plaintive*, but yet ſweet and engaging, kind of poem. It was firſt invented to bewail the death of a friend; and afterwards uſed to expreſs the complaints of lovers, or any other melancholy ſubject. In proceſs of time, not only matters of grief, but joy, wiſhes, prayers, expoſtulations, reproaches, admonitions, and almoſt every other ſubject, were admitted into elegy: however, funeral lamentations and affairs of love ſeem moſt agreeable to its character, which is gentleneſs and tenuity.

> The plaintive elegy, in mournful ſtate,
> Diſhevell'd weeps the ſtern decrees of fate:
> Now paints the lover's torments and delights;
> Now the nymph flatters, threatens, or invites.
> But he who would theſe paſſions well expreſs
> Muſt more of love than poetry poſſeſs.
> I hate thoſe lifeleſs writers whoſe forc'd fire
> In a cold ſtyle deſcribes a hot deſire;
> Who ſigh by rule, and, raging in cold blood,
> Their ſluggiſh muſe ſpur to an am'rous mood.
> Their ecſtaſies inſipidly they feign;
> And always pine, and fondly hug their chain;
> Adore their priſon, and their ſuff'rings bleſs;
> Make ſenſe and reaſon quarrel as they pleaſe.
> 'Twas not of old in this affected tone
> That ſmooth Tibullus made his am'rous moan;
> Or tender Ovid, in melodious ſtrains,
> Of love's dear art the pleaſing rules explains.
> You who in elegy would juſtly write,
> Conſult your heart; let that alone indite.
> [*From the French of* Deſpreux.] Soames.

The plan of an elegy, as indeed of all other poems, ought to be made before a line is written, or elſe the author will ramble in the dark, and his verſes have no dependence on each other. No *epigrammatic points* or *conceits*, none of thoſe *fine things* which moſt people are ſo fond of in every ſort of poem, can be allowed in this, but muſt give place to nobler beauties, thoſe of *nature* and the *paſſions*. Elegy rejects whatever is facetious, ſatirical, or majeſtic, and is content to be plain, decent, and unaffected; yet in this humble ſtate is ſhe ſweet and engaging, elegant and attractive. This poem is adorned with frequent *commiſerations*, *complaints*, *exclamations*, *addreſſes to things or perſons*, ſhort and proper *digreſſions*, *alluſions*, *compariſons*, *proſopopœias* or feigned perſons, and ſometimes with ſhort *deſcriptions*. The diction ought to be free from any *harſhneſs*; *neat*, *eaſy*, *perſpicuous*, *expreſſive of the manners*, *tender*, and *pathetic*; and the numbers ſhould be *ſmooth* and *flowing*, and captivate the ear with their uniform ſweetneſs and delicacy.

Of elegies on the ſubject of death, that by Mr. Gray, written in a country church-yard, is one of the beſt that has appeared in our language, and may be juſtly eſteemed a maſterpiece. But, being ſo generally known, it would be ſuperfluous to inſert it here.

On the ſubject of love, examples are to be found in the elegies of Mr. Hammond.

Sect. IV. *Of the Paſtoral.*

This poem takes its name from the Latin word *paſtor*, a "ſhepherd;" the ſubject of it being ſomething in the paſtoral or rural life; and the perſons, interlocutors, introduced in it, either ſhepherds or other ruſtics.

Theſe poems are frequently called *eclogues*, which ſignifies "ſelect or choice pieces;" though ſome account for this name in a different manner. They are alſo called *bucolicks*, from βȣκολος, "a herdſman."

This kind of poem, when happily executed, gives great delight; nor is it a wonder, ſince innocence and ſimplicity generally pleaſe: to which let us add, that the ſcenes of paſtorals are uſually laid in the country, where both poet and painter have abundant matter for the exerciſe of genius, ſuch as enchanting proſpects, purling ſtreams, ſhady groves, enamelled meads, flowery lawns, rural amuſements, the bleating of flocks, and the muſic of birds; which is of all melody the moſt ſweet and pleaſing, and calls to our mind the wiſdom and taſte of Alexander, who, on being importuned to hear a man that imitated the notes of the nightingale, and was thought a great curioſity, replied, that *he had had the happineſs of hearing the nightingale herſelf.*

The character of the paſtoral conſiſts in ſimplicity, brevity, and delicacy; the two firſt render an eclogue *natural*, and the laſt *delightful*. With reſpect to nature, indeed, we are to conſider, that as a paſtoral is an image of the ancient times of innocence and undeſigning plainneſs, we are not to deſcribe ſhepherds as they really are at this day, but as they may be conceived then to have been, when the beſt of men, and even princes, followed the employment. For this reaſon, an air of piety ſhould run through the whole poem, which is viſible in the writings of antiquity.

To make it natural with reſpect to the preſent age, ſome knowledge in rural affairs ſhould be diſcovered, and that in ſuch a manner as if it was done by chance rather than by deſign; leſt, by too much pains to ſeem natural, that ſimplicity be deſtroyed from whence ariſes the delight; for, what is ſo engaging in this kind of poeſy proceeds not ſo much from the idea of a country-life itſelf, as in expoſing only the beſt part of a ſhepherd's life, and concealing the misfortunes and miſeries which ſometimes attend it. Beſides, the ſubject muſt contain ſome particular beauty in itſelf, and each eclogue preſent a ſcene or proſpect to our view enriched with variety; which variety is in a great meaſure obtained by frequent compariſons drawn from the moſt agreeable objects of the country; by interrogations to things inanimate; by ſhort and beautiful digreſſions; and by elegant turns on the words, which render the numbers more ſweet and pleaſing. To this let us add, that the connections muſt be negligent, the narrations and deſcriptions ſhort, and the periods conciſe.

Riddles, parables, proverbs, antique phraſes, and ſuperſtitious fables, are fit materials to be intermixed with this kind of poem. They are here, when properly applied, very ornamental; and the more ſo as they give our modern compoſitions the air of the ancient manner of writing.

The ſtyle of the paſtoral ought to be humble, yet pure; neat, but not florid; eaſy, and yet lively: and the numbers ſhould be ſmooth and flowing.

This poem in general ſhould be ſhort, and ought never much to exceed 100 lines; for we are to conſider, that the ancients made this ſort of compoſition their amuſement, and not their buſineſs: but, however ſhort they are, every eclogue muſt contain a plot or fable, which muſt be ſimple and one; but yet ſo managed as to admit of ſhort digreſſions. Virgil has always obſerved this.—We ſhall give the plot or argument of his firſt paſtoral as an example. Melibœus, *an unfortunate ſhepherd, is introduced with* Tityrus, *one in more fortunate circumſtances; the former addreſſes the complaint of his ſufferings and baniſhment to the latter, who enjoys his flocks and folds in the midſt of the public calamity, and therefore expreſſes his gratitude to the benefactor from whom this favour flowed: but* Melibœus *accuſes fortune, civil wars, and bids adieu to his native country*. This is therefore a dialogue.

But we are to obſerve, that the poet is not always obliged to make his eclogue *allegorical*, and to have real perſons repreſented by the fictitious characters introduced, but is in this reſpect entirely at his own liberty.

Nor does the nature of the poem require it to be always carried on by way of dialogue; for a ſhepherd may with propriety ſing the praiſes of his love, complain of her inconſtancy, lament her abſence, her death, &c. and addreſs himſelf to groves, hills, rivers, and ſuch like rural objects, even when alone.

We ſhall now mention each of thoſe authors who have eminently diſtinguiſhed themſelves by this manner of writing, and introduce them in the order of time in which they wrote.

Theocritus, who was the father or inventor of this kind of poetry, has been deſervedly eſteemed by the beſt critics; and by ſome, whoſe judgment we cannot diſpute, preferred to all other paſtoral writers, with perhaps the ſingle exception of the tender and delicate Geſner.

Virgil ſucceeds Theocritus, from whom he has in ſome places copied, and always imitated with ſucceſs. As a ſpecimen of his manner, we refer to his firſt paſtoral, which is generally allowed to be the moſt perfect.

Spenſer was the firſt of our countrymen who acquired any conſiderable reputation by this method of writing. We recommend a peruſal of his ſixth eclogue, or that for June, which is allegorical, as will be ſeen by the ARGUMENT.—"Hobbinol, from a deſcription of the pleaſures of the place, excites Colin to the enjoyment of them. Colin declares himſelf incapable of delight, by reaſon of his ill ſucceſs in love, and his loſs of Roſalind, who had treacherouſly forſaken him for Menalcas another ſhepherd. By Tityrus (mentioned before in Spenſer's ſecond eclogue, and again in the twelfth) is plainly meant Chaucer, whom the author ſometimes profeſſed to imitate. In the perſon of Colin is repreſented the author himſelf; and Hobbinol's inviting him to leave the hill-country ſeems to allude to his leaving the North, where, as is mentioned in his Life, he had for ſome time reſided."—We regret that the length of this and other poems of which we have ſpoken precludes their admiſſion in theſe pages.

Mr. Pope's Paſtorals afterwards appeared, but in a different dreſs from thoſe of Spenſer and Philips; for he has diſcarded all antiquated words, drawn his ſwains more modern and polite, and made his numbers exquiſitely harmonious: his eclogues, therefore, may be called *better poems*, but not better paſtorals.

To the paſtorals we have referred to, which are written agreeably to the taſte of antiquity, and the rules above preſcribed, we might ſubjoin another that may be called *burleſque paſtoral*, wherein the ingenious author, Mr. Gay, has ventured to deviate from the beaten road, and deſcribed the ſhepherds and ploughmen of our own time and country, inſtead of thoſe of the golden age, to which the modern critics confine the paſtoral. His ſix paſtorals, which he calls the *Shepherd's Week*, are a beautiful and lively repreſentation of the manners, cuſtoms, and notions, of our ruſtics.

We have given the rules uſually laid down for paſtoral-writing, and exhibited ſome examples written on this plan; but we have to obſerve, that this poem may take very different forms. It may appear either as a comedy or a paſtoral. As a paſtoral comedy, there is nothing perhaps which poſſeſſes equal merit with Ramſay's *Gentle Shepherd*, and we know not where to find in any language a rival to the *Paſtoral Ballad* of Shenſtone. That the excellence of this poem is great can hardly be queſtioned, ſince it compelled a critic who was never laviſh of his praiſe, and who on all occaſions was ready to vilify the paſtoral, to expreſs himſelf in terms of high encomium. "In the firſt part (ſays he) are two paſſages, to which if any mind denies its ſympathy, it has no acquaintance with love or nature :

I priz'd every hour that went by,
Beyond all that had pleas'd me before ;
But now they are paſt, and I ſigh,
And I grieve that I priz'd them no more.
When forc'd the fair nymph to forego,
What anguiſh I felt in my heart !
Yet I thought—(but it might not be ſo,)
'Twas with pain that ſhe ſaw me depart.
She gaz'd, as I ſlowly withdrew,
My path I could hardly diſcern ;
So ſweetly ſhe bade me adieu,
I thought that ſhe bade me return.

" In the ſecond (continues the ſame critic) this paſſage has its prettineſs, though it be not equal to the former :"

I have found out a gift for my fair ;
I have found where the wood-pigeons breed :
But let me that plunder forbear,
She would ſay 'twas a barbarous deed :
For he ne'er could be true, ſhe averr'd,
Who could rob a poor bird of its young ;
And I lov'd her the more when I heard
Such tenderneſs fall from her tongue.

SECT. V. *Of Didactic or Preceptive Poetry.*

THE method of writing precepts in verſe, and embelliſhing them with the graces of poetry, had its riſe, we may ſuppoſe, from a due conſideration of the frailties and perverſeneſs of human nature ; and was intended to engage the affections, in order to improve the mind and amend the heart.

Didactic or preceptive poetry has been uſually employed either to illuſtrate and explain our moral duties, our philoſophical inquiries, our buſineſs and pleaſures ; or in teaching the art of criticiſm or poetry itſelf. It may be adapted, however, to any other ſubject ; and may in all caſes, where inſtruction is deſigned, be employed to good purpoſe. Some ſubjects, indeed, are more proper than others, as they admit of more poetical ornaments, and give a greater latitude to genius : but whatever the ſubject is, thoſe precepts are to be laid down that are the moſt uſeful : and they ſhould follow each other in a natural eaſy method, and be delivered in the moſt agreeable engaging manner. What the proſe writer tells you ought to be done, the poet often conveys under the form of a narration, or ſhows the neceſſity of in a deſcription ; and, by repreſenting the action as done, or doing, conceals the precept that ſhould enforce it. The poet likewiſe, inſtead of telling the whole truth, or laying down all the rules that are requiſite, ſelects ſuch parts only as are the moſt pleaſing, and communicates the reſt indirectly, without giving us an open view of them ; yet takes care that nothing ſhall eſcape the reader's notice with which he ought to be acquainted. He diſcloſes juſt enough to lead the imagination into the parts that are concealed ; and the mind, ever gratified with its own diſcoveries, is complimented with exploring and finding them out ; which, though done with eaſe, ſeems ſo conſiderable, as not to be obtained but in conſequence of its own adroitneſs and ſagacity.

But this is not ſufficient to render didactic poetry always pleaſing : for, where precepts are laid down one after another, and the poem is of conſiderable length, the mind will require ſome recreation and refreſhment by the way ; which is to be procured by ſeaſonable moral reflections, pertinent remarks, familiar ſimilies, and deſcriptions naturally introduced, by alluſions to ancient hiſtories or fables, and by ſhort and pleaſant digreſſions and excurſions into more noble ſubjects, ſo aptly brought in, that they may ſeem to have a remote relation, and be of a piece with the poem. By thus varying the form of inſtruction, the poet gives life to his precepts, and awakens and ſecures our attention, without permitting us to ſee by what means we are thus captivated : and his art is the more to be admired, becauſe it is ſo concealed as to eſcape the reader's obſervation.

The ſtyle, too, muſt maintain a dignity ſuitable to the ſubject, and every part be drawn in ſuch lively colours, that the things deſcribed may ſeem as if preſented to the reader's view.

But all this will appear more evident from example ; and though entire poems of this kind are not within the compaſs of our deſign, we ſhall endeavour to ſelect ſuch paſſages as will be ſufficient to illuſtrate the rules we have here laid down.

We have already obſerved, that, according to the uſual diviſions, there are four kinds of didactic poems, viz. thoſe that reſpect our moral duties, our philoſophical ſpeculations, our buſineſs and pleaſures, or that give precepts for poetry and criticiſm.

I. On the firſt ſubject, indeed, we have ſcarce any thing that deſerves the name of poetry, except Mr. Pope's *Eſſay on Man*, his *Ethic Epiſtles*, Blackmore's *Creation*, and part of Young's *Night Thoughts ;* to which therefore we refer as examples.

II. Thoſe preceptive poems that concern philoſophical ſpeculations, though the ſubject is ſo pregnant with matter, affords ſuch a field for fancy, and is ſo capable of every decoration, are but few. Lucretius is the moſt conſiderable among the ancients who has written in this manner ; among the moderns we have little elſe but ſmall detached pieces, except the poem called *Anti-Lucretius*, which has not yet received an Engliſh dreſs ; Dr. Akenſide's *Pleaſures of the Imagination*, and Dr. Darwin's *Botanic Garden ;* which are all worthy of our admiration. Some of the ſmall pieces in this department are alſo well executed ; and there is one entitled *The Univerſe*, written by Mr. Baker, from which we ſhall borrow an example.

The author's ſcheme is in ſome meaſure coincident with Mr. Pope's, ſo far eſpecially as it tends to reſtrain the pride of man ; with which deſign it was profeſſedly written.

The paſſage we have ſelected is that reſpecting the planetary ſyſtem.

Unwiſe ! and thoughtleſs ! impotent ! and blind !
Can wealth, or grandeur, ſatiſfy the mind ?
Of all thoſe pleaſures mortals moſt admire,
Is there one joy ſincere, that will not tire ?
Can love itſelf endure ? or beauty's charms
Afford that bliſs we fancy in its arms ?—
Then, let thy ſoul more glorious aims purſue :
Have thy CREATOR and his works in view.
Be theſe thy ſtudy : hence thy pleaſures bring :
And drink large draughts of wiſdom from its ſpring ;
That ſpring, whence perfect joy, and calm repoſe,
And bleſt content, and peace eternal, flows.
Obſerve how regular the planets run,
In ſtated times, their courſes round the Sun.
Diff'rent their bulk, their diſtance, their career,
And diff'rent much the compaſs of their year :
Yet all the ſame eternal laws obey,
While God's unerring finger points the way.
Firſt Mercury, amidſt full tides of light,
Rolls next the ſun, through his ſmall circle bright.
All that dwell here muſt be refin'd and pure :
Bodies like ours ſuch ardour can't endure :
Our earth would blaze beneath ſo fierce a ray,
And all its marble mountains melt away.
Fair Venus, next, fulfils her larger round,
With ſofter beams and milder glory crown'd.

Friend to mankind, ſhe glitters from afar,
Now the bright ev'ning, now the morning ſtar.
More diſtant ſtill, our earth comes rolling on,
And forms a wider circle round the ſun :
With her the moon, companion ever dear !
Her courſe attending through the ſhining year.
See, Mars, alone, runs his appointed race,
And meaſures out, exact, the deſtin'd ſpace :
Nor nearer does he wind, nor farther ſtray,
But finds the point whence firſt he roll'd away.
More yet remote from day's all-cheering ſource,
Vaſt Jupiter performs his conſtant courſe:
Four friendly moons with borrow'd luſtre riſe,
Beſtow their beams divine, and light his ſkies.
Fartheſt and laſt, ſcarce warm'd by Phœbus' ray,
Through his vaſt orbit Saturn wheels away.
How great the change could we be wafted there !
How ſlow the ſeaſons ! and how long the year !
One moon, on us, reflects its cheerful light :
There, five attendants brighten up the night.
Here, the blue firmament bedeck'd with ſtars ;
There, over-head, a lucid arch appears.
From hence, how large, how ſtrong, the ſun's bright ball !
But ſeen from thence, how languid and how ſmall !—
When the keen north with all its fury blows,
Congeals the floods, and forms the fleecy ſnows,
'Tis heat intenſe to what can there be known :
Warmer our poles than is its burning zone.
Who there inhabit muſt have other pow'rs,
Juices, and veins, and ſenſe, and life, than ours.
One moment's cold, like theirs, would pierce the bone,
Freeze the heart-blood, and turn us all to ſtone.
Strange and amazing muſt the diff'rence be
'Twixt this dull planet and bright Mercury :
Yet reaſon ſays, nor can we doubt at all,
Millions of beings dwell on either ball,
With conſtitutions fitted for that ſpot,
Where Providence, all-wiſe, has fix'd their lot.
Wondrous art thou, O God, in all thy ways !
Their eyes to thee let all thy creatures raiſe ;
Adore thy grandeur, and thy goodneſs praiſe.
Ye ſons of men ! with ſatisfaction know,
God's own right hand diſpenſes all below :
Nor good nor evil does by chance befall ;
He reigns ſupreme, and he directs it all.
At his command, affrighting human-kind,
Comets drag on their blazing lengths behind :
Nor, as we think, do they at random rove,
But, in determin'd times, through long ellipſes move.
And tho' ſometimes they near approach the ſun,
Sometimes beyond our ſyſtem's orbit run ;
Throughout their race they act their Maker's will,
His pow'r declare, his purpoſes fulfil.

III. Of thoſe preceptive poems that treat of the buſineſs and pleaſures of mankind, Virgil's *Georgics* claim our firſt and principal attention. In theſe he has laid down the rules of huſbandry in all its branches with the utmoſt exactneſs and perſpicuity, and at the ſame time embelliſhed them with all the beauties and graces of poetry. Though his ſubject was huſbandry, he has delivered his precepts, as Mr. Addiſon obſerves, not with the ſimplicity of a ploughman, but with the addreſs of a poet : the meaneſt of his rules are laid down with a kind of grandeur ; *and he breaks the clods, and toſſes about the dung, with an air of gracefulneſs.* Of the different ways of conveying the ſame truth to the mind, he takes that which is pleaſanteſt ; and this chiefly diſtinguiſhes poetry from proſe, and renders Virgil's rules of huſbandry more delightful and valuable than any other.

Theſe poems, which are eſteemed the moſt perfect of the author's works, are, perhaps, the beſt that can be propoſed for the young ſtudent's imitation in this manner of writing ; for the whole of his *Georgics* is wrought up with wonderful art, and decorated with all the flowers of poetry.

IV. Of thoſe poems which give precepts for the recreations and pleaſures of a country life, we have ſeveral in our own language that are juſtly admired. As the moſt conſiderable of thoſe diverſions, however, are finely treated by Mr. Gay in his *Rural Sports,* we particularly refer to that poem.

We ſhould here treat of thoſe preceptive poems that teach the art of poetry itſelf, of which there are many that deſerve particular attention ; but we have anticipated our deſign, and rendered any further notice of them in a manner uſeleſs, by the obſervations we have made in the courſe of this treatiſe. We ought however to remark, that Horace was the only poet among the ancients who wrote precepts for poetry in verſe ; at leaſt his epiſtle to the Piſos is the only piece of the kind that has been handed down to us ; and that is ſo perfect, it ſeems almoſt to have precluded the neceſſity of any other. Among the moderns we have ſeveral that are juſtly admired ; as Boileau, Pope, &c.

Poets who write in the preceptive manner ſhould take care to chooſe ſuch ſubjects as are worthy of their muſe, and of conſequence to all mankind ; for, to beſtow both parts and pains to teach people trifles that are unworthy of their attention, is to the laſt degree ridiculous.

Among poems of the uſeful and intereſting kind, Dr. Armſtrong's *Art of Preſerving Health* deſerves particular recommendation, as well in conſideration of the ſubject, as of the elegant and maſterly manner in which he has treated it ; for he has made thoſe things, which are in their own nature dry and unentertaining, perfectly agreeable and pleaſing, by adhering to the rules obſerved by Virgil and others, in the conduct of theſe poems.

With regard to the ſtyle or dreſs of theſe poems, it ſhould be ſo rich as to hide the nakedneſs of the ſubject, and the barrenneſs of the precepts ſhould be loſt in the luſtre of the language. " It ought to abound in the moſt bold and forcible metaphors, the moſt glowing and pictureſque epithets ; it ought to be elevated and enlivened by pomp of numbers and majeſty of words, and by every figure that can lift a language above the vulgar and current expreſſions." One may add, that in no kind of poetry (not even in the ſublime ode) is beauty of expreſſion ſo much to be regarded as in this. For the epic writer ſhould be very cautious of indulging himſelf in too florid a manner of expreſſion, eſpecially in the dramatic parts of his fable, where he introduces dialogue : and the writer of tragedy cannot fall into ſo nauſeous and unnatural an affectation, as to put laboured deſcriptions, pompous epithets, ſtudied phraſes, and high flown metaphors, into the mouths of his characters. But as the didactic poet ſpeaks in his own perſon, it is neceſſary and proper for him to uſe a brighter colouring of ſtyle, and to be more ſtudious of ornament. And this is agreeable to an admirable precept of Ariſtotle, which no writer ſhould ever forget, " That diction ought moſt to be laboured in the unactive, that is, the deſcriptive, parts of a poem, in which the opinions, manners, and paſſions of men are not repreſented ; for too glaring an expreſſion obſcures the manners and the ſentiments."

We have already obſerved that any thing in nature may be the ſubject of this poem. Some things however will appear to more advantage than others, as they give a greater latitude to genius, and admit of more poetical ornaments. Natural hiſtory and philoſophy are copious ſubjects. Precepts in theſe might be decorated with all the flowers in poetry ; and, as Dr.

Trapp obſerves, how can poetry be better employed, or more agreeably to its nature and dignity, than in celebrating the works of the great Creator, and deſcribing the nature and generation of animals, vegetables, and minerals; the revolutions of the heavenly bodies; the motions of the earth; the flux and reflux of the ſea; the cauſe of thunder, lightning, and other meteors; the attraction of the magnet; the gravitation, coheſion, and repulſion of matter; the impulſive motion of light; the ſlow progreſſion of ſounds; and other amazing phenomena of nature? Moſt of the arts and ſciences are alſo proper ſubjects for this poem; and none are more ſo than its two ſiſter arts, painting and muſic. In the former, particularly, there is room for the moſt entertaining precepts concerning the diſpoſal of colours; the arrangement of lights and ſhades; the ſecret attractives of beauty; the various ideas which make up the one; the diſtinguiſhing between the attitudes proper to either ſex, and every paſſion; the repreſenting proſpects of buildings, battles, or the country; and laſtly, concerning the nature of imitation, and the power of painting. What a boundleſs field of invention is here! What room for deſcription, compariſon, and poetical fable! How eaſy the tranſition, at any time, from the draught to the original, from the ſhadow to the ſubſtance! and from hence, what noble excurſions may be made into hiſtory, into panegyric upon the greateſt beauties or heroes of the paſt or preſent age!

SECT. VI. *Of the Epiſtle.*

THIS ſpecies of writing, if we are permitted to lay down rules from the examples of our beſt poets, admits of great latitude, and ſolicits ornament and decoration: yet the poet is ſtill to conſider, that the true character of the epiſtle is eaſe and elegance; nothing therefore ſhould be forced or unnatural, laboured, or affected, but every part of the compoſition ſhould breathe an eaſy, polite, and unconſtrained freedom.

It is ſuitable to every ſubject; for, as the epiſtle takes place of diſcourſe, and is intended as a ſort of diſtant converſation, all the affairs of life and reſearches into nature may be introduced. Thoſe, however, which are fraught with compliment or condolence, that contain a deſcription of places, or are full of pertinent remarks, and in a familiar and humourous way deſcribe the manners, vices, and follies of mankind, are the beſt; becauſe they are moſt ſuitable to the true character of epiſtolary writing, and (buſineſs ſet apart) are the uſual ſubjects upon which our letters are employed.

All further rules and directions are unneceſſary; for this kind of writing is better learned by example and practice than by precept. We ſhall therefore, in conformity to our plan, ſelect a few epiſtles for the reader's imitation; which, as this method of writing has of late much prevailed, may be beſt taken, perhaps, from our modern poets.

The letter from Mr. Addiſon to Lord Halifax contains an elegant deſcription of the curioſities and places about Rome, together with ſuch reflections on the ineſtimable bleſſings of liberty as muſt give pleaſure to every Briton, eſpecially when he ſees them thus placed in direct oppoſition to the baneful influence of ſlavery and oppreſſion, which are ever to be ſeen among the miſerable inhabitants of thoſe countries.

Thee, goddeſs, thee, Britannia's iſle adores;
How has ſhe oft exhauſted all her ſtores,
How oft in fields of death thy preſence ſought,
Nor thinks the mighty prize too dearly bought!
On foreign mountain may the ſun refine
The grape's ſoft juice, and mellow it to wine,
With citron groves adorn a diſtant ſoil,
And the fat olive ſwell with floods of oil:
We envy not the warmer clime, that lies
In ten degrees of more indulgent ſkies,
Nor at the coarſeneſs of our heav'n repine,
Tho' o'er our heads the frozen Pleiads ſhine:
'Tis liberty that crowns Britannia's iſle,
And makes her barren rocks and her bleak mountains ſmile.
Others with tow'ring piles may pleaſe the ſight,
And in their proud aſpiring domes delight;
A nicer touch to the ſtretch'd canvas give,
Or teach their animated rocks to live:
'Tis Britain's care to watch o'er Europe's fate,
And hold in balance each contending ſtate,
To threaten bold preſumptuous kings with war,
And anſwer her afflicted neighbour's pray'r.
The Dane and Swede, rous'd up by fierce alarms,
Bleſs the wiſe conduct of her pious arms:
Soon as her fleets appear, their terrors ceaſe,
And all the northern world lies huſh'd in peace.
Th' ambitious Gaul beholds with ſecret dread
Her thunder aim'd at his aſpiring head,
And fain her godlike ſons would diſunite
By foreign gold, or by domeſtic ſpite;
But ſtrives in vain to conquer or divide,
Whom Naſſau's arms defend and counſels guide.
Fir'd with the name, which I ſo oft have found
The diſtant climes and diff'rent tongues reſound,
I bridle in my ſtruggling muſe with pain,
That longs to launch into a bolder ſtrain.
But I've already troubled you too long,
Nor dare attempt a more advent'rous ſong:
My humble verſe demands a ſofter theme,
A painted meadow, or a purling ſtream;
Unfit for heroes; whom immortal lays,
And lines like Virgil's, or like yours, ſhould praiſe.

There is alſo a fine ſpirit of freedom, and love of liberty, diſplayed in the letter written by Lord Lyttelton to Mr. Pope; and the meſſage from the ſhade of Virgil, which is truly poetical, and juſtly preceptive, may prove an uſeful leſſon to future bards. This letter begins, "*Immortal bard! for whom each muſe has wove,*" &c.

We have already obſerved, that the eſſential, and indeed the true characteriſtic of epiſtolary writing, is eaſe; and on this account, as well as others, the following letter from Mr. Pope to Miſs Blount, on her leaving town after the coronation, is to be admired:

As ſome fond virgin, whom her mother's care
Drags from the town to wholeſome country air;
Juſt when ſhe learns to roll a melting eye,
And hear a ſpark, yet think no danger nigh;
From the dear man unwilling ſhe muſt ſever,
Yet takes one kiſs before ſhe parts for ever:
Thus from the world fair Zephalinda flew,
Saw others happy, and with ſighs withdrew:
Not that their pleaſures cauſ'd her diſcontent;
She ſigh'd, not that they ſtay'd, but that ſhe went
She went, to plain-work, and to purling brooks,
Old-faſhion'd halls, dull aunts, and croaking rooks:
She went from op'ra, park, aſſembly, play,
To morning-walks, and pray'rs three hours a-day;
To part her time 'twixt reading and bohea,
To muſe, and ſpill her ſolitary tea,
Or o'er cold coffee trifle with the ſpoon,
Count the ſlow clock, and dine exact at noon;
Divert her eyes with pictures in the fire,
Hum half a tune, tell ſtories to the 'ſquire;
Up to her godly garret after ſeven,
There ſtarve and pray, for that's the way to heav'n.
Some 'ſquire, perhaps, you take delight to rack,
Whoſe game is whiſk, whoſe treat 's a toaſt in ſack;

Who viſits with a gun, preſents you birds,
Then gives a ſmacking buſs, and cries,—No words!
Or with his hound comes hollaing from the ſtable,
Makes love with nods, and knees beneath a table;
Whoſe laughs are hearty, tho' his jeſts are coarſe,
And loves you beſt of all things—but his horſe.
In ſome fair ev'ning, on your elbow laid,
You dream of triumphs in the rural ſhade;
In penſive thought recall the fancy'd ſcene,
See coronations riſe on every green;
Before you paſs th' imaginary ſights
Of lords, and earls, and dukes, and garter'd knights,
While the ſpread fan o'erſhades your cloſing eyes:
Then give one flirt, and all the viſion flies.
Thus vaniſh ſceptres, coronets, and balls,
And leave you in lone woods, or empty walls!
So when your ſlave, at ſome dear idle time,
(Not plagu'd with head-achs, or the want of rhyme)
Stands in the ſtreets, abſtracted from the crew,
And, while he ſeems to ſtudy, thinks of you;
Juſt when his fancy points your ſprightly eyes,
Or ſees the bluſh of ſoft Parthenia riſe,
Gay pats my ſhoulder, and you vaniſh quite,
Streets, chairs, and coxcombs, ruſh upon my ſight;
Vex'd to be ſtill in town, I knit my brow,
Look ſour, and hum a tune, as you may now.

Sect. VII. *Of Deſcriptive Poetry.*

Descriptive poetry is of univerſal uſe, ſince there is nothing in nature but what may be deſcribed. As poems of this kind, however, are intended more to delight than to inſtruct, great care ſhould be taken to make them agreeable. Deſcriptive poems are made beautiful by ſimilies properly introduced, images of feigned perſons, and alluſions to ancient fables or hiſtorical facts; as will appear by a peruſal of the beſt of theſe poems, eſpecially Milton's *L'Allegro* and *Il Penſeroſo*, Denham's *Cooper's Hill*, and Pope's *Windſor Foreſt*. Every body being in poſſeſſion of Milton's works, we forbear inſerting the two former; and the others are too long for our purpoſe. That inimitable poem, *The Seaſons*, by Mr. Thomſon, notwithſtanding ſome parts of it are didactic, may be alſo with propriety referred to this head.

Sect. VIII. *Of Allegorical Poetry.*

Could truth engage the affections of mankind in her native and ſimple dreſs, ſhe would require no ornament or aid from the imagination; but her delicate light, though lovely in itſelf, and dear to the moſt diſcerning, does not ſtrike the ſenſes of the multitude ſo as to ſecure their eſteem and attention: the poets therefore dreſſed her up in the manner in which they thought ſhe would appear the moſt amiable, and called in allegories and airy diſguiſes as her auxiliaries in the cauſe of virtue.

An allegory is a fable or ſtory, in which, under the diſguiſe of imaginary perſons or things, ſome real action or inſtructive moral is conveyed to the mind. Every allegory therefore has two ſenſes, the one literal and the other myſtical; the firſt has been aptly enough compared to a dream or viſion, of which the laſt is the true meaning or interpretation.

From this definition of allegorical poetry the reader will perceive that it gives great latitude to genius, and affords ſuch a boundleſs ſcope for invention, that the poet is allowed to ſoar beyond all creation; to give life and action to virtues, vices, paſſions, diſeaſes, and natural and moral qualities; to raiſe floating iſlands, enchanted palaces, caſtles, &c. and to people them with the creatures of his own imagination.

The poet's eye, in a fine phrenſy rolling,
Doth glance from heav'n to earth, from earth to heav'n;
And, as imagination bodies forth
The forms of things unknown, the poet's pen
Turns them to ſhape, and gives to airy nothing
A local habitation and a name. Shakespeare.

But whatever is thus raiſed by the magic of his mind muſt be viſionary and typical, and the myſtical ſenſe muſt appear obvious to the reader, and inculcate ſome moral or uſeful leſſon in life; otherwiſe the whole will be deemed rather the effects of a diſtempered brain, than the productions of real wit and genius. The poet, like Jaſon, may ſail to parts unexplored, but will meet with no applauſe if he returns without a golden fleece; for theſe romantic reveries would be unpardonable but for the myſtical meaning and moral that is thus artfully and agreeably conveyed with them, and on which account only the allegory is indulged with a greater liberty than any other ſort of writing.

The ancients juſtly conſidered this ſort of allegory as the moſt eſſential part of poetry; for, the power of raiſing images of things not in being, giving them a ſort of life and action, and preſenting them as it were before the eyes, was thought to have ſomething in it like creation: but then, in ſuch compoſitions, they always expected to find a meaning couched under them of conſequence; and we may reaſonably conclude, that the allegories of their poets would never have been handed down to us, had they been deficient in this reſpect.

As the *fable* is the part immediately offered to the reader's conſideration, and intended as an agreeable vehicle to convey the moral, it ought to be bold, lively, and ſurpriſing, that it may excite curioſity and ſupport attention; for, if the fable be ſpiritleſs and barren of invention, the attention will be diſengaged, and the moral, however uſeful and important in itſelf, will be little regarded.

There muſt likewiſe be a juſtneſs and propriety in the fable, that is, it muſt be cloſely connected with the ſubject on which it is employed; for, notwithſtanding the boundleſs compaſs allowed the imagination in theſe writings, nothing abſurd or uſeleſs is to be introduced. In epic poetry ſome things may perhaps be admitted for no other reaſon but to ſurpriſe, and to raiſe what is called the *wonderful*, which is as neceſſary to the epic as the *probable*; but in allegories, however wild and extravagant the fable and the perſons introduced, each muſt correſpond with the ſubject they are applied to, and, like the members of a well-written ſimile, bear a due proportion and relation to each other: for we are to conſider, that the allegory is a ſort of extended or rather multiplied ſimile, and therefore, like that, ſhould never loſe the ſubject it is intended to illuſtrate. Whence it will appear, that genius and fancy are here inſufficient without the aid of taſte and judgment: theſe firſt, indeed, may produce a multitude of ornaments, a wilderneſs of ſweets; but the laſt muſt be employed to accommodate them to reaſon, and to arrange them ſo as to produce pleaſure and profit.

But it is not ſufficient that the fable be correſpondent with the ſubject, and have the properties above deſcribed; for it muſt alſo be conſiſtent with itſelf. The poet may invent what ſtory he pleaſes, and form any imaginary beings that his fancy ſhall ſuggeſt; but here, as in dramatic writings, when perſons are once introduced, they muſt be ſupported to the end, and all ſpeak and act in character: for, notwithſtanding the general licence here allowed, ſome order muſt be obſerved; and however wild and extravagant the characters, they ſhould not be abſurd. To this let me add, that the whole muſt be clear and intelligible; for the "fable (as Mr. Hughes obſerves) being deſigned only to clothe and adorn the moral, but not to hide it, ſhould reſemble the draperies we admire in ſome of the ancient ſtatues, in which the folds are not too many nor too thick, but ſo judiciouſly ordered, that the ſhape and beauty of the limbs may be ſeen through them."—But this will more obviouſly appear from a peruſal of the beſt compoſitions of this claſs; ſuch as Spenſer's Fairy Queen, Thomſon's Caſtle of Indolence, Addiſon and Johnſon's beautiful allegories in the Spectator and Rambler, &c. &c.

The word *allegory* has been uſed in a more extenſive ſenſe than that in which we have here applied it: for all writings, where the moral is conveyed under the cover of borrowed characters and actions, by which other characters and actions (that are real) are repreſented, have obtained the name of *allegories*; though the fable or ſtory contains nothing that is viſionary or romantic, but is made up of real or hiſtorical perſons, and of actions either probable or poſſible. But theſe writings ſhould undoubtedly be diſtinguiſhed by ſome other name, becauſe the literal ſenſe is conſiſtent with right reaſon, and may convey an uſeful moral, and ſatiſfy the reader, without putting him under the neceſſity of ſeeking for another.

Some of the ancient critics, as Mr. Addiſon obſerves, were fond of giving the works of their poets this ſecond or concealed meaning, though there was no apparent neceſſity for the attempt, and often but little ſhow of reaſon in the application. Thus the Iliad and Odyſſey of Homer are ſaid to be fables of this kind, and that the gods and heroes introduced are only the affections of the mind repreſented in a viſible ſhape and character. They tell us, ſays he, that Achilles in the firſt Iliad repreſents anger, or the iraſcible part of human nature: that upon drawing his ſword againſt his ſuperior in a full aſſembly, Pallas (which, ſay they, is another name for reaſon) checks and adviſes him on the occaſion, and at her firſt appearance touches him upon the head; that part of the man being looked upon as the ſeat of reaſon. In this ſenſe, as Mr. Hughes has well obſerved, the whole Æneis of Virgil may be ſaid to be an allegory, if you ſuppoſe Æneas to repreſent Auguſtus Cæſar, and that his conducting the remains of his countrymen from the ruins of Troy, to a new ſettlement in Italy, is an emblem of Auguſtus's forming a new government out of the ruins of the ariſtocracy, and eſtabliſhing the Romans, after the confuſion of the civil war, in a peaceable and flouriſhing condition. However ingenious this coincidence may appear, and whatever deſign Virgil had in view, he has avoided a particular and direct application, and ſo conducted his poem, that it is perfect without any allegorical interpretation; for, whether we conſider Æneas or Auguſtus as the hero, the morals contained are equally inſtructive. And indeed it ſeems abſurd to ſuppoſe, that becauſe the epic poets have introduced ſome allegories into their works, every thing is to be underſtood in a myſtical manner, where the ſenſe is plain and evident without any ſuch application. Nor is the attempt that Taſſo made to turn his Jeruſalem into a myſtery, any particular recommendation of the work: for, notwithſtanding he tells us, in what is called the *allegory*, printed with it, that the Chriſtian army repreſents man, the city of Jeruſalem civil happineſs, Godfrey the underſtanding, Rinaldo and Tancred the other powers of the ſoul, and that the body is typified by the common ſoldiers and the like; yet the reader will find himſelf as little delighted as edified by the explication: for the mind has little pleaſure in an allegory that cannot be opened without a key made by the hand of the ſame artiſt; and indeed every allegory that is ſo dark, and, as it were, inexplicable, loſes its very eſſence, and becomes an enigma or riddle, that is left to be interpreted by every crude imagination.

This laſt ſpecies of writing, whether called an *allegory*, or by any other name, is not leſs eminent and uſeful; for the introducing of real or hiſtorical perſons may not abridge or leſſen either our entertainment or inſtruction. In theſe compoſitions we often meet with an uncommon moral conveyed by the fable in a new and entertaining manner; or with a known truth ſo artfully decorated, and placed in ſuch a new and beautiful light, that we are amazed how any thing ſo charming and uſeful ſhould ſo long have eſcaped our obſervation. Such, for example, are many of Johnſon's pieces publiſhed in the Rambler under the title of *Eaſtern Stories*, and by Hawkeſworth in the Adventurer.

The ancient parables are of this ſpecies of writing: and it is to be obſerved, that thoſe in the New Teſtament have a moſt remarkable elegance and propriety; and are the moſt ſtriking, and the moſt inſtructive, for being drawn from objects that are familiar. The more ſtriking, becauſe, as the things are ſeen, the moral conveyed becomes the object of our ſenſes, and requires little or no reflection: the more inſtructive, becauſe, every time they are ſeen, the memory is awakened, and the ſame moral is again exhibited with pleaſure to the mind, and accuſtoms it to reaſon and dwell on the ſubject. So that this method of inſtruction improves nature, as it were, into a book of life; ſince every thing before us may be ſo managed, as to give leſſons for our advantage. Our Saviour's parables of the ſower and the ſeed, of the tares, of the muſtard-ſeed, and of the leaven (Matthew xiii.), are all of this kind, and were obviouſly taken from the harveſt juſt ripening before him; for *his diſciples plucked the ears of corn and did eat, rubbing them in their hands.* See the articles ALLEGORY, and METAPHOR *and Allegory*, in the general alphabet.

SECT. IX. *Of Fables.*

No method of inſtruction has been more ancient, more univerſal, and probably none more effectual, than that by apologue or fable. In the firſt ages, amongſt a rude and fierce people, this perhaps was the only method that would have been borne; and even ſince the progreſs of learning has furniſhed other helps, the fable, which at firſt was uſed through neceſſity, is retained from choice, on account of the elegant happineſs of its manner, and the refined addreſs with which, when well conducted, it inſinuates its moral.

As to the actors in this little drama, the fabuliſt has authority to preſs into his ſervice every kind of exiſtence under heaven; not only beaſts, birds, inſects, and all the animal creation; but flowers, ſhrubs, trees, and all the tribe of vegetables. Even mountains, foſſils, minerals, and the inanimate works of nature, diſcourſe articulately at his command, and act the part which he aſſigns them. The virtues, vices, and every property of beings, receive from him a local habitation and a name. In ſhort, he may perſonify, beſtow life, ſpeech, and action, on whatever he thinks proper.

It is eaſy to imagine what a ſource of novelty and variety this muſt open to a genius capable of conceiving and of employing theſe ideal perſons in a proper manner; what an opportunity it affords him to diverſify his images, and to treat the fancy with changes of objects, while he ſtrengthens the underſtanding, or regulates the paſſions, by a ſucceſſion of truths. To raiſe beings like theſe into a ſtate of action and intelligence, gives the fabuliſt an undoubted claim to that firſt character of the poet, a *creator*.

When theſe perſons are once raiſed, we muſt carefully enjoin them proper taſks, and aſſign them ſentiments and language ſuitable to their ſeveral natures and reſpective properties. A raven ſhould not be extolled for her voice, nor a bear be repreſented with an elegant ſhape. It were a very obvious inſtance of abſurdity to paint a hare cruel, or a wolf compaſſionate. An aſs were but ill qualified to be general of an army, though he may well enough ſerve, perhaps, for one of the trumpeters. But ſo long as popular opinion allows to the lion magnanimity, rage to the tiger, ſtrength to the mule, cunning to the fox, and buffoonery to the monkey; why may not they ſupport the characters of an Agamemnon, Achilles, Ajax, Ulyſſes, and Therſites? The truth is, when moral actions are with judgment attributed to the brute creation, we ſcarce perceive that nature is at all violated by the fabuliſt. He appears at moſt to have only tranſlated their language. His lions, wolves, and foxes, behave and argue as thoſe creatures would, had they originally been endowed with the human faculties of ſpeech and reaſon.

But greater art is yet required whenever we perſonify inanimate beings. Here the copy ſo far deviates from the great lines of nature, that, without the niceſt care, reaſon will revolt againſt the fiction. However, beings of this ſort, managed ingeniouſly and with addreſs, recommend the fabuliſt's invention by the grace of novelty and of variety. Indeed the analogy between things natural and artificial, animate and inanimate, is often ſo very ſtriking, that we can, with ſeeming propriety, give paſſions and ſentiments to every individual part of exiſtence. Appearance favours the deception. The vine may be enamoured of the elm; her embraces teſtify her paſſion. The ſwelling mountain may, naturally enough, be delivered of a mouſe. The gourd may reproach the pine, and the ſky-rocket inſult the ſtars. The axe may ſolicit a new handle of the foreſt; and the moon, in her female character, requeſt a faſhionable garment. Here is nothing incongruous; nothing that ſhocks the reader with impropriety. On the other hand, were the axe to deſire a periwig, and the moon petition for a new pair of boots, probability would then be violated, and the abſurdity become too glaring.

The moſt beautiful fables that ever were invented may be diſfigured by the language in which they are clothed. Of this poor Æſop, in ſome of his Engliſh dreſſes, affords a melancholy proof. The ordinary ſtyle of fable ſhould be familiar, but alſo elegant.

The familiar, ſays Mr. La Motte, is the general tone or accent of fable. It was thought ſufficient, on its firſt appearance, to lend the animals our moſt common language. Nor indeed have they any extraordinary pretenſions to the ſublime; it being requiſite they ſhould ſpeak with the ſame ſimplicity that they behave.

The familiar alſo is more proper for inſinuation than the elevated; this being the language of reflection, as the former is the voice of ſentiment. We guard ourſelves againſt the one, but lie open to the other; and inſtruction will always the moſt effectually ſway us, when it appears leaſt jealous of its rights and privileges.

The familiar ſtyle, however, that is here required, notwithſtanding that appearance of eaſe which is its character, is perhaps more difficult to write than the more elevated or ſublime. A writer more readily perceives when he has riſen above the common language, than he perceives, in ſpeaking this language, whether he has made the choice that is moſt ſuitable to the occaſion: and it is, nevertheleſs, upon this happy choice that all the charms of the familiar depend. Moreover, the elevated ſtyle deceives and ſeduces, although it be not the beſt choſen; whereas the familiar can procure itſelf no ſort of reſpect, if it be not eaſy, natural, juſt, delicate, and unaffected. A fabuliſt muſt therefore beſtow great attention upon his ſtyle; and even labour it ſo much the more, that it may appear to have coſt him no pains at all.

The authority of Fontaine juſtifies theſe opinions in regard to ſtyle. His fables are perhaps the beſt examples of the genteel familiar, as Sir Roger L'Eſtrange affords the groſſeſt of the indelicate and low. When we read, that "while the frog and the mouſe were diſputing it at ſwords-point, down comes a kite powdering upon them in the interim, and gobbets up both together to part the fray;" and "where the fox reproaches a bevy of jolly goſſiping wenches making merry over a diſh of pullets, that if he but peeped into a hen-rooſt, they always made a bawling with their dogs and their baſtards; while you yourſelves (ſays he) can lie ſtuffing your guts with your hens and capons, and not a word of the pudding:' this may be familiar; but it is alſo coarſe and vulgar, and cannot fail to diſguſt a reader that has the leaſt degree of taſte or delicacy.

The ſtyle of fable then muſt be ſimple and familiar; and it muſt likewiſe be correct and elegant. By the former, we mean, that it ſhould not be loaded with figure and metaphor; that the diſpoſition of words be natural, the turn of ſentences eaſy, and their conſtruction unembarraſſed. By elegance, we would exclude all coarſe and provincial terms; all affected and puerile conceits; all obſolete and pedantic phraſes. To this we would adjoin, as the word perhaps implies, a certain finiſhing poliſh, which gives a grace and ſpirit to the whole; and which, though it have always the appearance of nature, is almoſt ever the effect of art.

But notwithſtanding all that has been ſaid, there are ſome occaſions on which it is allowable, and even expedient, to change the ſtyle. The language of a fable muſt riſe or fall in conformity to the ſubject. A lion, when introduced in his regal capacity, muſt hold diſcourſe in a ſtrain ſomewhat more elevated than a country-mouſe. The lioneſs then becomes his queen, and the beaſts of the foreſt are called his ſubjects: a method that offers at once to the imagination both the animal and the perſon he is deſigned to repreſent. Again, the buffoon-monkey ſhould avoid that pomp of phraſe, which the owl employs as her beſt pretence to wiſdom. Unleſs the ſtyle be thus judiciouſly varied, it will be impoſſible to preſerve a juſt diſtinction of character.

Deſcriptions, at once conciſe and pertinent, add a grace to fable; but are then moſt happy when included in the action: whereof the fable of Boreas and the Sun affords us an example. An epithet well choſen is often a deſcription in itſelf; and ſo much the more agreeable, as it the leſs retards us in our purſuit of the cataſtrophe.

Laſtly, little ſtrokes of humour when ariſing naturally from the ſubject, and incidental reflections when kept in due ſubordination to the principal, add a value to theſe compoſitions. Theſe latter, however, ſhould be employed very ſparingly, and with great addreſs; be very few, and very ſhort: it is ſcarcely enough that they naturally ſpring out of the ſubject; they ſhould be ſuch as to appear neceſſary and eſſential parts of the fable. And when theſe embelliſhments, pleaſing in themſelves, tend to illuſtrate the main action, they then afford that nameleſs grace remarkable in Fontaine and ſome few others, and which perſons of the beſt diſcernment will more eaſily conceive than they can explain.

SECT. X. *Of Satire.*

THIS kind of poem is of very ancient date, and (if we believe Horace) was introduced by way of interlude, by the Greek dramatic poets in their tragedies, to relieve the audience, and take off the force of thoſe ſtrokes which they thought too deep and affecting. In thoſe ſatirical interludes, the ſcene was laid in the country; and the perſons were rural deities; ſatyrs, country peaſants, and other ruſtics.

> The firſt Tragedians found that ſerious ſtyle
> Too grave for their uncultivated age,
> And ſo brought wild and naked Satyrs in
> (Whoſe motion, words, and ſhape, were all a farce)
> As oft as decency would give them leave;
> Becauſe the mad ungovernable rout,
> Full of confuſion and the fumes of wine,
> Lov'd ſuch variety and antic tricks.
>
> ROSCOMMON'S *Horace.*

The ſatire we now have is generally allowed to be of Roman invention. It was firſt introduced without the decorations of ſcenes and action; but written in verſes of different meaſures by Ennius, and afterwards moulded into the form we now have it by Lucilius, whom Horace has imitated, and mentions with eſteem. This is the opinion of moſt of the critics, and particularly of Boileau, who ſays,

Lucilius led the way, and, bravely bold,
To Roman vices did the mirror hold;
Protected humble goodneſs from reproach,
Show'd worth on foot, and raſcals in a coach.
Horace his pleaſing wit to this did add,
That none, uncenſur'd, might be fools or mad:
And Juvenal, with rhetorician's rage,
Scourg'd the rank vices of a wicked age;
Tho' horrid truths thro' all his labours ſhine,
In what he writes there's ſomething of divine.

Our ſatire, therefore, may be diſtinguiſhed into two kinds; the *jocoſe*, or that which makes ſport with vice and folly, and ſets them up to ridicule; and the *ſerious*, or that which deals in aſperity, and is ſevere and acrimonious. Horace is a perfect maſter of the firſt, and Juvenal much admired for the laſt. The one is facetious, and ſmiles; the other is angry, and ſtorms. The foibles of mankind are the object of one; but crimes of a deeper dye have engaged the other. They both agree, however, in being pungent and biting: and from a due conſideration of the writings of theſe authors, who are our maſters in this art, we may define ſatire to be, A free, (and often jocoſe) witty, and ſharp poem, wherein the follies and vices of men are laſhed and ridiculed in order to their reformation. Its ſubject is whatever deſerves our contempt or abhorrence, (including every thing that is ridiculous and abſurd, or ſcandalous and repugnant to the golden precepts of religion and virtue.) Its manner is *invective*; and its end, *ſhame*. So that ſatire may be looked upon as the phyſician of a diſtempered mind, which it endeavours to cure by bitter and unſavoury, or by pleaſant and ſalutary applications.

A good ſatiriſt ought to be a man of wit and addreſs, ſagacity and eloquence. He ſhould alſo have a great deal of good-nature, as all the ſentiments which are beautiful in this way of writing muſt proceed from that quality in the author. It is good-nature produces that diſdain of all baſeneſs, vice and folly, which prompts the poet to expreſs himſelf with ſuch ſmartneſs againſt the errors of men, but without bitterneſs to their perſons. It is this quality that keeps the mind even, and never lets an offence unſeaſonably throw the ſatiriſt out of his character.

In writing ſatire, care ſhould be taken that it be true and general; that is, levelled at abuſes in which numbers are concerned: for the perſonal kind of ſatire, or lampoon, which expoſes particular characters, and affects the reputation of thoſe at whom it is pointed, is ſcarce to be diſtinguiſhed from ſcandal and defamation. The poet alſo, whilſt he is endeavouring to correct the guilty, muſt take care not to uſe ſuch expreſſions as may corrupt the innocent: he muſt therefore avoid all obſcene words and images that tend to debaſe and miſlead the mind. Horace and Juvenal, the chief ſatiriſts among the Romans, are faulty in this reſpect, and ought to be read with caution.

The ſtyle proper for ſatire is ſometimes grave and animated, inveighing againſt vice with warmth and earneſtneſs; but that which is pleaſant, ſportive, and, with becoming raillery, banters men out of their bad diſpoſitions, has generally the beſt effect, as it ſeems only to play with their follies, though it omits no opportunity of making them feel the laſh. The verſes ſhould be ſmooth and flowing, and the language manly, juſt, and decent.

Of well-choſe words ſome take not care enough,
And think they ſhould be as the ſubject rough:
But ſatire muſt be more exactly made,
And ſharpeſt thoughts in ſmootheſt words convey'd.

Duke of Bucks's *Eſſay*.

Satires, either of the *jocoſe* or *ſerious* kind, may be written in the epiſtolary manner, or by way of dialogue. Horace, Juvenal, and Perſius, have given us examples of both. Nay, ſome of Horace's ſatires may, without incongruity, be called *epiſtles*, and his epiſtles, *ſatires*. But this is obvious to every reader.

Of the facetious kind, the ſecond ſatire of the ſecond book of Horace imitated by Mr. Pope, and Swift's verſes on his own death, may be referred to as examples.

As to thoſe ſatires of the ſerious kind, for which Juvenal is ſo much diſtinguiſhed, the characteriſtic properties of which are morality, dignity, and ſeverity; a better example cannot be mentioned than the poem entitled *London*, written in imitation of the third ſatire of Juvenal, by Dr. Johnſon, who has kept up to the ſpirit and force of the original.

Nor muſt we omit to mention Dr. Young's *Love of Fame the Univerſal Paſſion*, in ſeven ſatires; which, though characteriſtical, abound with morality and good ſenſe. The characters are well ſelected, the ridicule is high, and the ſatire well pointed and to the purpoſe.

We have already obſerved, that perſonal ſatire approaches too near defamation to deſerve any countenance or encouragement. Dryden's *Mack Flecknoe* is for this reaſon exceptionable, but as a compoſition it is inimitable.

We have dwelt thus long on the preſent ſubject, becauſe there is reaſon to apprehend, that the benefits ariſing from well-conducted ſatire have not been ſufficiently conſidered. A ſatire may often do more ſervice to the cauſe of religion and virtue than a ſermon; ſince it gives pleaſure at the ſame time that it creates fear or indignation, and conveys its ſentiments in a manner the moſt likely to captivate the mind.

Of all the ways that wiſeſt men could find
To mend the age and mortify mankind,
Satire well writ has moſt ſucceſsful prov'd,
And cures, becauſe the remedy is lov'd.

Duke of Bucks's *Eſſay*.

But to produce the deſired effect, it muſt be jocoſe, free, and impartial, though ſevere. The ſatiriſt ſhould always preſerve good-humour; and, however keen he cuts, ſhould cut with kindneſs. When he loſes temper, his weapons will be inverted, and the ridicule he threw at others will retort with contempt upon himſelf: for the reader will perceive that he is angry and hurt, and conſider his ſatire as the effect of malice, not of judgement; and that it is intended rather to wound perſons than reform manners.

Rage you muſt hide, and prejudice lay down:
A ſatyr's ſmile is ſharper than his frown.

The beſt, and indeed the only method to expoſe vice and folly effectually, is to turn them to ridicule, and hold them up for public contempt; and as it moſt offends theſe objects of ſatire, ſo it leaſt hurts ourſelves. One paſſion frequently drives out another; and as we cannot look with indifference on the bad actions of men (for they muſt excite either our wrath or contempt), it is prudent to give way to that which moſt offends vice and folly, and leaſt affects ourſelves; and to ſneer and laugh, rather than be angry and ſcold.

Burleſque poetry, which is chiefly uſed by way of drollery and ridicule, falls properly to be ſpoken of under the head of ſatire. An excellent example of this kind is a poem in blank verſe, entitled *The Splendid Shilling*, written by Mr. John Philips, which, in the opinion of one of the beſt judges of the age, is the fineſt burleſque in the Engliſh language. In this poem the author has handled a low ſubject in the lofty ſtyle and numbers of Milton; in which way of writing Mr. Philips has been imitated by ſeveral, but none have come up to the humour and happy turn of the original. When we read it, we are betrayed into a pleaſure that we could not expect; though at the ſame time, the ſublimity of the ſtyle, and gravity of the phraſe, ſeem to chaſtiſe that laughter which they provoke.

There is another ſort of verſe and ſtyle, which is moſt frequently made uſe of in treating any ſubject in a ludicrous manner, viz. that which is generally called *Hudibraſtic*, from Butler's admirable poem entitled *Hudibras*. Almoſt every one knows, that this poem is a ſatire upon the authors of our civil diſſenſions in the reign of king Charles I. wherein the poet has, with abundance of wit and humour, expoſed and ridiculed the hypocriſy or blind zeal of thoſe unhappy times. In ſhort, it is a kind of burleſque epic poem, which, for the oddity of the rhymes, the quaintneſs of the ſimilies, the novelty of the thoughts, and that fine raillery which runs through the whole performance, is not to be paralleled.

Sect. XI. *Of the Epigram.*

THE *epigram is a little poem, or compoſition in verſe, treating of one thing only, and whoſe diſtinguiſhing characters are* brevity, beauty, and point.

The word *epigram* ſignifies "inſcription;" for epigrams derive their origin from thoſe inſcriptions placed by the ancients on their ſtatues, temples, pillars, triumphal arches, and the like; which, at firſt, were very ſhort, being ſometimes no more than a ſingle word; but afterwards increaſing their length, they made them in verſe, to be the better retained by the memory. This ſhort way of writing came at laſt to be uſed upon any occaſion or ſubject; and hence the name of *epigram* has been given to any little copy of verſes, without regard to the original application of ſuch poems.

Its uſual limits are from two to 20 verſes, though ſometimes it extends to 50; but the ſhorter, the better it is, and the more perfect, as it partakes more of the nature and character of this kind of poem: beſides, the epigram, being only a ſingle thought, ought to be expreſſed in a little compaſs, or elſe it loſes its force and ſtrength.

The beauty required in an epigram is a harmony and apt agreement of all its parts, a ſweet ſimplicity, and polite language.

The point is a ſharp, lively, unexpected turn of wit, with which an epigram ought to be concluded. There are ſome critics, indeed, who will not admit the point in an epigram; but require that the thought be equally diffuſed through the whole poem, which is uſually the practice of Catullus, as the former is that of Martial. It is allowed there is more delicacy in the manner of Catullus; but the point is more agreeable to the general taſte, and ſeems to be the chief characteriſtic of the epigram.

This ſort of poem admits of all manner of ſubjects, provided that brevity, beauty, and point, are preſerved; but it is generally employed either in praiſe or ſatire.

Though the beſt epigrams are ſaid to be ſuch as are compriſed in two or four verſes, we are not to underſtand it as if none can be perfect which exceed thoſe limits. Neither the ancients nor moderns have been ſo ſcrupulous with reſpect to the length of their epigrams; but, however, brevity in general is always to be ſtudied in theſe compoſitions.

For examples of good epigrams in the Engliſh language, we ſhall make choice of ſeveral in the different taſtes we have mentioned; ſome remarkable for their delicate turn and ſimplicity of expreſſion; and others for their ſalt and ſharpneſs, their equivocating pun, or pleaſant alluſion. In the firſt place take that of Mr. Pope, ſaid to be written on a glaſs with the earl of Cheſterfield's diamond pencil.

Accept a miracle, inſtead of wit;
See two dull lines by Stanhope's pencil writ.

The beauty of this epigram is more eaſily ſeen than deſcribed; and it is difficult to determine, whether it does more honour to the poet who wrote it, or to the nobleman for whom the compliment is deſigned.—The following epigram of Mr. Prior is written in the ſame taſte, being a fine encomium on the performance of an excellent painter.

On a Flower painted by VARELST.

When fam'd Varelſt this little wonder drew,
Flora vouchſaf'd the growing work to view:
Finding the painter's ſcience at a ſtand,
The goddeſs ſnatch'd the pencil from his hand,
And, finiſhing the piece, ſhe ſmiling ſaid,
Behold one work of mine which ne'er ſhall fade.

Another compliment of this delicate kind he has made Mr. Howard in the following epigram.

VENUS *Miſtaken.*

When Chloe's picture was to Venus ſhown;
Surpris'd, the goddeſs took it for her own.
And what, ſaid ſhe, does this bold painter mean?
When was I bathing thus, and naked ſeen?
Pleas'd Cupid heard, and check'd his mother's pride:
And who's blind now, mamma? the urchin cry'd.
'Tis Chloe's eye, and cheek, and lip, and breaſt:
Friend Howard's genius fancy'd all the reſt.

Moſt of Mr. Prior's epigrams are of this delicate caſt, and have the thought, like thoſe of Catullus, diffuſed through the whole. Of this kind is his addreſs

To CHLOE *Weeping.*

See, whilſt thou weep'ſt, fair Chloe, ſee
The world in ſympathy with thee.
The cheerful birds no longer ſing,
Each drops his head, and hangs his wing.
The clouds have bent their boſom lower,
And ſhed their ſorrow in a ſhow'r.
The brooks beyond their limits flow,
And louder murmurs ſpeak their wo:
The nymphs and ſwains adopt thy cares;
They heave thy ſighs, and weep thy tears.
Fantaſtic nymph! that grief ſhould move
Thy heart obdurate againſt love!
Strange tears! whoſe pow'r can ſoften all
But that dear breaſt on which they fall.

The epigram written on the leaves of a fan by Dr. Atterbury, late biſhop of Rocheſter, contains a pretty thought, expreſſed with eaſe and conciſeneſs, and cloſed in a beautiful manner.

On a FAN.

Flavia the leaſt and ſlighteſt toy
Can with reſiſtleſs art employ.
This fan in meaner hands would prove
An engine of ſmall force in love:
Yet ſhe, with graceful air and mien,
Not to be told or ſafely ſeen,
Directs its wanton motion ſo,
That it wounds more than Cupid's bow,
Gives coolneſs to the matchleſs dame,
To ev'ry other breaſt a flame.

We ſhall now ſelect ſome epigrams of the biting and ſatirical kind, and ſuch as turn upon the *pun* or *equivoque*, as the French call it: in which ſort the point is more conſpicuous than in thoſe of the former character.

The following diſtich is an admirable epigram, having all the neceſſary qualities of one, eſpecially point and brevity.

On a Company of bad DANCERS *to good Muſic.*
How ill the motion with the muſic ſuits!
So Orpheus fiddled, and ſo danced the brutes.

This brings to mind another epigram upon a bad fiddler, which we ſhall venture to inſert merely for the humour of it, and not for any real excellence it contains.

To a bad FIDDLER.
Old Orpheus play'd ſo well, he mov'd Old Nick;
But thou mov'ſt nothing but thy fiddle-ſtick.

One of Martial's epigrams, wherein he agreeably rallies the fooliſh vanity of a man who hired people to make verſes for him, and publiſhed them as his own, has been thus tranſlated into Engliſh:

Paul ſo fond of the name of a poet is grown,
With gold he buys verſes, and calls them his own.
Go on, maſter Paul, nor mind what the world ſays;
They are ſurely his own for which a man pays.

Some bad writer having taken the liberty to cenſure Mr. Prior, the poet very wittily laſhed his impertinence in this epigram:

While faſter than his coſtive brain indites,
Philo's quick hand in flowing letters writes,
His caſe appears to me like honeſt Teague's,
When he was run away with by his legs.
Phœbus, give Philo o'er himſelf command;
Quicken his ſenſes, or reſtrain his hand:
Let him be kept from paper, pen, and ink;
So he may ceaſe to write, and learn to think.

Mr. Weſley has given us a pretty epigram, alluding to a well-known text of Scripture, on the ſetting up a monument in Weſtminſter Abbey to the memory of the ingenious Mr. Butler, author of *Hudibras*.

While Butler, needy wretch, was yet alive,
No generous patron would a dinner give.
See him when ſtarv'd to death, and turn'd to duſt,
Preſented with a monumental buſt!
The poet's fate is here in emblem ſhown:
He aſk'd for *Bread*, and he receiv'd a *Stone*.

We ſhall cloſe this ſection with an epigram written on the well-known ſtory of Apollo and Daphne, by Mr. Smart.

When Phœbus was am'rous, and long'd to be rude,
Miſs Daphne cry'd Piſh! and ran ſwift to the wood;
And rather than do ſuch a naughty affair,
She became a fine laurel to deck the god's hair.
The nymph was, no doubt, of a cold conſtitution;
For, ſure, to turn tree was an odd reſolution!
Yet in this ſhe behav'd like a true modern ſpouſe,
For ſhe fled from his arms to diſtinguiſh his brows.

SECT. XII. *Of the Epitaph.*

THESE compoſitions generally contain ſome eulogium of the virtues and good qualities of the deceaſed, and have a turn of ſeriouſneſs and gravity adapted to the nature of the ſubject. Their elegance conſiſts in a nervous and expreſſive brevity; and ſometimes they are cloſed with an epigrammatic point. In theſe compoſitions, no mere epithet (properly ſo called) ſhould be admitted; for here illuſtration would impair the ſtrength, and render the ſentiment too diffuſe and languid. Words that are ſynonymous are alſo to be rejected.

Though the true characteriſtic of the epitaph is ſeriouſneſs and gravity, yet we may find many that are jocoſe and ludicrous: ſome likewiſe have true metre and rhyme; while others are between proſe and verſe, without any certain meaſure, though the words are truly poetical; and the beauty of this laſt ſort is generally heightened by an apt and judicious antitheſis. We ſhall give examples of each.

The following epitaph on Sir Philip Sidney's ſiſter, the counteſs of Pembroke, ſaid to be written by the famous Ben Jonſon, is remarkable for the noble thought with which it concludes.

On MARY *Counteſs Dowager of* PEMBROKE.
Underneath this marble hearſe
Lies the ſubject of all verſe,
Sidney's ſiſter, Pembroke's mother:
Death, ere thou haſt kill'd another
Fair, and learn'd, and good as ſhe,
Time ſhall throw a dart at thee.

Take another epitaph of Ben Jonſon's, on a beautiful and virtuous lady, which has been deſervedly admired by very good judges.

Underneath this ſtone doth lie
As much virtue as could die;
Which when alive did vigour give
To as much beauty as could live.

The following epitaph, by Dr. Samuel Johnſon, on a muſician much celebrated for his performance, will bear a compariſon with theſe, or perhaps with any thing of the kind in the Engliſh language.

Philips! whoſe touch harmonious could remove
The pangs of guilty pow'r and hapleſs love,
Reſt here, diſtreſt by poverty no more;
Find here that calm thou gav'ſt ſo oft before;
Sleep undiſturb'd within this peaceful ſhrine,
Till angels wake thee with a note like thine.

It is the juſt obſervation of an eminent critic, that the beſt ſubject for epitaphs is private virtue; virtue exerted in the ſame circumſtances in which the bulk of mankind are placed, and which, therefore, may admit of many imitators. He that has delivered his country from oppreſſion, or freed the world from ignorance and error, beſides that he ſtands in no need of monumental panegyric, can excite the emulation of a very ſmall number. The bare name of ſuch men anſwers every purpoſe of a long inſcription, becauſe their achievements are univerſally known, and their fame is immortal.—But the virtues of him who has repelled the temptations of poverty, and diſdained to free himſelf from diſtreſs at the expenſe of his honour or his conſcience, as they were practiſed in private, are fit to be told, becauſe they may animate multitudes to the ſame firmneſs of heart and ſteadineſs of reſolution. On this account, there are few epitaphs of more value than the following, which was written by Pope on Mrs. Corbet, who died of a cancer in her breaſt.

Here reſts a woman, good without pretence,
Bleſt with plain reaſon, and with ſober ſenſe:
No conqueſt ſhe but o'er herſelf deſir'd;
No arts eſſay'd, but not to be admir'd.
Paſſion and pride were to her ſoul unknown,
Convinced that virtue only is our own.
So unaffected, ſo compos'd a mind,
So firm, yet ſoft, ſo ſtrong, yet ſo refin'd,
Heav'n, as its pureſt gold, by tortures try'd;
The ſaint ſuſtain'd it, but the woman dy'd.

This epitaph, as well as the ſecond quoted from Ben Jonſon, has indeed one fault; the name is omitted. The end of an epitaph is to convey ſome account of the dead; and to what purpoſe is any thing told of him whoſe name is concealed? The name, it is true, may be inſcribed by itſelf upon the ſtone; but ſuch a ſhift of the poet is like that of an unſkilful painter, who is obliged to make his purpoſe known by adventitious help.

Amongſt the epitaphs of a punning and ludicrous caſt, we know of none prettier than that which is ſaid to have been written by Mr. Prior on himſelf, wherein he is pleaſantly ſatirical upon the folly of thoſe who value themſelves upon account of the long ſeries of anceſtors through which they can trace their pedigree.

Nobles and heralds, by your leave,
  Here lie the bones of Matthew Prior,
The ſon of Adam and of Eve:
  Let Bourbon or Naſſau go higher.

The following epitaph on a miſer contains a good caution and an agreeable raillery.

Reader, beware immod'rate love of pelf:
Here lies the worſt of thieves, who robb'd himſelf.

But Dr. Swift's epitaph on the ſame ſubject is a maſterpiece of the kind.

Beneath this verdant hillock lies
Demar, the wealthy and the wiſe.
His heirs, that he might ſafely reſt,
Have put his carcaſe in a cheſt;
The very cheſt, in which, they ſay,
His other Self, his money, lay.
And if his heirs continue kind
To that dear ſelf he left behind,
I dare believe that four in five
Will think his better half alive.

We ſhall give but one example more of this kind, which is a merry epitaph on an old fiddler, who was remarkable (we may ſuppoſe) for beating time to his own muſic.

On STEPHEN *the Fiddler.*

Stephen and time are now both even;
Stephen beat time, now time's beat Stephen.

We are now come to that ſort of epitaph which rejects rhyme, and has no certain and determinate meaſure; but where the diction muſt be pure and ſtrong, every word have weight, and the antitheſis be preſerved in a clear and direct oppoſition. We cannot refer to a better example of this ſort of epitaph than that on the tomb of Mr. Pulteney in the cloiſters of Weſtminſter-abbey.

That poignant ſatire, as well as extravagant praiſe, may be conveyed in the manner of an epitaph, will be ſeen by the following written by Dr. Arbuthnot on Francis Chartres; which is too well known, and too much admired, to need our commendation.

HERE continueth to rot
The Body of FRANCIS CHARTRES,
Who with an INFLEXIBLE CONSTANCY,
And INIMITABLE UNIFORMITY of Life,
PERSISTED,
In ſpite of AGE and INFIRMITIES,
In the Practice of EVERY HUMAN VICE,
Excepting PRODIGALITY and HYPOCRISY:
His inſatiable AVARICE exempted him from the firſt,
His matchleſs IMPUDENCE from the ſecond.
Nor was he more ſingular
In the undeviating *Pravity* of his *Manners*,
Than ſucceſsful
In *Accumulating* WEALTH:
For, without TRADE or PROFESSION,
Without TRUST of PUBLIC MONEY,
And without BRIBE-WORTHY Service,
He acquired, or more properly created,
A MINISTERIAL ESTATE.
He was the only Perſon of his Time
Who could CHEAT without the Maſk of HONESTY;
Retain his Primæval MEANNESS
When poſſeſſed of TEN THOUSAND a-year;
And, having daily deſerved the GIBBET for what he *did*,
Was at laſt condemn'd to it for what he *could* not *do*.
Oh indignant Reader!
Think not his Life uſeleſs to Mankind:
PROVIDENCE connived at his execrable Deſigns,
To give to After-ages
A conſpicuous PROOF and EXAMPLE
Of how ſmall Eſtimation is EXORBITANT WEALTH
In the Sight of GOD,
By his beſtowing it on the moſt UNWORTHY of ALL
MORTALS.

PART III. ON VERSIFICATION.

ON this ſubject it is meant to confine our inquiry to Latin or Greek hexameters, and to French and Engliſh heroic verſe; as the obſervations we ſhall have occaſion to make, may, with proper variations, be eaſily transferred to the compoſition of other ſorts of verſe.

Before entering upon particulars, it muſt be premiſed in general, that to verſe of every kind five things are of importance. 1ſt, The number of ſyllables that compoſe a line. 2d, The different lengths of ſyllables, *i. e.* the difference of time taken in pronouncing. 3d, The arrangement of theſe ſyllables combined in words. 4th, The pauſes or ſtops in pronouncing. 5th, Pronouncing ſyllables in a high or a low tone. The three firſt mentioned are obviouſly eſſential to verſe: if any of them be wanting, there cannot be that higher degree of melody which diſtinguiſheth verſe from proſe. To give a juſt notion of the fourth, it muſt be obſerved, that pauſes are neceſſary for three different purpoſes: one, to ſeparate periods, and members of the ſame period, according to the ſenſe: another, to improve the melody of verſe: and the laſt, to afford opportunity for drawing breath in reading. A pauſe of the firſt kind is variable, being long or ſhort, frequent or leſs frequent, as the ſenſe requires. A pauſe of the ſecond kind being determined by the melody, is in no degree arbitrary. The laſt ſort is in a meaſure arbitrary, depending on the reader's command of breath. But as one cannot read with grace, unleſs, for drawing breath, opportunity be taken of a pauſe in the ſenſe or in the melody, this pauſe ought never to be diſtinguiſhed from the others; and for that reaſon ſhall be laid aſide. With reſpect then to the pauſes of ſenſe and of melody, it may be affirmed without heſitation, that their coincidence in verſe is a capital beauty: but as it cannot be expected, in a long work eſpecially, that every line ſhould be ſo perfect; we ſhall afterward have occaſion to ſee, that, unleſs the reader be uncommonly ſkilful, the pauſe neceſſary for the ſenſe muſt often, in ſome degree, be ſacrificed to the verſe-pauſe, and the latter ſometimes to the former.

The pronouncing ſyllables in a high or low tone contributes alſo to melody. In reading, whether verſe or proſe, a certain tone is aſſumed, which may be called the *key-note*; and in that tone the bulk of the words is ſounded. Sometimes to humour the ſenſe, and ſometimes the melody, a particular ſyllable is ſounded in a higher tone, and this is termed *accenting a ſyllable*, or gracing it with an accent. Oppoſed to the accent is the cadence, which, however, being entirely regulated by the ſenſe, hath no peculiar relation to verſe. The cadence is a falling of the voice below the key-note at the cloſe of every period; and ſo little is it eſſential to verſe, that in correct reading the final ſyllable of every line is accented, that ſyllable only excepted which cloſes the period, where the ſenſe requires a cadence.

Though the five requiſites above mentioned enter the compoſition of every ſpecies of verſe, they are, however, governed by different rules, peculiar to each ſpecies. Upon quantity only, one general obſervation may be premiſed, becauſe it is applicable to every ſpecies of verſe: That ſyllables, with reſpect to the time taken in pronouncing, are long or ſhort; two ſhort ſyllables, with reſpect to time, being preciſely equal to a long one. Theſe two lengths are eſſential to verſe of all kinds; and to no verſe, it is believed, is a greater variety of time neceſſary in pronouncing ſyllables. The voice, indeed, is frequently made to reſt longer than uſual upon a word that bears an important ſignification; but this is done to humour the ſenſe, and is not neceſſary for melody. A thing not more neceſſary for melody occurs with reſpect to accenting, ſimilar to that now mentioned: A word ſignifying any thing humble, low, or dejected, is naturally, in proſe as well as in verſe, pronounced in a tone below the key-note.

We are now ſufficiently prepared for particulars; beginning with Latin or Greek hexameter, which are the ſame. The obſervations upon this ſpecies of verſe will come under the four following heads; number, arrangement, pauſe, and accent; for, as to quantity, what is obſerved above may ſuffice.

I. HEXAMETER LINES, as to time, are all of the ſame length; being equivalent to the time taken in pronouncing twelve long ſyllables or twenty-four ſhort. An hexameter line may conſiſt of ſeventeen ſyllables; and when regular and not ſpondaic it never has fewer than thirteen: whence it follows, that where the ſyllables are many, the plurality muſt be ſhort; where few, the plurality muſt be long.

This line is ſuſceptible of much variety as to the ſucceſſion of long and ſhort ſyllables. It is, however, ſubjected to laws that confine its variety within certain limits: and for aſcertaining theſe limits, grammarians have invented a rule by dactyls and ſpondees, which they denominate *feet*.

Among the ancient Greeks and Romans, theſe feet regulated the pronunciation, which they are far from doing among us; of which the reaſon will be diſcovered from the explanation that we ſhall give of the Engliſh accent. We ſhall at preſent content ourſelves with pointing out the difference between our pronunciation and that of the Romans in the firſt line of Virgil's eclogues, where it is ſcarcely credible how much we pervert the quantity.

Ti′tyre tú pat′ulæ rec′ubans ſub teg′mine ſági.

It will be acknowledged by every reader who has an ear, that we have placed the accentual marks upon every ſyllable, and the letter of every ſyllable, that an Engliſhman marks with the *ictus* of his voice when he recites the line. But, as will be ſeen preſently, a ſyllable which is pronounced with the ſtreſs of the voice upon a conſonant is uttered in the ſhorteſt time poſſible. Hence it follows, that in this verſe, as recited by us, there are but two long ſyllables, *tú* and *fá*; though it is certain, that, as recited by a Roman, it contained no fewer than eight long ſyllables.

Tītўrĕ | tū pătŭ | lāē rĕcŭ | bāns ſūb | tĕgmĭnĕ | fāgi.

But though to pronounce it in this manner with the voice dwelling on the vowel of each long ſyllable would undoubtedly be correct, and preſerve the true movement of the verſe, yet to an Engliſh ear, prejudiced in behalf of a different movement, it ſounds ſo very uncouth, that lord Kames has pronounced the true feet of the Greek and Roman verſes extremely artificial and complex; and has ſubſtituted in their ſtead the following rules, which he thinks more ſimple and of more eaſy application. 1ſt, The line muſt always commence with a long ſyllable, and cloſe with two long preceded by two ſhort. 2d, More than two ſhort can never be found together, nor fewer than two. And, 3d, Two long ſyllables which have been preceded by two ſhort cannot alſo be followed by two ſhort. Theſe few rules fulfil all the conditions of an hexameter line with relation to order or arrangement. For theſe again a ſingle rule may be ſubſtituted, which has alſo the advantage of regulating more affirmatively the conſtruction of every part. To put this rule into words with perſpicuity, a hint is taken from the twelve long ſyllables that compoſe an hexameter line, to divide it into twelve equal parts or portions, being each of them one long ſyllable or two ſhort. The rule then is: "The 1ſt, 3d, 5th, 7th, 9th, 11th, and 12th portions muſt each of them be one long ſyllable; the 10th muſt always be two ſhort ſyllables; the 2d, 4th, 6th, and 8th, may either be one long or two ſhort." Or, to expreſs the thing ſtill more ſhortly, "The 2d, 4th, 6th, and 8th portions may be one long ſyllable or two ſhort; the 10th muſt be two ſhort ſyllables; all the reſt muſt conſiſt each of one long ſyllable." This fulfils all the conditions of an hexameter line, and comprehends all the combinations of dactyls and ſpondees that this line admits.

Next in order comes the pauſe. At the end of every hexameter line, every one muſt be ſenſible of a complete cloſe or full pauſe; the cauſe of which follows. The two long ſyllables preceded by two ſhort, which always cloſe an hexameter line, are a fine preparation for a pauſe: for long ſyllables, or ſyllables pronounced ſlow, reſembling a ſlow and languid motion tending to reſt, naturally incline the mind to reſt, or, which is the ſame, to pauſe; and to this inclination the two preceding ſhort ſyllables contribute, which, by contraſt, make the ſlow pronunciation of the final ſyllables the more conſpicuous. Beſide this complete cloſe or full pauſe at the end, others are alſo requiſite for the ſake of melody; of which two are clearly diſcoverable, and perhaps there may be more. The longeſt and moſt remarkable ſucceeds the 5th portion: the other, which, being ſhorter and more faint, may be called the *ſemipauſe*, ſucceeds the 8th portion. So ſtriking is the pauſe firſt mentioned, as to be diſtinguiſhed even by the rudeſt ear: the monkiſh rhymes are evidently built upon it; in which, by an invariable rule, the final word always chimes with that which immediately precedes the pauſe:

> De planctu cudo || metrum cum carmine nudo
>
> Mingere cum bumbis || res eſt ſaluberrima lumbis.

The difference of time in the pauſe and ſemipauſe occaſions another difference not leſs remarkable; that it is lawful to divide a word by a ſemipauſe, but never by a pauſe, the bad effect of which is ſenſibly felt in the following examples:

> Effuſus labor, at||que immitis rupta Tyranni

Again:

> Obſervans nido im||plumes detraxit; at illa

Again:

> Loricam quam De||moleo detraxerat ipſe

The dividing a word by a ſemipauſe has not the ſame bad effect:

> Jamque pedem referens || caſus e|vaſerat omnes,

Again :
Qualis populea || mœrens Philo|mela ſub umbra
Again :
Ludere quæ vellem || calamo per|miſit agreſti.

Lines, however, where words are left entire, without being divided even by a ſemipauſe, run by that means much the more ſweetly.

Nec gemere aërea || ceſſabit | turtur ab ulmo.
Again :
Quadrupedante putrem || ſonitu quatit | ungula campum.
Again :
Eurydicen toto || referebant | flumine ripæ.

The reaſon of theſe obſervations will be evident upon the ſlighteſt reflection. Between things ſo intimately connected in reading aloud as are ſenſe and ſound, every degree of diſcord is unpleaſant: and for that reaſon it is a matter of importance to make the muſical pauſes coincide as much as poſſible with thoſe of ſenſe; which is requiſite more eſpecially with reſpect to the pauſe, a deviation from the rule being leſs remarkable in a ſemipauſe. Conſidering the matter as to melody ſolely, it is indifferent whether the pauſes be at the end of words or in the middle; but when we carry the ſenſe along, it is diſagreeable to find a word ſplit into two by a pauſe, as if there were really two words: and though the diſagreeableneſs here be connected with the ſenſe only, it is by an eaſy tranſition of perceptions transferred to the ſound; by which means we conceive a line to be harſh and grating to the ear, when in reality it is only ſo to the underſtanding.

To the rule that fixes the pauſe after the 5th portion there is one exception and no more. If the ſyllable ſucceeding the 5th portion be ſhort, the pauſe is ſometimes poſtponed to it:

Pupillis quos dura || premit cuſtodia matrum
Again :
In terras oppreſſa || gravi ſub religione
Again :
Et quorum pars magna || fui; quis talio fando

This contributes to diverſify the melody; and, where the words are ſmooth and liquid, is not ungraceful; as in the following examples:

Formoſam reſonare || doces Amaryllida ſylvas
Again :
Agricolas, quibus ipſa || procul diſcordibus armis

If this pauſe, placed as aforeſaid after the ſhort ſyllable, happen alſo to divide a word, the melody by theſe circumſtances is totally annihilated. Witneſs the following line of Ennius, which is plain proſe:

Romæ mœnia terru||it impiger | Hannibal armis.

Hitherto the arrangement of the long and ſhort ſyllables of an hexameter line and its different pauſes have been conſidered with reſpect to melody: but to have a juſt notion of hexameter verſe, theſe particulars muſt alſo be conſidered with reſpect to ſenſe. There is not perhaps in any other ſort of verſe ſuch latitude in the long and ſhort ſyllables; a circumſtance that contributes greatly to that richneſs of melody which is remarkable in hexameter verſe, and which made Ariſtotle pronounce that an epic poem in any other verſe would not ſucceed. One defect, however, muſt not be diſſembled, that the ſame means which contribute to the richneſs of the melody render it leſs fit than ſeveral other ſorts for a narrative poem. There cannot be a more artful contrivance, as above obſerved, than to cloſe an hexameter line with two long ſyllables preceded by two ſhort: but unhappily this conſtruction proves a great embarraſſment to the ſenſe; which will thus be evident. As in general there ought to be a ſtrict concordance between the thought and the words in which it is dreſſed; ſo, in particular, every cloſe in the ſenſe ought to be accompanied with a cloſe in the ſound. In proſe this law may be ſtrictly obſerved, but in verſe the ſame ſtrictneſs would occaſion inſuperable difficulties. Willing to ſacrifice to the melody of verſe ſome ſhare of the concordance between thought and expreſſion, we freely excuſe the ſeparation of the muſical pauſe from that of the ſenſe during the courſe of a line; but the cloſe of an hexameter line is too conſpicuous to admit this liberty: for which reaſon there ought always to be ſome pauſe in the ſenſe at the end of every hexameter line, were it but ſuch a pauſe as is marked by a comma; and for the ſame reaſon there ought never to be a full cloſe in the ſenſe but at the end of a line, becauſe there the melody is cloſed. An hexameter line, to preſerve its melody, cannot well admit any great relaxation; and yet, in a narrative poem, it is extremely difficult to adhere ſtrictly to the rule even with theſe indulgences. Virgil, the chief of poets for verſification, is forced often to end a line without any cloſe in the ſenſe, and as often to cloſe the ſenſe during the running of a line; though a cloſe in the melody during the movement of the thought, or a cloſe in the thought during the movement of the melody, cannot be agreeable.

The accent, to which we proceed, is not leſs eſſential than the other circumſtances above handled. By a good ear it will be diſcerned, that in every line there is one ſyllable diſtinguiſhable from the reſt by a capital accent: That ſyllable being the ſeventh portion, is invariably long.

Nec bene promeritis || capitûr nec | tangitur ira
Again :
Non ſibi ſed toto || genitûm ſe | credere mundo
Again :
Qualis ſpelunca || ſubitô com|mota columba

In theſe examples the accent is laid upon the laſt ſyllable of a word; which is favourable to the melody in the following reſpect, that the pauſe, which for the ſake of reading diſtinctly muſt follow every word, gives opportunity to prolong the accent. And for that reaſon, a line thus accented has a more ſpirited air than when the accent is placed on any other ſyllable. Compare the foregoing lines with the following.

Alba neque Aſſyrio || fucátur | lana veneno
Again :
Panditur interea || domus ômnipo|tentis Olympi
Again :
Olli ſedato || reſpôndit | corde Latinus.

In lines where the pauſe comes after the ſhort ſyllable ſucceeding the 5th portion, the accent is diſplaced, and rendered leſs ſenſible: it ſeems to be ſplit into two, and to be laid partly on the 5th portion, and partly on the 7th, its uſual place; as in

Nuda genu, nodôque || ſinùs col|lecta fluentes.
Again :
Formoſam reſonâre || docês Amar|yllida ſylvas.

Beſide this capital accent, ſlighter accents are laid upon other portions: particularly upon the 4th, unleſs where it conſiſts of two ſhort ſyllables; upon the 9th, which is always a long ſyllable; and upon the 11th, where the line concludes with a monoſyllable. Such concluſion, by the by, impairs the melody, and for that reaſon is not to be indulged unleſs where it is expreſſive of the ſenſe. The following lines are marked with all the accents:

Ludere quæ vêllem calamô permiſit agreſti
Again :
Et duræ quêrcus ſudâbunt rôſcida mella
Again :
Parturiunt môntes, naſcêtur ridiculûs mus.

Reflecting upon the melody of hexameter verſe, we find, that order or arrangement doth not conſtitute the whole of it: for, when we compare different lines equally regular as to the ſucceſſion of long and ſhort ſyllables, the melody is found in very different degrees of perfection; which is not occaſioned by any particular combination of dactyls and ſpondees, or of long and ſhort ſyllables, becauſe we find lines where dactyls prevail, and lines where ſpondees prevail, equally melodious. Of the former take the following inſtance:

Æneadum genitrix hominum divûmque voluptas.

Of the latter:

Molli paulatim flaveſcet campus ariſta.

What can be more different as to melody than the two following lines, which, however, as to the ſucceſſion of long and ſhort ſyllables, are conſtructed preciſely in the ſame manner?

Spond. Dact. Spond. Spond. Dact. Spond.
Ad talos ſtola dimiſſa et circumdata palla. *Hor.*
Spond. Dact. Spond. Spond. Dact. Spond.
Placatumque nitet diffuſo lumine cœlum. *Lucret.*

In the former, the pauſe falls in the middle of a word, which is a great blemiſh, and the accent is diſturbed by a harſh eliſion of the vowel *a* upon the particle *et*. In the latter, the pauſes and the accent are all of them diſtinct and full: there is no eliſion: and the words are more liquid and ſounding. In theſe particulars conſiſts the beauty of an hexameter line with reſpect to melody; and by neglecting theſe, many lines in the ſatires and epiſtles of Horace are leſs agreeable than plain proſe; for they are neither the one nor the other in perfection. To draw melody from theſe lines, they muſt be pronounced without relation to the ſenſe: it muſt not be regarded that words are divided by pauſes, nor that harſh eliſions are multiplied. To add to the account, proſaic low-ſounding words are introduced; and, which is ſtill worſe, accents are laid on them. Of ſuch faulty lines take the following inſtances.

Candida rectaque ſit, munda hactenus ſit neque longa
Jupiter exclamat ſimul atque audirit; at in ſe
Cuſtodes, lectica, ciniflones, paraſitæ
Optimus eſt modulator, ut Alfenus Vafer omni
Nunc illud tantum quæram, meritone tibi ſit.

Theſe obſervations on pauſes and ſemi-pauſes, and on the ſtructure of an hexameter line, are doubtleſs ingenious; but it is by no means certain that a ſtrict attention to them would aſſiſt any man in the writing of ſuch verſes as would have been pleaſing to a Roman ear. Many of his lordſhip's rules have no other foundation than what reſts on our improper mode of accenting Latin words; which to Virgil or Lucretius would probably have been as offenſive as the Scotch accent is to a native of Middleſex.

II. Next in order comes ENGLISH HEROIC VERSE; which ſhall be examined under the heads of *number*, *accent*, *quantity*, *movement*, and *pauſe*. Theſe have been treated in ſo clear and maſterly a manner by Sheridan in his *Art of Reading*, that we ſhall have little more to do than abridge his doctrine, and point out the few inſtances in which attachment to a ſyſtem and partiality to his native tongue ſeem to have betrayed him into error, or at leaſt made him carry to an extreme what is juſt only when uſed with moderation.

"Numbers, in the ſtrict ſenſe of the word, whether with regard to poetry or muſic, conſiſt in certain impreſſions made on the ear at ſtated and regular diſtances. The loweſt ſpecies of numbers is a *double* ſtroke of the ſame note or ſound, repeated a certain number of times, at equal diſtances. The repetition of the ſame *ſingle* note in a continued ſeries, and exactly at equal diſtances, like the ticking of a clock, has in it nothing numerous; but the ſame note, *twice* ſtruck a certain number of times, with a pauſe between each *repetition* of double the time of that between the *ſtrokes*, is numerous. The reaſon is, that the pleaſure ariſing from *numbers* conſiſts in the obſervation of *proportion*; now the repetition of the ſame note, in exactly the *ſame intervals*, will admit of no proportion. But the ſame note *twice* ſtruck, with the pauſe of *one* between the two ſtrokes, and repeated again at the diſtance of a pauſe equal to *two*, admits of the proportional meaſurement in the pauſes of *two* to *one*, to which time can be beaten, and is the loweſt and ſimpleſt ſpecies of numbers. It may be exemplified on the drum, as tuˋm-tuˋm--tuˋm-tu m--tuˋm-tuˋm, &c.

"The next progreſſion of numbers is, when the ſame note is repeated, but in ſuch a way as that one makes a more ſenſible impreſſion on the ear than the other, by being more forcibly ſtruck, and therefore having a greater degree of loudneſs; as tĭ-tuˋm--tĭ-tuˋm; or, tuˋm-tĭ--tuˋm-tĭ: or when two weak notes precede a more forcible one, as tĭ tĭ-tuˋm--tĭ tĭ-tuˋm; or when the weak notes follow the forcible one, tuˋm-tĭ tĭ--tuˋm-tĭ-tĭ.

"In the firſt and loweſt ſpecies of numbers which we have mentioned, as the notes are exactly the ſame in every reſpect, there can be no proportion obſerved but in the time of the pauſes. In the ſecond, which riſes in a degree juſt above the other, though the notes are ſtill the ſame, yet there is a diverſity to be obſerved in their reſpective loudneſs and ſoftneſs, and therefore a meaſurable proportion of the quantity of ſound. In them we muſt likewiſe take into conſideration the order of the notes, whether they proceed from ſtrong to weak, or from weak to ſtrong; for this diverſity of order occaſions a great difference in the impreſſions made upon the ear, and in the effects produced upon the mind. To expreſs the diverſity of order in the notes in all its ſeveral kinds, the common term *movement* may be uſed, as the term *meaſure* will properly enough expreſs the different proportions of time both in the pauſes and in the notes."

For it is to be obſerved, that all notes are not of the ſame length or on the ſame key. In poetry, as well as in muſic, notes may be high or low, flat or ſharp; and ſome of them may be prolonged at pleaſure. "Poetic numbers are indeed founded upon the very ſame principles with thoſe of the muſical kind, and are governed by ſimilar laws (ſee MUSIC). Proportion and order are the ſources of the pleaſure which we receive from both; and the beauty of each depends upon a due obſervation of the laws of meaſure and movement. The eſſential difference between them is, that the matter of the one is articulate, that of the other inarticulate ſounds: but ſyllables in the one correſpond to notes in the other; poetic feet to muſical bars; and verſes to ſtrains: in a word, they have all like properties, and are governed by laws of the ſame kind.

"From what has been ſaid, it is evident, that the *eſſence* of numbers conſiſts in certain impreſſions made on the mind through the ear at ſtated and regular diſtances of time, with an obſervation of a relative proportion in thoſe diſtances: and that the other circumſtances of long or ſhort in ſyllables, or diverſity of notes in uttering them, are *not* eſſentials but only *accidents* of poetic numbers. Should this be queſtioned, the objector might be ſilenced by having the experiment tried on a drum, on which, although it is incapable of producing long or ſhort, high or low notes, there is no kind of metre which may not be beat. That, therefore, which regulates the ſeries and movement of the impreſſions given to the ear by the recitation of an Engliſh verſe, muſt, when properly diſpoſed, conſtitute the eſſence of Engliſh poetic numbers: but it is the accent which particularly impreſſes the ſound of certain ſyllables or letters upon the ear; for in every word there is a ſyllable or letter accented. The neceſſity and uſe of the accent, as well in proſe as in verſe, we ſhall therefore proceed to explain.

"As words may be formed of various numbers of ſyllables, from one up to eight or nine, it was neceſſary that there ſhould be ſome peculiar mark to diſtinguiſh words from disjointed ſyllables; otherwiſe ſpeech would be nothing but a continued ſucceſſion of ſyllables conveying no ideas. This diſtinction of one word from another might be made by a perceptible pauſe at the end of each in ſpeaking, analogous to the diſtance made between them in writing and in printing. But theſe pauſes would make diſcourſe diſguſtingly tedious; and though they might render words ſufficiently diſtinct, they would make the meaning of ſentences extremely confuſed. Words might alſo be diſtinguiſhed from each other, and form a collection of detached ſyllables, by an *elevation* or *depreſſion* of the voice upon one ſyllable of each word; and this, as is well known to the learned, was the practice of the Greeks and Romans. But the Engliſh tongue has for this purpoſe adopted a mark of the eaſieſt and ſimpleſt kind, which is called *accent*. By accent is meant, a certain ſtreſs of the voice upon a particular letter of a ſyllable, which diſtinguiſhes it from the reſt, and at the ſame time diſtinguiſhes the ſyllable itſelf to which it belongs from the other ſyllables which compoſe the word. Thus, in the word *hab'it*, the accent upon the *b* diſtinguiſhes that letter from the others, and the firſt ſyllable from the laſt; add more ſyllables to it. and it will ſtill do the ſame, as *hab'itable*. In the word *accep't*, the *p* is the diſtinguiſhed letter, and the ſyllable which contains it the diſtinguiſhed ſyllable; but if we add more ſyllables to it, as in the word *ac'ceptable*, the ſeat of the accent is changed to the firſt ſyllable, of which *c* is the diſtinguiſhed letter. Every word in our language of more ſyllables than one has one of the ſyllables diſtinguiſhed from the reſt in this manner, and every monoſyllable has a letter. Thus, in the word *bat* the *t* is accented, in *báte* the vowel *a*, in *cub'* the *b*, and in *cúbe* the *u*: ſo that, as articulation is the eſſence of ſyllables, accent is the eſſence of words; which without it would be nothing more than a mére ſucceſſion of ſyllables."

We have ſaid, that it was the practice of the Greeks and Romans to elevate or depreſs their voice upon one ſyllable of each word. In this elevation or depreſſion conſiſted their accent; but the Engliſh accent conſiſts in the mere ſtreſs of the voice, without any change of note. "Among the Greeks, all ſyllables were pronounced either in a high, low, or middle note; or elſe in a union of the high and low by means of the intermediate. The middle note, which was exactly at an equal diſtance between the high and the low, was that in which the unaccented ſyllables were pronounced. But every word had one letter, if a monoſyllable, or one ſyllable, if it conſiſted of more than one, diſtinguiſhed from the reſt; either by a note of the voice perceptibly higher than the middle note, which was called the *acute accent*; or by a note perceptibly, and in an equal proportion, lower than the middle one, which was called the *grave accent*; or by an union of the acute and grave on one ſyllable, which was done by the voice paſſing from the acute, through the middle note, in continuity down to the grave, which was called the *circumflex*."

"Now, in pronouncing Engliſh words, it is true that one ſyllable is always diſtinguiſhed from the reſt; but it is not by any perceptible elevation or depreſſion of the voice, any high or low note, that it is done, but merely by dwelling longer upon it, or by giving it a more forcible ſtroke. When the ſtreſs or accent is on the vowel, we dwell longer on that ſyllable than on the reſt; as, in the words *glóry, fáther, hóly*. When it is on the conſonant, the voice, paſſing rapidly over the vowel, gives a ſmarter ſtroke to the conſonant, which diſtinguiſhes that ſyllable from others, as in the words *bat'tle, hab'it, bar'row*."

Having treated ſo largely of *accent* and *quantity*, the next thing to be conſidered in verſe will be quickly diſcuſſed; for in Engliſh it depends wholly on the ſeat of the accent. "When the accent or ſtreſs is on the vowel, the ſyllable is neceſſarily long, becauſe the accent cannot be made without dwelling on the vowel a longer time than uſual. When it is on the conſonant, the ſyllable is ſhort; becauſe the accent is made by paſſing rapidly over the vowel, and giving a ſmart ſtroke of the voice to the following conſonant. Thus the words *ad'd, led', bid', cub'*, are all ſhort, the voice paſſing quickly over the vowel to the conſonant: but, for the contrary reaſon, the words *áll, láid, bíde, cúbe*, are long; the accent being on the vowels, on which the voice dwells ſome time before it takes in the ſound of the conſonant."

"Obvious as this point is, it has wholly eſcaped the obſervation of many an ingenious and learned writer. Lord Kames affirms, that accenting is confined in Engliſh heroic verſe to the long ſyllables; for a ſhort ſyllable (ſays he) is not capable of an accent: and Dr. Forſter, who ought to have underſtood the nature of the Engliſh language better than his lordſhip, aſks, whether we do not 'employ more time in uttering the *firſt* ſyllables of *heavily, haſtily, quickly, ſlowly*; and the *ſecond* in *ſolicit, miſtaking, reſearches, deluſive*, than in the *others*?' To this queſtion Mr. Sheridan replies, that "in ſome of theſe words we certainly do as the Doctor ſuppoſes; in *háſtily, ſlówly, miſtáking, delúſive*, for inſtance; where the accent being on the vowels, renders their ſound long: but in all the others, *heav'ily, quick'-ly, ſolis'-it, re-ſear'-ches*, where the accent is on the conſonant, the ſyllables *heav', quick', lis', ſer'*, are pronounced as rapidly as poſſible, and the vowels are all ſhort. In the Scotch pronunciation (continues he) they would indeed be all reduced to an equal quantity, as thus; *hái-vily, háis-tily, quéek-ly, ſlów-ly, ſo-léc-cit, re-ſáir-chés, de-lú-ſive*. But here we ſee that the four ſhort ſyllables are changed into four long ones of a different ſound, occaſioned by their placing the ſeat of the accent on the vowels inſtead of the conſonants: thus, inſtead of *hev'* they ſay *háiv*; for *quick'*, *quéek*; for *lis'*, *léece*; and for *ſer*, *ſair*.

"It appears therefore, that the quantity of Engliſh ſyllables is adjuſted by one eaſy and ſimple rule; which is, that when the ſeat of the accent is on a vowel, the ſyllable is long; when on a conſonant, ſhort; and that all unaccented ſyllables are ſhort. Without a due obſervation of quantity in reciting verſes, there will be no poetic numbers; yet in compoſing Engliſh verſes the poet need not pay the leaſt attention to the quantity of his ſyllables, as meaſure and movement will reſult from the obſervation of other laws, which are now to be explained."

It has been affirmed by a writer of great authority among the critics, that in Engliſh heroic verſe every line conſiſts of ten ſyllables, five ſhort and five long; from which there are but two exceptions, both of them rare. The firſt is, where each line of a couplet is made eleven ſyllables, by an additional ſhort ſyllable at the end.

> Thére héroes wit's are kep't in pond'rous váſes,
> And beaus' in ſnuff-boxes and tweezer-caſes.

The other exception, he ſays, concerns the ſecond line of a couplet, which is ſometimes ſtretched out to twelve ſyllables, termed an *Alexandrine line*.

> A needleſs Alexandrine ends the ſong,
> That, like a wounded ſnake, drags its ſlow length along.

After what has been juſt ſaid, it is needleſs to ſtop for the purpoſe of pointing out the ingenious author's miſtake reſpecting long and ſhort ſyllables. Every attentive reader of what has been already laid down, muſt perceive, that in the firſt line of the former couplet, though there are no fewer than ſix accented ſyllables when it is properly read, yet of theſe there are but three that are long, *viz*. thoſe which have the accent on the vowel. Our buſineſs at preſent is, to ſhow the falſity of the rule which reſtrains the heroic line to ten ſyllables; and this we ſhall do by producing lines of a greater number.

> And the ſhrill ſounds ran echoing through the wood.

This line, though it conſiſts of eleven ſyllables, and has the laſt of thoſe accented, or, as lord Kames would ſay, long, is yet undoubtedly a heroic verſe of very fine ſound. Perhaps the advocates for the rule may contend, that the vowel *o* in echoing ought to be ſtruck out by an apoſtrophe; but as no one reads,

> And the ſhrill ſounds ran ech'ing through the wood,

it is ſurely very abſurd to omit in writing what cannot be omitted in utterance. The two following lines have each eleven ſyllables, of which not one can be ſuppreſſed in recitation.

> Their glittering textures of the filmy dew,
> The great hierarchal ſtandard was to move.

Mr. Sheridan quotes as a heroic line,

> O'er many a frozen, many a fiery Alp;

and obſerves what a monſtrous line it would appear, if pronounced,

> O'er man' a frozen, man' a fi'ry Alp,

inſtead of that noble verſe, which it certainly is, when all the thirteen ſyllables are diſtinctly uttered. He then produces a couplet, of which the former line has fourteen, and the latter twelve ſyllables.

> And many an amorous, many a humorous lay,
> Which many a bard had chaunted many a day.

That this is a couplet of very fine ſound cannot be controverted; but we doubt whether the numbers of it or of the other quoted line of thirteen ſyllables be truly heroic. To our ear at leaſt there appears a very perceptible difference between the movement of theſe verſes and that of the verſes of Pope or Dryden; and we think, that, though ſuch couplets or ſingle lines may, for the ſake of variety or expreſſion, be admitted into a heroic poem, yet a poem wholly compoſed of them would not be conſidered as heroic verſe. It has a much greater reſemblance to the verſe of Spenſer, which is now broken into two lines, of which the firſt has eight and the ſecond ſix ſyllables. Nothing, however, ſeems to be more evident, from the other quoted inſtances, than that a heroic line is not confined to the ſyllables, and that it is not by the number of ſyllables that an Engliſh verſe is to be meaſured.

But if a heroic verſe in our tongue be not compoſed, as in French, of a certain number of ſyllables, how is it formed? We anſwer, By feet, as was the hexameter line of the ancients; though between their feet and ours there is at the ſame time a great difference. The poetic feet of the Greeks and Romans are formed by quantity, thoſe of the Engliſh by ſtreſs or accent. "Though theſe terms are in continual uſe, and in the mouths of all who treat of poetic numbers, very confuſed and erroneous ideas are ſometimes annexed to them. Yet, as the knowledge of the peculiar genius of our language with regard to poetic numbers and its characteriſtical difference from others in that reſpect, depends upon our having clear and preciſe notions of thoſe terms, it will be neceſſary to have them fully explained. The general nature of them has been already ſufficiently laid open, and we have now only to make ſome obſervations on their particular effects in the formation of metre.

"No ſcholar is ignorant that quantity is a term which relates to the length or the ſhortneſs of ſyllables, and that a long ſyllable is double the length of a ſhort one. Now the plain meaning of this is, that a long ſyllable takes up double the time in ſounding that a ſhort one does; a fact of which the ear alone can be the judge. When a ſyllable in Latin ends with a conſonant, and the ſubſequent ſyllable commences with one, every ſchoolboy knows that the former is long, to uſe the technical term, by the law of *poſition*. This rule was in pronunciation ſtrictly obſerved by the Romans, who always made ſuch ſyllables long by dwelling on the vowels; whereas the very reverſe is the caſe with us, becauſe a quite contrary rule takes place in Engliſh words ſo conſtructed, as the accent or ſtreſs of the voice is in ſuch caſes always transferred to the conſonant, and the preceding vowel being rapidly paſſed over, that ſyllable is of courſe ſhort.

"The Romans had another rule of proſody, that when one ſyllable ending with a vowel was followed by another beginning with a vowel, the former ſyllable was pronounced ſhort; whereas in Engliſh there is generally an accent in that caſe on the former ſyllable, as in the word *píous*, which renders the ſyllable long. Pronouncing Latin therefore by our own rule, as in the former caſe, we make thoſe ſyllables ſhort which were ſounded long by them; ſo in the latter, we make thoſe ſyllables long which with them were ſhort. We ſay *ar'ma* and *virum'que* inſtead of *árma* and *virúmque*; *ſcío* and *túus*, inſtead of *ſció* and *tuus'*.

"Having made theſe preliminary obſervations, we proceed now to explain the nature of poetic feet. Feet in verſe correſpond to bars in muſic: a certain number of ſyllables connected form a foot in the one, as a certain number of notes make a bar in the other. They are called feet, becauſe it is by their aid that the voice as it were ſteps along through the verſe in a meaſured pace: and it is neceſſary that the ſyllables which mark this regular movement of the voice ſhould in ſome meaſure be diſtinguiſhed from the others. This diſtinction, as we have already obſerved, was made among the ancient Romans, by dividing their ſyllables into long and ſhort, and aſcertaining their quantity by an exact proportion of time in ſounding them; the long being to the ſhort as two to one; and the long ſyllables, being thus the more important, marked the movement of the verſe. In Engliſh, ſyllables are divided into accented and unaccented; and the accented ſyllables being as ſtrongly diſtinguiſhed from the unaccented, by the peculiar ſtreſs of the voice upon them, are as capable of marking the movement, and pointing out the regular paces of the voice, as the long ſyllables were by their quantity among the Romans. Hence it follows, that our accented ſyllables correſponding to their long ones, and our unaccented to their ſhort, in the ſtructure of poetic feet; an accented ſyllable followed by one unaccented in the ſame foot will anſwer to their *trochee*; and preceded by an unaccented one, to their *iambus*; and ſo with the reſt.

"All feet uſed in poetry conſiſt either of two or three ſyllables; and the feet among the ancients were denominated from the number and quantity of their ſyllables. The meaſure of quantity was the ſhort ſyllable, and the long one in time was equal to two ſhort. A foot could not conſiſt of leſs than two times, becauſe it muſt contain at leaſt two ſyllables; and by a law reſpecting numbers, which is explained elſewhere (ſee MUSIC), a poetic foot would admit of no more than four of thoſe times. Conſequently the poetic feet were neceſſarily reduced to eight; four of two ſyllables, and four of three. Thoſe of two ſyllables muſt either conſiſt of two ſhort, called a *pyrrhic*; two long, called a *ſpondee*; a long and a ſhort, called a *trochee*; or a ſhort and a long, called an *iambus*. Thoſe of three ſyllables were, either three ſhort, a *tribrach*; a long and two ſhort, a *dactyl*; a ſhort, long, and ſhort, an *amphibrach*; or two ſhort and a long, an *anapæſt**.

We are now ſufficiently prepared for conſidering what feet enter into the compoſition of an Engliſh heroic verſe.

The Greeks and Romans made uſe of but two feet in the ſtructure of their hexameters; and the Engliſh heroic may be wholly compoſed of one foot, viz. the *iambic*, which is therefore the foot moſt congenial to that ſpecies of verſe. Our poetry indeed abounds with verſes into which no other foot is admitted. Such as,

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* For the convenience of the leſs learned reader we ſhall here ſubjoin a ſcheme of poetic feet, uſing the marks (- ⏑) in uſe

> The pow'rs | gave éar | and grán|ted hálf | his práy'r,
> The reſt′ | the wínds | diſpérs'd | in emp|ty áir.

Our heroic line, however, is not wholly reſtrained to the uſe of this foot. In the opinion of Mr. Sheridan it admits all the eight before enumerated; and it certainly excludes none, unleſs perhaps the *tribrach*. It is known to every reader of Engliſh poetry, that ſome of the fineſt heroic verſes in our language begin with a *trochee;* and that Pope, the ſmootheſt of all our verſifiers, was remarkable for his uſe of this foot, as is evident from the following example, where four ſucceeding lines out of ſix have a trochaic beginning.

> Her lively looks a ſprightly mind diſcloſe,
> Quick as | her eyes | and as unfix'd as thoſe:
> Favours | to none, | to all ſhe ſmiles extends,
> O′ft ſhe | rejects, | but never once offends.
> Bríght as | the ſun | her eyes the gazers ſtrike,
> And like the ſun ſhe ſhines on all alike.

The uſe of this foot, however, is not neceſſarily confined to the beginning of a line. Milton frequently introduces it into other parts of the verſe; of which take the following inſtances:

> That áll | was loſt′ | back′ to | the thick′et ſlunk——
> Of E′ve | whoſe ey′e | dárted contá|gions fire.

The laſt line of the following couplet begins with a *pyrrhic:*

> She ſáid, | and mél|ting as in tears ſhe lay,
> In ă | ſoft síl|ver ſtream diſſolv'd away.

But this foot is introduced likewiſe with very good effect into other parts of the verſe, as

> Pánt on | thy lip′ | and tŏ | thy heárt | be preſt.|
> The phantom flies me | ăs ŭn|kind as you.
> Leaps o'er the fence with eaſe | intŏ | the fold.
>
> And thĕ | ſhrill′ ſoúnds | ran echoing through the wood.

In this laſt line we ſee that the firſt foot is a *pyrrhic*, and the ſecond a *ſpondee;* but in the next the two firſt feet are *ſpondees*.

> Hill′s peép | o'ér hill's | and Alps | on Alps | ariſe.

In the following verſe a trochee is ſucceeded by two ſpondees, of which the former is a genuine ſpondee by quantity, and the latter equivalent to a ſpondee by accent.

> Sée thĕ | bōld yōūth | ſtráin up′ | the threat|'ning ſteep.

We ſhall now give ſome inſtances of lines containing both the *pyrrhic* and the *ſpondee,* and then proceed to the conſideration of the other four feet.

> Thăt ŏn | wēāk wīngs | from far purſues your flight.
> Thrŏ' thĕ | fāīr ſcēne | rōll ſlow | the ling'ring ſtreams.
> Ŏn hĕr | whīte breas′t | a ſparkling croſs ſhe wore.

Of the four triſyllabic feet, the firſt, of which we ſhall give inſtances in heroic lines, is the *dactyl;* as

> Mur′muring, | and with | him′fled | the ſhades | of night.
> Hov′ering | on wing | un′der | the cápe | of hell′.
> Tim′orous | and ſloth | ful, yet he pleas'd the ear.
> Of trúth | in word | míghtier | than they | in arms.

Of the *anapæſt* a ſingle inſtance ſhall ſuffice; for except by Milton it is not often uſed.

> The great | hĭĕrár|chal ſtandard was to move.

The *amphibrach* is employed in the four following verſes, and in the three laſt with a very fine effect.

> With wheels | yet hóver|ing o'er the ocean brim
> Rous'd from their ſlumber on | thăt fíĕ|ry | couch.
> While the | prŏmis′cŭous crowd ſtood yet aloof.
> Throws his ſteep flight | ĭn mánў | ăn ai|ry whirl.

Having thus ſufficiently proved that the Engliſh heroic verſe admits of all the feet except the *tribrach*, it may be proper to add, that from the nature of our accent we have duplicates of theſe feet, viz. ſuch as are formed by quantity, and ſuch as are formed by the mere *ictus* of the voice; an opulence peculiar to our tongue, and which may be the ſource of a boundleſs variety. But as feet formed of ſyllables which have the *accent* or *ictus* on the conſonant are neceſſarily pronounced in leſs time than ſimilar feet formed by quantity, it may be objected, that the meaſure of a whole line, conſtructed in the former manner, muſt be ſhorter than that of another line conſtructed in the latter; and that the intermixture of verſes of ſuch different meaſures in the ſame poem muſt have a bad effect on the melody, as being deſtructive of proportion. This objection would be well founded, were not the time of the ſhort accented ſyllables compenſated by a ſmall pauſe at the end of each word to which they belong, as is evident in the following verſe:

> Then rus′|tling crack′|ling craſh|ing thun′der down.

This line is formed of iambics by accent upon conſonants, except the laſt ſyllable; and yet by means of theſe ſoft pauſes or reſts, the meaſure of the whole is equal to that of the following, which conſiſts of pure iambics by quantity.

> O'er hēāps | of rū|in ſtālk'd | the ſtate|ly hīnd.

Movement, of ſo much importance in verſification, regards the order of ſyllables in a foot, meaſure their quantity. The order of ſyllables reſpects their progreſs from ſhort to long or from long to ſhort, as in the Greek and Latin languages; or from ſtrong to weak or weak to ſtrong, *i. e.* from accented or unaccented ſyllables, as in our tongue. It has been already obſerved, that an Engliſh heroic verſe may be compoſed wholly of iambics; and experience ſhows that ſuch verſes have a fine melody. But as the ſtreſs of the voice, in repeating verſes of pure iambics, is regularly on every ſecond ſyllable, ſuch uniformity would diſguſt the ear in any long ſucceſſion, and therefore ſuch changes were ſought for as might introduce the pleaſure of variety without prejudice to melody; or which might even contribute to its improvement. Of this nature was the introduction of the trochee to form the firſt foot of a heroic verſe, which experience has ſhown us is ſo far from ſpoiling the melody, that in many caſes it heightens it. This foot, however, cannot well be admitted into any other part of the verſe without prejudice to the melody, becauſe it interrupts and ſtops the

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among the Latin grammarians to denote the genuine feet by quantity; and the following marks (′ ◡) to denote the Engliſh feet by accent which anſwer to thoſe.

	Roman	Engliſh		Roman	Engliſh
Trochee	- ◡	′ ◡	Dactyl	- ◡ ◡	′ ◡ ◡
Iambus	◡ -	◡ ′	Amphibrach	◡ - ◡	◡ ′ ◡
Spondee	- -	′ ′	Anapæſt	◡ ◡ -	◡ ◡ ′
Pyrrhic	◡ ◡	◡ ◡	Tribrach	◡ ◡ ◡	◡ ◡ ◡

uſual movement by another directly oppoſite. But though it be excluded with regard to pure melody, it may often be admitted into any part of the verſe with advantage to expreſſion, as is well known to the readers of Milton.

The next change admitted for the ſake of variety, without prejudice to melody, is the intermixture of pyrrhics and ſpondees; in which two impreſſions in the one foot make up for the want of one in the other; and two long ſyllables compenſate two ſhort, ſo as to make the ſum of the quantity of the two feet equal to two iambics. That this may be done without prejudice to the melody, take the following inſtances:

Ŏn hĕr | whīte brēāſt | a ſparkling croſs ſhe wore.——
Nŏr thĕ | dēēp trāct | of hell—ſay firſt what cauſe.

This intermixture may be employed *ad libitum*, in any part of the line; and ſometimes two ſpondees may be placed together in one part of the verſe, to be compenſated by two pyrrhics in another; of which Mr. Sheridan quotes the following lines as inſtances:

Stōōd rūl'd | ſtōōd vāſt | ĭnfĭn|ĭtŭde | confined.
Shē āll | nīght lōng | hĕr ămŏ|rŏus dĕs|cant ſung.

That the former is a proper example, will not perhaps be queſtioned; but the third foot in the latter is certainly no pyrrhic. As it is marked here and by him, it is a tribrach; but we appeal to our Engliſh readers, if it ought not to have been marked an amphibrach by accent, and if the fourth foot be not an iambus. To us the feet of the line appear to be as follow:

Shē āll | nīght lōng | hĕr am´ŏ|rŏus des´|cănt ſung.

It is indeed a better example of the proper uſe of the amphibrach than any which he has given, unleſs perhaps the two following lines:

Up to | thĕ fíĕ|ry con|căve tow´ĕr|ing high
Thrōws hĭs | ſtēēp flīght | ĭn man´y̆ | ăn áĭ|ry whīrl.

That in theſe three lines the introduction of the amphibrach does not hurt the melody, will be acknowledged by every perſon who has an ear; and thoſe who have not, are not qualified to judge. But we appeal to every man of taſte, if the two amphibrachs ſucceeding each other in the laſt line do not add much to the expreſſion of the verſe. If this be queſtioned, we have only to change the movement to the common iambic, and we ſhall diſcover how feeble the line will become.

Throws his | ſteep flight | in manly ai|ry whirls.

This is ſimple deſcription, inſtead of that magical power of numbers which to the imagination produces the object itſelf, *whirling* as it were round an axis.

Having thus ſhown that the iambus, ſpondee, pyrrhic, and amphibrach, by accent, may be uſed in our meaſure with great latitude; and that the trochee may at all times begin the line, and in ſome caſes with advantage to the melody; it now remains only to add, that the dactyl, having the ſame movement, may be introduced in the place of the trochee; and the anapæſt in the place of the iambus. In proof of this, were not the article ſwelling in our hands, we could adduce many inſtances which would ſhow what an inexhauſtible fund of riches, and what an immenſe variety of materials, are prepared for us, "to build the lofty rhime." But we haſten to the next thing to be conſidered in the art of verſifying, which is known by the name of *pauſes*.

"Of the poetic pauſes there are two ſorts, the *ceſural* and the *final*. The ceſural divides the verſe into equal or unequal parts: the final cloſes it. In a verſe there may be two or more ceſural pauſes, but it is evident that there can be but one final. As the final pauſe concerns the reader more than the writer of verſes, it has been ſeldom treated of by the critics. Yet as it is this final pauſe which in many caſes diſtinguiſhes verſe from proſe, it cannot be improper in the preſent article to ſhow how it ought to be made. Were it indeed a law of our verſification, that every line ſhould terminate with a ſtop in the ſenſe, the boundaries of the meaſure would be fixed, and the nature of the final pauſe could not be miſtaken. But nothing has puzzled the bulk of readers, or divided their opinions, more than the manner in which thoſe verſes ought to be recited, where the ſenſe does not cloſe with the line; and whoſe laſt words have a neceſſary connection with thoſe that begin the ſubſequent verſe. "Some (ſays Mr. Sheridan) who ſee the neceſſity of pointing out the metre, pronounce the laſt word of each line in ſuch a note as uſually accompanies a comma, in marking the ſmalleſt member of a ſentence. Now this is certainly improper, becauſe it makes that appear to be a complete member of a ſentence which is an incomplete one; and, by disjoining the ſenſe as well as the words, often confounds the meaning. Others again, but theſe fewer in number, and of the more abſurd kind, drop their voice at the end of every line, in the ſame note which they uſe in marking a full ſtop; to the utter annihilation of the ſenſe. Some readers (continues our author) of a more enthuſiaſtic kind, elevate their voices at the end of all verſes to a higher note than is ever uſed in the ſtops which divide the meaning. But ſuch a continued repetition of the ſame high note becomes diſguſting by its monotony, and gives an air of chanting to ſuch recitation. To avoid theſe ſeveral faults, the bulk of readers have choſen what they think a ſafer courſe, which is that of running the lines one into another without the leaſt pauſe, where they find none in the ſenſe; but by this mode of recitation they reduce poetry to ſomething worſe than proſe, to verſe run mad.

But it may be aſked, If this final pauſe muſt be marked neither by an elevation nor by a depreſſion of the voice, how is it to be marked at all? To which Mr. Sheridan replies, By making no change whatever in the voice before it. This will ſufficiently diſtinguiſh it from the other pauſes, the comma, ſemicolon, &c. becauſe ſome change of note, by raiſing or depreſſing the voice, always precedes them, whilſt the voice is here only ſuſpended.

Now this pauſe of ſuſpenſion is the very thing wanting to preſerve the melody at all times, without interfering with the ſenſe. For it perfectly marks the bound of the metre: and being made only by a ſuſpenſion, not by a change of note in the voice, it never can affect the ſenſe; becauſe the ſentential ſtops, or thoſe which affect the ſenſe, being all made with a change of note, where there is no ſuch change the ſenſe cannot be affected. Nor is this the only advantage gained to numbers by this ſtop of ſuſpenſion. It alſo prevents the monotony at the end of lines; which, however pleaſing to a rude, is diſguſting to a delicate, ear. For, as this ſtop has no peculiar note of its own, but always takes that which belongs to the preceding word, it changes continually with the matter, and is as various as the ſenſe.

Having ſaid all that is neceſſary with regard to the final, we proceed now to conſider the ceſural, pauſe. To theſe two pauſes it will be proper to give the denomination of *muſical*, to diſtinguiſh them from the comma, ſemicolon, colon, and full ſtop, which may be called *ſentential pauſes*; the office of the former being to mark the melody, as that of the latter is to point out the ſenſe. The ceſural, like the final pauſe, ſometimes coincides with the ſentential; and ſometimes takes place where there is no ſtop in the ſenſe. In this laſt caſe, it is exactly of the ſame nature, and governed by the ſame laws with the pauſe of ſuſpenſion, which we have juſt deſcribed.

The ceſure, though not eſſential, is however a great ornament to verſe, as it improves and diverſifies the melody, by a judicious management in varying its ſituation; but it diſcharges a ſtill more important office than this. Were there no ceſure, verſe could aſpire to no higher ornament than that of ſimple melody; but by means of this pauſe there is a new ſource of delight opened in poetic numbers, correſpondent in ſome ſort to harmony in muſic. This takes its riſe from that act of the mind which compares the relative proportions that the members of a verſe thus divided bear to each other, as well as to thoſe in the adjoining lines. In order to ſee this matter in a clear light, let us examine what effect the ceſure produces in ſingle lines, and afterwards in comparing contiguous lines with each other.

With regard to the place of the ceſure, Mr. Pope and others have expreſsly declared, that no line appeared muſical to their ears, where the ceſure was not after the fourth, fifth, or ſixth ſyllable of the verſe. Some have enlarged its empire to the third and ſeventh ſyllables; whilſt others have aſſerted that it may be admitted into any part of the line.

“ There needs but a little diſtinguiſhing (ſays Mr. Sheridan) to reconcile theſe different opinions. If melody alone is to be conſidered, Mr. Pope is in the right when he fixes its ſeat in or as near as may be to the middle of the verſe. To form lines of the firſt melody, the ceſure muſt either be at the end of the ſecond or of the third foot, or in the middle of the third between the two. Of this movement take the following examples:

1. Of the ceſure at the end of the ſecond foot:

Our plenteous ſtréams || a various race ſupply;
The bright-ey'd per'ch || with fins of Tyrian dye;
The ſilver eél || in ſhining volúmes roll'd;
The yellow carp' || in ſcales bedrop'd with gold.

2. At the end of the third foot:

With tender billet-doúx || he lights the pyre,
And breathes three amorous ſighs || to raiſe the fire.

3. Between the two, dividing the third foot:

The fields are ráviſh'd || from the induſtrious ſwains,
From men their cities, || and from gods their fanes.

Theſe lines are certainly all of a fine melody, yet they are not quite upon an equality in that reſpect. Thoſe which have the ceſure in the middle are of the firſt order; thoſe which have it at the end of the ſecond foot are next; and thoſe which have the pauſe at the end of the third foot the laſt. The reaſon of this preference it may not perhaps be difficult to aſſign.

In the pleaſure ariſing from comparing the proportion which the parts of a whole bear to each other, the more eaſily and diſtinctly the mind perceives that proportion, the greater is the pleaſure. Now, there is nothing which the mind more inſtantaneouſly and clearly diſcerns, than the diviſion of a whole into two equal parts, which alone would give a ſuperiority to lines of the firſt order over thoſe of the other two. But this is not the only claim to ſuperiority which ſuch lines poſſeſs. The ceſure being in them always on an unaccented, and the final pauſe on an accented, ſyllable, they have a mixture of variety and equality of which neither of the other orders can boaſt, as in theſe orders the ceſural and final pauſes are both on accented ſyllables.

In the diviſion of the other two ſpecies, if we reſpect quantity only, the proportion is exactly the ſame, the one being as two to three, and the other as three to two; but it is the order or movement which here makes the difference. In lines where the ceſure bounds the ſecond foot, the ſmaller portion of the verſe is firſt in order, the greater laſt; and this order is reverſed in lines which have the ceſure at the end of the third foot. Now, as the latter part of the verſe leaves the ſtrongeſt and moſt laſting impreſſion on the ear, where the larger portion belongs to the latter part of the line the impreſſion muſt in proportion be greater; the effect in ſound being the ſame as that produced by a climax in ſenſe, where one part riſes above another.

Having ſhown in what manner the ceſure improves and diverſifies the melody of verſe, we ſhall now treat of its more important office, by which it is the chief ſource of harmony in numbers. But, firſt, it will be neceſſary to explain what we mean by the term *harmony*, as applied to verſe.

Melody in muſic regards only the effects produced by ſucceſſive ſounds; and harmony, ſtrictly ſpeaking, the effects produced by different co-exiſting ſounds, which are found to be in concord. Harmony, therefore, in this ſenſe of the word, can never be applied to poetic numbers, of which there can be only one reciter, and conſequently the ſounds can only be in ſucceſſion. When therefore we ſpeak of the harmony of verſe, we mean nothing more than an effect produced by an action of the mind in comparing the different members of verſe already conſtructed according to the laws of melody with each other, and perceiving a due and beautiful proportion between them.

The firſt and loweſt perception of this kind of harmony ariſes from comparing two members of the ſame line with each other, divided in the manner to be ſeen in the three inſtances already given; becauſe the beauty of proportion in the members, according to each of theſe diviſions, is founded in nature. But there is a perception of harmony in verſification, which ariſes from the compariſon of two lines, and obſerving the relative proportion of their members; whether they correſpond exactly to each other by ſimilar diviſions, as in the couplets already quoted; or whether they are diverſified by ceſures in different places. As,

See the bold youth || ſtrain up the threatening ſteep,
Ruſh thro' the thickets, || down the valleys ſweep.

Where we find the ceſure at the end of the ſecond foot of the firſt line, and in the middle of the third foot of the laſt.

Hang o'er their courſers' heads || with eager ſpeed,
And earth rolls back || beneath the flying ſteed.

Here the ceſure is at the end of the third foot in the former, and of the ſecond in the latter line.——The perception of this ſpecies of harmony is far ſuperior to the former; becauſe, to the pleaſure of comparing the members of the ſame line with each other, there is ſuperadded that of comparing the different members of the different lines with each other; and the harmony is enriched by having four members of compariſon inſtead of two. The pleaſure is ſtill increaſed in comparing a greater number of lines, and obſerving the relative proportion of the couplets to each other in point of ſimilarity and diverſity. As thus,

Thy foreſts, Windſor, || and thy green retreats,
At once the monarch's || and the muſe's ſeats,
Invite my lays. || Be preſent, ſylvan maids,
Unlock your ſprings, || and open all your ſhades.

Here we find that the ceſure is in the middle of the verſe in each line of the firſt couplet, and at the end of the ſecond foot in each line of the laſt; which gives a ſimilarity in each couplet diſtinctly conſidered, and a diverſity when the one is compared with the other, that has a very pleaſing effect. Nor is the pleaſure leſs where we find a diverſity in the lines of each couplet, and a ſimilarity in comparing the couplets themſelves. As in theſe,

Not half ſo ſwift || the trembling doves can fly,
When the fierce eagle || cleaves the liquid ſky;
Not half ſo ſwiftly || the fierce eagle moves,
When thro' the clouds || he drives the trembling doves.

There is another mode of dividing lines well ſuited to the nature of the couplet, by introducing ſemipauſes, which with the ceſure divide the line into four portions. By a ſemipauſe, we mean a ſmall reſt of the voice, during a portion of time equal to half of that taken up by the ceſure; as will be perceived in the following fine couplet:

Warms | in the ſun, || refreſhes | in the breeze,
Glows | in the ſtars, || and bloſſoms | in the trees.

That the harmony, and of courſe the pleaſure, reſulting from poetic numbers, is increaſed as well by the ſemipauſe as by the ceſure, is obvious to every ear; becauſe lines ſo conſtructed furniſh a greater number of members for compariſon: but it is of more importance to obſerve, that by means of the ſemipauſes, lines which, ſeparately conſidered, are not of the fineſt harmony, may yet produce it when oppoſed to each other, and compared in the couplet. Of the truth of this obſervation, the following couplet, eſpecially as it ſucceeds that immediately quoted, is a ſtriking proof:

Lives | thro' all life, || extends | thro' all extent,
Spreads | undivided, || operates | unſpent.

What we have advanced upon this ſpecies of verſe, will contribute to ſolve a poetical problem thrown out by Dryden as a crux to his brethren: it was, to account for the peculiar beauty of that celebrated couplet in Sir John Denham's *Cooper's Hill*, where he thus deſcribes the Thames:

Tho' deep | yet clear, || tho' gentle | yet not dull,
Strong | without rage, || without o'erflowing | full.

This deſcription has great merit independent of the harmony of the numbers; but the chief beauty of the verſification lies in the happy diſpoſition of the pauſes and ſemipauſes, ſo as to make a fine harmony in each line when its portions are compared, and in the couplet when one line is compared with the other.

Having now ſaid all that is neceſſary upon pauſes and ſemipauſes, we have done the utmoſt juſtice to our ſubject which the limits aſſigned us will permit. *Feet* and *pauſes* are the conſtituent parts of verſe; and the proper adjuſtment of them depends upon the poet's knowledge of *numbers*, *accent*, *quantity*, and *movement*, all of which we have endeavoured briefly to explain. In conformity to the practice of ſome critics, we might have treated ſeparately of rhime and of blank verſe; but, as the eſſentials of all heroic verſes are the ſame, ſuch a diviſion of our ſubject would have thrown no light upon the art of Engliſh verſification. It may be juſt worth while to obſerve, that the pauſe at the end of a couplet ought to coincide, if poſſible, with a ſlight pauſe in the ſenſe, and that there is no neceſſity for this coincidence of pauſes at the end of any particular blank verſe. We might likewiſe compare our heroic line with the ancient hexameter, and endeavour to appretiate their reſpective merits; but there is not a reader capable of attending to ſuch a compariſon who will not judge for himſelf; and it may perhaps be queſtioned, whether there be two who will form preciſely the ſame judgment. Mr. Sheridan, and all the mere Engliſh critics, give a high degree of preference to our heroic, on account of the vaſt variety of feet which it admits; whilſt the readers of Greek and Latin poetry prefer the hexameter, on account of its more muſical notes and majeſtic length.

POGGE, the CATAPHRACTUS COTTUS, in ichthyology. See COTTUS.

POGGIUS BRACCIOLINUS, a man of great parts and learning, who contributed much to the revival of knowledge in Europe, was born at Terranuova, in the territories of Florence, in 1380. His firſt public employment was that of writer of the apoſtolic letters, which he held 10 years, and was then made apoſtolic ſecretary, in which capacity he officiated 40 years, under ſeven popes. In 1453, when he was 72 years of age, he accepted the employment of ſecretary to the republic of Florence, to which place he removed, and died in 1459. He viſited ſeveral countries, and ſearched many monaſteries, to recover antient authors, numbers of which he brought to light: his own works conſiſt of moral pieces, orations, letters, and A Hiſtory of Florence from 1350 to 1455, which is the moſt conſiderable of them.

POGO, is a name by which the inhabitants of the Philippine iſlands diſtinguiſh their quail, which, though ſmaller than ours, is in every other reſpect very like it.

POICTIERS, a town of France, capital of the department of Vienne and late province of Poictou, with a biſhop's ſee. Its population is not in proportion to its extent; for it includes a number of gardens and fields within its circuit; and the inhabitants are not eſtimated at more than 16,000. It has ſeveral Roman antiquities, particularly an amphitheatre, partly demoliſhed; and a triumphal arch, which ſerves as a gate to the great ſtreet. Here, in 1356, Edward the Black Prince gained a victory over the French, taking priſoners king John and his ſon Philip, whom he brought to England. The environs abound with vipers in ſuch numbers, that they are exported to Venice to make treacle. This town is ſeated on a hill, on the river Clain, 52 miles S. W. of Tours, and 120 N. by E. of Bourdeaux. E. lon. 0. 25. N. lat. 46. 35.

POICTOU, a late province of France, bounded on the N. by Bretagne, Anjou, and part of Touraine; on the E. by Touraine, Berry, and Marche; on the S. by Angoumois, Saintonge, and Aunis; and on the W. by the bay of Biſcay. It is fertile in corn and wine, and feeds a great number of cattle, particularly mules. It now forms the three departments of Vendee, Vienne, and the Two Sevres.

Colic of POICTOU, in medicine; the ſame with *Devonſhire* colic, or that produced by drinking liquors which accidentally contain lead. See MEDICINE.

POINCIANA, BARBADOES FLOWER-FENCE: A genus of the monogynia order, belonging to the decandria claſs of plants, and in the natural method ranking under the 33d order, *Lomentaceæ*. The calyx is pentaphyllous; the petals five, the uppermoſt larger than the reſt; the ſtamina long, and all fertile; the ſeed-veſſel a legumen. There is only one ſpecies, viz. the *pulcherrima*, a native of both Indies. It riſes with a ſtraight ſtalk 10 or 12 feet high, which is covered with a gray bark, and is ſometimes as thick as the ſmall of a man's leg, dividing into ſeveral ſpreading branches at the top, which are armed at each joint with two ſhort, crooked, ſtrong ſpines, and garniſhed with decompound winged leaves, each leaf conſiſting of ſix or eight pair of ſimple winged leaves. They are of a light green colour, and when bruiſed emit a ſtrong odour. The branches are terminated by looſe ſpikes of flowers, which are ſometimes formed into a kind of pyramid, and at others diſpoſed more in the form of an umbel. The fooſtalk of each flower is near three inches long; the flower is compoſed of five petals, which are roundiſh at the top, but are contracted to narrow tails at the baſe. They ſpread open, and are beautifully variegated with a deep red or orange colour, yellow, and ſome ſpots of green; and emit a very agreeable odour. After the flower is paſt, the germen becomes a broad flat pod three inches long, divided into three or four cells by tranſverſe partitions, each including one flattiſh irregular ſeed. The plant is propagated by ſeeds; but, being tender, is to be conſtantly kept in the bark-ſtove. It is very impatient of moiſture in winter; and if the leaſt damp ſeizes its top, it either kills the plant or deſtroys its head. With proper management it will grow taller here than in the places where it is native; but its ſtems will not be thicker than a man's finger In Barbadoes it is planted in hedges to divide the lands, whence it has the name of *flower-fence*. In the Weſt Indies, its leaves are made uſe of as a purge inſtead of ſenna; and in Jamaica it is called *ſena*.

POINT, a term uſed in various arts.

Point, in grammar, a character uſed to mark the diviſions of diſcourſe. See Comma, Colon, &c. A point proper is what we otherwiſe call a *full ſtop* or *period*. See Punctuation.

Point, in geometry, according to Euclid, is that which hath neither parts nor magnitude.

Point, in muſic, a mark or note anciently uſed to diſtinguiſh the tones or ſounds: hence we ſtill call it *ſimple counter-point*, when a note of the lower part anſwers exactly to that of an upper; and *figurative counter-point*, when any note is ſyncopated, and one of the parts makes ſeveral notes or inflexions of the voice, while the other holds on one. We ſtill uſe a point, to raiſe the value of a note, and prolong its time by one half, *e. g.* a point added to a ſemibreve inſtead of two minims, makes it equal to three; and ſo of the other notes. See the article Time.

Point, in aſtronomy, a term applied to certain points or places marked in the heavens, and diſtinguiſhed by proper epithets. The four grand points or diviſions of the horizon, viz. the eaſt, weſt, north, and ſouth, are called the *cardinal points*. The zenith and nadir are the vertical points; the points wherein the orbits of the planets cut the plane of the ecliptic are called the *nodes*: the points wherein the equator and ecliptic interſect are called the *equinoctial points*; particularly, that whence the ſun aſcends towards the north pole, is called the *vernal point*; and that by which he deſcends to the ſouth pole, the *autumnal point*. The points of the ecliptic, where the ſun's aſcent above the equator, and deſcent below it, terminate, are called the *ſolſtitial point*; particularly the former of them, the *eſtival* or *ſummer-point*; the latter, the *brumal* or *winter-p int*.

Point, is alſo uſed for a cape or headland jutting out into the ſea: thus ſeamen ſay, two points of land are in one another, when they are ſo in a right line againſt each other, as that the innermoſt is hindered from being ſeen by the outermoſt.

Point, in perſpective, is uſed for various poles or places, with regard to the perſpective plane. See Perspective.

Point is alſo an iron or ſteel inſtrument, uſed with ſome variety in ſeveral arts. Engravers, etchers, cutters in wood, &c. uſe points to trace thir deſigns on the copper, wood, ſtone, &c. See the article Engraving, &c.

Point, in the manufactories, is a general term, uſed for all kinds of laces wrought with the needle; ſuch are the point de Venice, point de France, point de Genoa, &c. which are diſtinguiſhed by the particular economy and arrangement of their points.—*Point* is ſometimes uſed for lace woven with bobbins: as Engliſh point, point de Malines, point d'Havre, &c.

Point, in poetry, denotes a lively briſk turn or conceit, uſually found or expected at the cloſe of an epigram. See Poetry.

Point-*Blank*, in gunnery, denotes the ſhot of a gun levelled horizontally, without either mounting or ſinking the muzzle of the piece.—In ſhooting point-blank, the ſhot or bullet is ſuppoſed to go directly forward in a ſtraight line to the mark; and not to move in a curve, as bombs and highly elevated random-ſhots do.—When a piece ſtands upon a level plane, and is laid level, the diſtance between the piece and the point where the ſhot touches the ground firſt, is called the *point blank* range of that piece; but as the ſame piece ranges more or leſs, according to a greater or leſs charge, the point blank range is taken from that of a piece loaded with ſuch a charge as is uſed commonly in action. It is therefore neceſſary that theſe ranges of all pieces ſhould be known, ſince the gunner judges from thence what elevation he is to give to his pieces when he is either further from or nearer to the object to be fired at; and this he can do pretty nearly by ſight, after conſiderable practice.

POINTING, in grammar, the art of dividing a diſcourſe, by points, into periods and members of periods, in order to ſhow the proper pauſes to be made in reading, and to facilitate the pronunciation and underſtanding thereof. See the article Punctuation.

POINTS, in heraldry, are the ſeveral different parts of an eſcutcheon, denoting the local poſitions of any figure. See Heraldry.

Points, in electricity, are thoſe acute terminations of bodies which facilitate the paſſage of the electrical fluid from or to ſuch bodies. See Electricity.

Points, or *Vowel points*, in the Hebrew language. See Philology.

POISON, is any ſubſtance which proves deſtructive to the life of animals in a ſmall quantity, either taken by the mouth, mixed with the blood, or applied to the nerves. Of poiſons there are many different kinds, which are exceedingly various in their operations. The mineral poiſons, as arſenic and corroſive mercury, ſeem to attack the ſolid parts of the ſtomach, and to produce death by eroding its ſubſtance: the antimonials ſeem rather to attack the nerves, and to kill by throwing the whole ſyſtem into convulſions; and in this manner alſo moſt of the vegetable poiſons ſeem to operate. All of theſe, however, ſeem to be inferior in ſtrength to the poiſons of ſome of the more deadly kinds of ſerpents, which operate ſo ſuddenly that the animal bit by them will be dead before another that had ſwallowed arſenic would be affected.

Much has been written concerning a poiſon made uſe of by the African negroes, by the Americans, and by the Eaſt Indians. To this very ſtrange effects have been aſcribed. It has been ſaid that by this poiſon a man might be killed at any certain time; as, for inſtance, after the interval of a day, a week, a month, a year, or even ſeveral years. Theſe wonderful effects, however, do not ſeem worthy of credit; as the Abbé Fontana has given a particular account of an American poiſon called *ticunas*, which in all probability is the ſame with that uſed in Africa and the Eaſt Indies; and from his account it is extremely improbable that any ſuch effects could be produced with certainty.

With this poiſon the Abbé was furniſhed by Dr. Heberden. It was cloſed and ſealed up in an earthen pot encloſed in a tin caſe. Within the tin caſe was a note containing the following words: "Indian poiſon, brought from the banks of the river of the Amazons by Don Pedro Maldonado. It is one of the ſorts that are mentioned in the Philoſophical Tranſactions, vol. xlvii. No. 12." In the volume of the Philoſophical Tranſactions here quoted, mention is made of two poiſons little different in their activity; the one called the *poiſon of Lamas*, and the other of *Ticunas*. The poiſon in the earthen veſſel uſed by the Abbé Fontana was that of the ticunas; he was alſo furniſhed with a number of American arrows dipped in poiſon, but whether that of the lamas or ticunas he could not tell.

Our author begins his account of the nature of this poiſon with detecting ſome of the miſtakes which had been propagated concerning it.—It had been aſſerted, that the Ticunas poiſon proves noxious by the mere effluvia, but much more by the ſteam which exhales from it in boiling or burning; that among the Indians, it is prepared only by women condemned to die; and that the mark of its being ſufficiently prepared is when the attendant is killed by its ſteam. All theſe aſſertions are by the Abbé refuted in the cleareſt manner. He expoſed a young pigeon to the ſmell of the poiſon when the veſſel was opened, to the ſteam of it when boiling, and to the vapour of it when burning to the ſides of the veſſel, without the animal's being the leaſt injured; on which, concluding that the vapours of this poiſon were not to be dreaded, he expoſed himſelf to them without any fear.

This poiſon diſſolves very readily even in cold water, and likewiſe in the vegetable and mineral acids. With oil of vitriol it becomes as black as ink, but not with the reſt of the acids. In oil of vitriol it alſo diſſolves more ſlowly than in any of the reſt. It does not effervefce with acids or alkalis; neither does it alter milk, nor tinge it, except with the natural colour of the poifon; nor does it tinge the vegetable juices either red or green. When examined by the microſcope, there is no appearance of regularity or cryſtallization; but it for the moſt part appears made up of very ſmall, irregular, roundiſh bodies, like vegetable juices. It dries without making any noiſe, and has an extremely bitter taſte when put upon the tongue.

The ticunas poiſon is harmleſs when put into the eyes; nor is it fatal when taken by the mouth, unleſs the quantity is conſiderable. Six grains of the ſolid poiſon, diſſolved in water, killed a young pigeon which drank it in leſs than 20 minutes. Five grains killed a ſmall Guinea-pig in 25 minutes. Eight grains killed a rabbit in an hour and eight minutes, &c. In thoſe experiments it was obſerved that much leſs poiſon was required to kill an animal whoſe ſtomach was empty than one that had a full ſtomach. Three rabbits and two pigeons were killed in leſs than 35 minutes by taking a doſe of three grains each on an empty ſtomach; but when the experiment was repeated on five animals with full ſtomachs, only one of them died.

The moſt fatal operation of this poiſon is when mixed with the blood. The ſmalleſt quantity, injected into the jugular vein, killed the animal as if by a ſtroke of lightning. When applied to wounds in ſuch a manner that the flowing of the blood could not waſh it away, the animal fell into convulſions and a train of fatal nervous ſymptoms, which put an end to its life in a few minutes. Yet, notwithſtanding theſe ſeeming affections of the nerves, the poiſon proved harmleſs when applied to the naked nerves themſelves, or even to the medullary ſubſtance of them ſlit open.

The ſtrength of this poiſon ſeems to be diminiſhed, and even deſtroyed, by mineral acids, but not at all by alkalis or ardent ſpirits; but if the freſh poiſon was applied to a wound, the application of mineral acids immediately after could not remove the pernicious effects. So far, indeed, was this from being the caſe, that the application of nitrous acid to the wounded muſcle of a pigeon killed the animal in a ſhort time without any poiſon at all. The effects of the arrows were equally fatal with thoſe of the poiſon itſelf *.

The poiſon of the viper is analogous in its effects to that of ticunas, but inferior in ſtrength; the latter killing more inſtantaneouſly when injected into a vein than even the poiſon of the moſt venomous rattleſnake.

The Abbe has, however, obſerved a difference in the action of the two poiſons upon blood taken out of the body. He cut off the head of a pigeon, and received its blood into two warm conical glaſſes, to the amount of about 80 drops into each. Into the blood contained in one porringer, he put four drops of water; and into the other four drops of the poiſon diſſolved in water as uſual. The event of this experiment was, that the blood, with which the water only was mixed, coagulated in a ſhort time; but that in which the poiſon was mixed did not coagulate at all. The poiſon of the viper alſo hinders the blood from coagulating, but gives it a much blacker tinge than the poiſon of the ticunas. The poiſon of the viper alſo proves certainly fatal when injected into the veins, even in very ſmall quantity; but it produces a kind of grumous coagulation and blackneſs in the blood when drawn from a vein, though it prevents the proper coagulation of that fluid, and its ſeparation into craſſamentum and ſerum as uſual. See Viper.

In the Philoſophical Tranſactions, No. 335, we have a number of experiments which ſhow the effects of many different poiſons upon animals; from whence it appears, that many ſubſtances which are not at all accounted poiſonous, yet prove as certainly fatal when mixed with the blood as even the poiſon of rattleſnakes, or the ticunas itſelf. An ounce of emetic wine, being injected into the jugular vein of a large dog, produced no effect for a quarter of an hour. At the expiration of that ſpace he became ſick, had a continual vomiting, and evacuation of ſome hard excrements by ſtool. By theſe evacuations he ſeemed to be ſomewhat relieved; but ſoon grew uneaſy, moved from place to place, and vomited again. After this he laid himſelf down on the ground pretty quietly; but his reſt was diſturbed by a return of his vomiting, and his ſtrength greatly decreaſed. An hour and a half after the operation he appeared half dead, but was greatly revived by having ſome warm broth poured down his throat with a funnel. This, however, proved only a temporary relief; for in a ſhort time the vomiting returned, he made urine in great quantity, howled miſerably, and died in convulſions. A dram and a half of ſal ammoniac diſſolved in an ounce and a half of water, and injected into the jugular vein of a dog, killed him with convulſions almoſt inſtantly. The ſame effect followed from injecting a dram of ſalt of tartar diſſolved in an ounce of warm water; but a dram and a half of common ſalt injected into the jugular produced little other bad conſequence than a temporary thirſt. A dram of purified white vitriol, injected into the crural vein of a dog, killed him immediately. Fifteen grains of ſalt of urine diſſolved in an ounce of water, and injected into the crural vein of a dog, threw him into ſuch violent convulſions that he ſeemed to be dying; nevertheleſs he recovered from a ſecond doſe, though not without a great deal of difficulty: but

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* Mr. Paterſon, in his *Travels in Africa in the years* 1777-8-9, fell in with an European woman who had been wounded with a poiſoned arrow. Great pains had been taken to cure her, but in vain; for at different periods of the year an inflammation came on which was ſucceeded by a partial mortification. She told him that the wound was eaſily healed up; but in two months afterwards there was a certainty of its breaking out again, and this had been the caſe for many years. The Hottentots poiſon their arrows with a ſpecies of euphorbia. See Euphorbia.—The amaryllis diſticha, a large bulbous plant growing about the Cape of Good Hope, called *mad poiſon*, is uſed for the ſame purpoſe. The natives take the bulbs when they are putting out their leaves, cut them tranſverſely, extract a thick fluid, and keep it in the ſun till it acquires the conſiſtence of gum, when it is fit for uſe. With arrows poiſoned with this gum they kill antelopes and other ſmall animals intended for food. After they are wounded, the animals generally run for ſeveral miles, and are frequently not found till next day. When the leaves of this plant are young, the cattle are very fond of them, though they occaſion inſtant death. Mr. Paterſon mentions another ſhrubby plant producing a nut, called by the Dutch *woolf gift* or *wolf poiſon*, the only poiſon uſeful to the European inhabitants. The nuts are roaſted like coffee, pulverized, and ſtuffed into ſome pieces of meat or a dead dog, which are thrown into the fields. By this means the voracious hyenas are generally killed. See Rhus.

an ounce of urine made by a man faſting produced no bad effect. Diluted aquafortis injected into the jugular and crural vein of a dog killed him immediately by coagulating the blood. Oil of ſulphur (containing ſome quantity of the volatile vitriolic acid) did not kill a dog after repeated trials. On the contrary, as ſoon as he was let go, he ran into all the corners of the room ſearching for meat; and having found ſome bones, he fell a-gnawing them with ſtrange avidity, as if the acid, by injection into his veins, had given him a better appetite. Another dog who had oil of tartar injected into his veins, ſwelled and died, after ſuffering great torment. His blood was found florid, and not coagulated.—A dram and a half of ſpirit of ſalt diluted with water, and injected into the jugular vein of a dog, killed him immediately. In the right ventricle of the heart the blood was found partly grumous and concreted into harder clots than ordinary, and partly frothy. Warm vinegar was injected without doing any manifeſt harm.—Two drams of ſugar diſſolved into an ounce of water were injected into the jugular vein of a dog without any hurt.

Theſe are the reſults of the experiments where ſaline ſubſtances were injected into the veins. Many acrids proved equally fatal. A decoction of two drams of white hellebore, injected into the jugular vein of a dog, killed him like a ſtroke of lightning. Another dog was killed in a moment by an injection of an ounce of rectified ſpirit of wine in which a dram of camphor was diſſolved.—Ten drams of highly rectified ſpirit of wine, injected into the crural vein of a dog, killed him in a very ſhort time: he died quietly, and licking his jaws with his tongue, as if with pleaſure. In the vena cava and right ventricle of the heart the blood was coagulated into a great many little clots.—Three drams of rectified ſpirit of wine injected into the crural vein of a ſmall dog made him apoplectic, and as it were half dead. In a little time he recovered from the apoplexy, and became giddy; and, when he endeavoured to go, reeled and fell down. Though his ſtrength increaſed by degrees, yet his drunkenneſs continued. His eyes were red and fiery; and his ſight ſo dull that he ſcarce ſeemed to take notice of any thing: and when he was beat, he would ſcarce move. However, in four hours he began to recover, and would eat bread when offered him; the next day he was out of danger.—Five ounces of ſtrong white-wine injected into the crural vein of a dog made him very drunk for a few hours, but did not produce any other conſequences. An ounce of ſtrong decoction of tobacco injected into a vein killed a dog in a very ſhort time in terrible convulſions. Ten drops of oil of ſage rubbed with half a dram of ſugar, and thus diſſolved in water, did no harm by being injected into the blood.

Mercury, though ſeemingly void of all acrimony, proves alſo fatal when injected into the blood. Soon after the injection of half an ounce of this mineral into the jugular vein of a dog, he was ſeized with a dry ſhort cough which came by intervals. About two days after, he was troubled with a great difficulty of breathing, and made a noiſe like that of a broken-winded horſe. There was no tumour about the root of the tongue or the parotid glands, nor any appearance of a ſalivation. In four days he died; having been for two days before ſo much troubled with an orthopnœa, that he could ſleep only when he leaned his head againſt ſomething. When opened, about a pint of bloody ſerum was found in the thorax, and the outſide of the lungs in moſt places was bliſtered. Some of the bliſters were larger and others ſmaller than a pea, but moſt of them contained mercurial globules. Several of them were broken; and upon being preſſed a little, the mercury ran out with a mixture of a little ſanies; but upon ſtronger preſſure, a conſiderable quantity of ſanies iſſued out. In the right ventricle of the heart ſome particles of quickſilver were found in the very middle of the coagulated blood lodged there, and the ſame thing alſo was obſerved in the pulmonary artery. Some blood alſo was found coagulated in a very ſtrange and unuſual manner between the columnæ of the right ventricle of the heart, and in this a greater quantity of quickſilver than anywhere elſe. In the left ventricle was found a very tenacious blood, coagulated, and ſticking to the great valve, including the tendons of it, and a little reſembling a polypus. No mercury could be found in this ventricle by the moſt diligent ſearch; whence it appears, that the mercury had paſſed no further than the extremities of the pulmonary artery, where it had ſtuck, and occaſioned fatal obſtructions.—In another dog, which had mercury injected into the jugular, it appears to have paſſed the pulmonary artery, as part of it was found in the cavity of the abdomen, and part alſo in ſome other cavities of the body. All the glandules were very turgid and full of liquor, eſpecially in the ventricles of the brain, and all round there was a great quantity of ſerum.

In like manner, oil of olives proves certainly fatal when injected into the blood. Half an ounce of this, injected into the crural vein of a dog, produced no effect in half a quarter of an hour: but after that, the animal barked, cried, looked dejected, and fell into a deep apoplexy; ſo that his limbs were deprived of all ſenſe and motion, and were flexible any way at pleaſure. His reſpiration continued very ſtrong, with a ſnorting and wheezing, and a thick humour ſometimes mixed with blood flowing out of his mouth. He loſt all external ſenſe: the eyes, though they continued open, were not ſenſible of any objects that were put to them; and even the cornea could be touched and rubbed, without his being the leaſt ſenſible of it: his eyelids, however, had a convulſive motion. The hearing was quite loſt; and in a ſhort time the feeling became ſo dull, that his claws and ears could be bored with red-hot pincers without his expreſſing the leaſt ſenſe of pain. Sometimes he was ſeized with a convulſive motion of the diaphragm and muſcles ſubſervient to reſpiration; upon which he would bark ſtrongly, as if he had been awake: but this waking was only in appearance; for all the time of this barking he continued as inſenſible as ever. In three hours he died; and on opening his body, the bronchiæ were filled with a thick froth.—An ounce of oil of olives injected into the jugular of another dog killed him in a moment; but a third lived an hour after it. He was ſeized with great ſleepineſs, ſnorting, and wheezing, but did not bark like the firſt. In all of them a great quantity of thick froth was found in the lungs.

We come now to ſpeak of thoſe poiſons which prove mortal[*] when taken by the mouth. The principal of theſe are, arſenic, corroſive mercury, glaſs of antimony, and lead. What the effects of theſe ſubſtances are when injected into the blood, cannot be related, as no experiments ſeem to have been made with them in that way, excepting antimony, whoſe effects have been already mentioned. The effects of opium, when injected into the veins, ſeem to be ſimilar to its effects when taken by the mouth. Fifty grains of opium, diſſolved in an ounce of water, were injected into the crural vein of a cat. Immediately after the operation ſhe ſeemed much dejected, but did not cry; only made a low, interrupted, and complaining noiſe. This was ſucceeded by trembling of the limbs, convulſive motions of the eyes, ears, lips, and almoſt all parts of the body, with violent convulſions of the breaſt. Sometimes ſhe would raiſe up her head, and ſeem to look about her; but her eyes were very dull, and looked dead. Though ſhe was let looſe, and had nothing tied about her neck, yet her mouth was ſo filled with froth, that ſhe was almoſt ſtrangled. At laſt, her convulſive motions continuing, and being ſeized with ſtretching of her limbs, ſhe died in a quarter of an hour. Upon opening the body, the blood was found not to be much altered from its natural ſtate.—A dram and a half of opium was diſſolved in an ounce and a half of water, and then injected into the crural vein of a luſty ſtrong dog. He ſtruggled violently; made a loud noiſe, though his jaws were tied; had a great difficulty of breathing, and palpitation of the heart; with convulſive motions of almoſt all parts of his body. Theſe ſymptoms were ſucceeded by a profound and apoplectic ſleep. Having untied him, he lay upon the ground without moving, or making any noiſe, though ſeverely beaten. About half an hour after he began to recover ſome ſenſe, and would move a little when beaten. The ſleepineſs ſtill decreaſed; ſo that in an hour and a half he would make a noiſe and walk a little when beat. However, he died in four days, after having voided a quantity of fetid excrements, in colour reſembling the diluted opium he had ſwallowed.

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[*] Of all poiſons thoſe which may be called culinary are perhaps the moſt deſtructive, becauſe they are generally the leaſt ſuſpected. All copper veſſels, therefore, and veſſels of bell-metal, which contains copper, ſhould be laid aſide. Even the common *earthen-ware*, when they contain acids, as in pickling, become very pernicious, as they are glazed with lead, which in the ſmalleſt quantity when diſſolved is very fatal; and even tin, the leaſt exceptionable of the metals for culinary purpoſes except iron, is not always quite free of poiſonous qualities, it having been found to contain a ſmall portion of arſenic. Muſhrooms and the common laurel are alſo very fatal. The bitter almond contains a poiſon, and its antidote likewiſe. The cordial dram *ratafia*, much uſed in France, is a ſlow poiſon, its flavour being procured from the kernels of peach, black cherry ſtones, &c.—The ſpirit of *lauroceraſus* is peculiarly fatal. The adulteration of bread, beer, wine, porter, &c. produces very fatal conſequences, and merits exemplary puniſhment. Next to culinary poiſons the abuſe of medicines deſerves particular attention.

The oil of tobacco has generally been reckoned a very violent poiſon when introduced into the blood; but from the Abbé Fontana's experiments, it appears to be far inferior in ſtrength to the poiſon of ticunas, or to the bite of a viper. A drop of oil of tobacco was put into a ſmall inciſion in the right thigh of a pigeon, and in two minutes the animal could not ſtand on its right foot. The ſame experiment was repeated on another pigeon, and produced exactly the ſame effect. In another caſe, the oil was applied to a ſlight wound in the breaſt; three minutes after which, the animal could not ſtand on the left foot. This experiment was alſo repeated a ſecond time, with the ſame ſucceſs. A tooth-pick, ſteeped in oil of tobacco, and introduced into the muſcles of the breaſt, made the animal fall down in a few ſeconds as if dead. Applied to two others, they threw up ſeveral times all the food they had eaten. Two others treated in the ſame manner, but with empty ſtomachs, made many efforts to vomit.—In general, the vomiting was found to be a conſtant effect of this poiſon: but the loſs of motion in the part to which the poiſon is applied, was found to be only accidental. None of the animals died by the application of oil of tobacco. Dr. Leake however aſſerts the contrary; ſaying, that this oil, which is uſed by the Indians in poiſoning arrows, when infuſed into a freſh wound, beſides ſickneſs and vomiting, occaſions convulſions and death. See *Practical Eſſay on Diſeaſes of the Viſcera*, p. 67.

The pernicious effects of laurel-water are taken notice of by the Abbé Fontana; who tells us, that it not only kills in a ſhort time when taken by the mouth, but that, when given in ſmall doſes, the animal writhes ſo that the head joins the tail, and the vertebræ arch out in ſuch a manner as to ſtrike with horror every one who ſees it. In order to aſcertain the effects of this water when taken into the blood, our author opened the ſkin of the lower belly of a pretty large rabbit, and made a wound in it about an inch long; and having ſlightly wounded the muſcles under it in many parts, applied two or three tea-ſpoonfuls of laurel-water. The animal fell down convulſed in leſs than three minutes, and died ſoon after. The experiment was repeated with ſimilar ſucceſs in other animals; but was always found to act moſt powerfully, and in the ſhorteſt time, when taken by the mouth, or injected by way of clyſter. From theſe experiments, however, he concluded, that laurel-water would kill by being injected into the blood: but in this he was deceived; for two rabbits had each of them a large tea-ſpoonful injected into the jugular vein, without any inconvenience either at the time of injection or afterwards. It proved innocent alſo when applied to the bare nerves, and even when introduced into their medullary ſubſtance.

We ought now to give ſome account of the proper antidotes for each kind of poiſon; but from what has been related concerning the extreme activity of ſome of them, it is evident that in many caſes there can be but very little hope. People are moſt apt to be bit by ſerpents in the legs or hands; and as the poiſon, from the Abbé Fontana's experiments, appears to act only in conſequence of being abſorbed into the blood, it is plain that to prevent this abſorption is the chief indication of cure. For this purpoſe, the Abbé Fontana propoſes the uſe of a ligature. This, if properly applied between the wounded part and the heart, muſt certainly prevent the bad effects of the poiſon: but then it tends to produce a diſeaſe almoſt equally fatal; namely, a gangrene of the part; and our author gives inſtances of animals being thus deſtroyed after the effects of the poiſon were perverted; for which reaſon he prefers amputation. But the good effects of either of theſe methods, it is evident, muſt depend greatly on the nature of the part wounded, and the time when the ligature is applied or the amputation performed. If the teeth of the ſerpent, or the poiſoned arrow, happen to ſtrike a large vein, the only poſſibility of eſcaping inſtant death is to compreſs the trunk of the vein above the wounded place, and to enlarge the wound, that the blood may flow freely and in large quantity, in order to waſh away the poiſon, and diſcharge the infected parts of the blood itſelf. If this is neglected, and the perſon falls into the agonies of death, perhaps ſtrongly ſtimulating medicines given in large doſes, and continued for a length of time, may enable nature to counteract the virulence of the poiſon. For this purpoſe volatile alkalis ſeem moſt proper, as acting ſooneſt; and perhaps a combination of them with ether might be advantageous, as by the volatility of that medicine the activity of the alkali probably would be increaſed. In the Philoſophical Tranſactions, we have an account of the recovery of a dog ſeemingly by means of the volatile alkali, when probably he was in a dying condition. This dog indeed ſeems to have had a remarkable ſtrength of conſtitution. The poor creature had firſt got two ounces of the juice of nightſhade, which he bore without any inconvenience. An equal quantity of the juice of hemlock was then given him without effect. He then got a large doſe of the root of wolfſbane with the ſame ſucceſs. Two drachms of white hellebore root were next given. Theſe cauſed violent vomitings and purgings, but ſtill he outlived the operation. He was then made to ſwallow five roots of the colchicum, or meadow-ſaffron, dug freſh out of the earth. The effect of theſe was ſimilar to that of the white hellebore, but ſtill he did not die. Laſtly, he got two drachms of opium; and he even outlived this doſe. He was firſt caſt into a deep ſleep by it; but ſoon awaked, and was ſeized with violent vomitings and purgings, which carried off the effect of the opium. Seeing then that the animal had reſiſted the moſt violent poiſons, it was reſolved to try the effects of the bite of a viper; and he was accordingly bit three or four times on the belly a little below the navel by one enraged. The immediate conſequence of this was an incipient gangrene in the parts adjoining to the wound, as appeared by the riſing of little black bladders filled with a ſanious matter, and a livid colour which propagated itſelf all around. The motion of the heart became very faint and irregular, and the animal lay without ſtrength or ſenſation, as if he had been ſeized with a lethargy or apoplexy. In this condition his wound was cupped and ſcarified, and Venice treacle (a famous antidote) applied to it. In two hours after this all the ſymptoms were increaſed, and he ſeemed to be nearly dead; upon which half a drachm of volatile ſalt of hartſhorn mixed with a little broth was poured down his throat; and the conſequence was, that in a ſhort time he was able to ſtand on his feet and walk. Another doſe entirely diſpelled his lethargy, and the heart began to recover its ſtrength. However, he continued very weak; and though he ate no ſolid meat for three days, yet at the end of that time his ſtrength was evidently increaſed. The firſt day he drank water plentifully and greedily, and on the ſecond day he drank ſome broth. On the third day he began to eat ſolid meat, and ſeemed out of danger; only ſome large and foul ulcers remained on that part of the belly which was bit, and before theſe were healed he was killed by another dog.

From comparing this with ſome other obſervations, indeed, it would ſeem that volatile alkali is the beſt antidote againſt all poiſons which ſuddenly kill by a mixture with the blood, and even of ſome others. Indeed, its effects in curing the bite of ſnakes ſeems to be put beyond all doubt, by a paper in the 2d volume of the Aſiatic Reſearches, p. 323. "From the effect of a ligature applied between the bitten part and the heart (ſays Mr. Williams, the author of the paper), it is evivident that the poiſon diffuſes itſelf over the body by the returning venous blood; deſtroying the irritability, and rendering the ſyſtem paralytic. It is therefore probable, that the volatile cauſtic alkali, in reſiſting the diſeaſe of the poiſon, does not act ſo much as a ſpecific in deſtroying its quality, as by counteracting the effect on the ſyſtem, by ſtimulating the fibres, and preſerving that irritability which it tends to deſtroy."

But whatever be the mode of its operation, the medicine is unqueſtionably powerful. Mr. Williams uſed either the volatile cauſtic alkali, or eau-de-luce; the former of which he ſeems to have preferred. Of it he gave 60 drops as a doſe in water, and of the eau-de-luce he gave 40, at the ſame time applying ſome of the medicine to the part bitten, and repeating the doſe as he found occaſion. Of ſeven caſes, ſome of which were apparently very deſperate, only one died, and that appears to have been occaſioned by bad treatment after the cure. Many of the patients were perfectly recovered in ſeven or eight minutes, and none of them required more than two hours: On the whole, Mr. Williams ſays that he "never knew an inſtance of the volatile cauſtic alkali failing in its effect, where the patient has been able to ſwallow it." Dr. Mead aſſerts, that the alkali counteracts the deadly effects of laurel water; we have ſeen its effects in curing the bite of a viper, and of ſnakes; and from Dr. Wolfe's experiments on hydrophobous patients, it may even claim ſome merit there. Still, however, there is another method of attempting a cure in ſuch deplorable caſes; and that is, by injecting into the veins any thing which will not deſtroy life, but will deſtroy the effects of the poiſon. It is much to be regretted, that in thoſe cruel experiments which we have already related, the intention ſeems almoſt always to have been to kill the animal at all events; whereas, it ought to have been to preſerve him alive, and to aſcertain what medicines could be ſafely injected into the blood, and what could not, with the effects which followed the injection of different quantities, none of which were ſufficient to deſtroy life. But in the way they were managed, ſcarce any concluſion can be drawn from them. Indeed it appears that little good is to be expected from this mode; it is mere ſpeculation, and future experiments muſt ſhow whether it ever ſhall be uſed for the cure of poiſons, or for any other purpoſes: its being now totally laid aſide, ſeems to militate ſtrongly againſt the efficacy of it: beſides, the extreme cruelty of the operation will ever be a ſtrong bar to its general introduction. See INJECTION.

There ſtill remains another method of cure in deſperate caſes, when there is a certainty that the whole maſs of blood is infected; and that is, by the bold attempt of changing the whole diſeaſed fluid for the blood of a ſound animal. Experiments of this kind have alſo been tried; and the method of making them, together with the conſequences of ſuch as are recorded in the Philoſophical Tranſactions, we ſhall notice under the article TRANSFUSION.

Dr. Mead, finding that many pretenders to philoſophy have called the goodneſs of the Creator in queſtion, for having created ſubſtances whoſe manifeſt and obvious qualities are noxious and deſtructive, remarks, by way of anſwer, that they have alſo ſalutary virtues. But, beſides their phyſical effects, they are likewiſe food for animals which afford us good nouriſhment, goats and quails being fattened by hellebore, ſtarlings by hemlock, and hogs innocently eating henbane: beſides, ſome of thoſe vegetables which were formerly thought poiſonous are now uſed in medicine, and future diſcoveries may probably increaſe the number. The poiſon of many vegetables is their only defence againſt the ravages of animals; and by means of them we are often enabled to defend uſeful plants from the deſtroying inſect; ſuch as by ſprinkling them with eſſential oil of turpentine; and by means of ſome ſubſtances poiſonous to them, we are enabled to deſtroy thoſe inſects which infeſt the human body, and the bodies of domeſtic animals, &c.—As for poiſonous minerals, arſenic for example, Dr. Mead obſerves, that it is not a perfect mineral, but only an active ſubſtance, made uſe of by nature in preparing ſeveral metals in the earth, which are of great ſervice to mankind; and, after confirming this by ſeveral inſtances, he concludes by ſaying, the caſe will be found much the ſame in all natural productions of this kind. As for poiſonous animals, &c. their noxious qualities may eaſily be accounted for, by reflecting that it is their only mode of ſelf-defence. See ARANEA and SERPENT.

Poiſon of COPPER. This metal, though when in an undiſſolved ſtate it produces no ſenſible effects, becomes exceedingly active when diſſolved; and ſuch is the facility with which the ſolution is effected, that it becomes a matter of ſome conſequence to prevent the metal from being taken into the human body even in its proper form. It doth not, however, appear that the poiſon of copper is equally pernicious with thoſe of arſenic or lead; much leſs with ſome others treated of in the laſt article. The reaſon of this is, that it excites vomiting ſo ſpeedily as to be expelled, even though taken in conſiderable quantity, before it has time to corrode the ſtomach. Blue vitriol, which is a ſolution of copper in the vitriolic acid, has been uſed as a medicine in ſome diſeaſes with great ſucceſs. Verdigriſe alſo, which is another very active preparation of the metal, has been by ſome phyſicians preſcribed as an emetic, eſpecially in caſes where other poiſons had been ſwallowed, in order to procure the moſt ſpeedy evacuation of them by vomit. Where copper is not uſed with this view, it has been employed as a tonic and antiſpaſmodic, with which it has been admitted into the Edinburgh Diſpenſatory under the title of *Cuprum Ammoniacale*. The effects of the metal, however, when taken in a pretty large quantity, and in a diſſolved ſtate, or when the ſtomach abounds with acid juices ſufficient to diſſolve it, are very diſagreeable and even dangerous; as it occaſions violent vomitings, pains in the ſtomach, faintings, and ſometimes convulſions and death. The only cure for theſe ſymptoms is to expel the poiſon by vomiting as ſoon as poſſible, and to obtund its acrimony; for which purpoſe drinking warm milk will probably be found the moſt efficacious remedy. In order to prevent the entrance of the poiſon into the body, no copper veſſels ſhould be uſed in preparing food but ſuch as are either well tinned or kept exceedingly clean. The practice of giving a fine blue or green colour to pickles, by preparing them in copper veſſels, ought not to be tolerated; for Dr. Falconer, in a treatiſe on this ſubject, aſſures us, that theſe are ſometimes ſo ſtrongly impregnated by this method of preparing them, that a ſmall quantity of them will produce nauſea.——Mortars of braſs or bell-metal ought for the ſame reaſon to be avoided, as by this means a conſiderable quantity of the pernicious metal may be mixed with our food, or with medicines. In other caſes, an equal caution ought to be uſed. The cuſtom of keeping pins in the mouth, of giving copper halfpence to children to play with, &c. ought to be avoided; as thus a quantity of the metal may be inſenſibly taken into the body, after which its effects muſt be uncertain.——It is proper to obſerve, however, that copper is much more eaſily diſſolved when cold than when hot; and therefore the greateſt care ſhould be taken never to let any thing deſigned for food, even common water, remain long in copper veſſels when cold; for it is obſerved, that though the confectioners can ſafely prepare the moſt acid ſyrups in clean copper veſſels without their receiving any detriment whilſt hot, yet if the ſame ſyrups are allowed to remain in the veſſels till quite cold, they become impregnated with the pernicious qualities of the metal.

Poison *of Lead.* This metal, when taken ſlowly into the ſtomach with our food, is capable of producing the diſeaſe uſually called *Devonſhire colic*, which, after a length of time, is ſucceeded by palſy. Dr. Houlſton, in his Eſſay on Poiſons, has given a remarkable inſtance of a whole family, who, having ſucceſſively fallen a prey to paralytic diſorders, after a ſeries of years, the cauſe was diſcovered to be their having uſed the water of a leaden pump, which had been gradually diſſolved, and thus rendered the water poiſonous. For the treatment of colic and palſy, ſee Medicine. Calomel adminiſtered in ſmall doſes, till ptyaliſm is produced, is the moſt effectual way of reſtoring ſenſibility to the nerves, when loſt from this cauſe.

Poison-*Tree.* See Rhus.

Poison-*Tree of Java*, called in the Malayan language *bohun upas*, is a tree which has often been deſcribed by naturaliſts; but its exiſtence has been very generally doubted, and the deſcriptions given of it, containing much of the marvellous, have been often treated as idle fictions. N. P. Foerſch, however, in an account of it written in Dutch, aſſerts that it does exiſt; and tells us, that he once doubted it as much as any perſon; but, determined not to truſt general opinions, he made the moſt particular inquiries poſſible; the reſult of which was, that he found that it is ſituated in the iſland of Java, about 27 leagues from Batavia, 14 from Soura Charta, the emperor's ſeat, and about 19 from Tinkjoe, the reſidence of the ſultan of Java. It is ſurrounded on all ſides by hills and mountains, and the adjacent country for 12 miles round the tree is totally barren. Our author ſays he has gone all round the ſpot at about 18 miles from the centre, and on all ſides he found the country equally dreary; which he aſcribes to its noxious effluvia. The poiſon procured from it is a gum, iſſuing from between the bark and the tree; and it is brought by malefactors who have been condemned to death, but who are allowed by this alternative to have a chance for their life. An old eccleſiaſtic, our author informs us, dwelt on the outſide of the ſurrounding hills, whoſe buſineſs it was to prepare the criminals for their fate, if death ſhould be the conſequence of their expedition. And indeed ſo fatal is its effluvia, that he acknowledged that ſcarcely two out of 20 returned, from above 700 whom he had diſmiſſed.

Mr. Foerſch further tells us, that he had ſeen ſeveral of the criminals who had returned, and who told him, that the tree ſtands on the borders of a rivulet, is of a middling ſize, and that five or ſix young ones of the ſame kind ſtand cloſe to it. They could not, however, ſee any other plant or ſhrub near it; and the ground was of browniſh ſand, full of ſtones and dead bodies, and difficult to paſs. The Malayans think this tract was thus rendered noxious and uninhabitable by the judgement of God, at Mahomet's deſire, on account of the ſins of the inhabitants. No animal whatever is ever ſeen there; and ſuch as get there by any means never return, but have been brought out dead by ſuch of the criminals as have themſelves eſcaped death.

Our author relates a circumſtance which happened in the year 1775, to about 400 families (1600 ſouls), who refuſed to pay ſome duty to the emperor, and who were in conſequence declared rebels and baniſhed: they petitioned for leave to ſettle in the uncultivated parts round Upas: the conſequence of which was, that in leſs than two months their number was reduced to about 300 ſouls, who begged to be reconciled to the emperor, and were again received under his protection. Many of theſe ſurvivors Mr. Foerſch ſaw, and they had juſt the appearance of perſons tainted with an infectious diſorder.

With the juice of this tree, arrows, lances and other offenſive weapons are poiſoned. With lances thus poiſoned, Mr. Foerſch obſerves, that he ſaw 13 of the emperor's concubines executed for infidelity to his bed in February 1776. They were lanced in the middle of their breaſts; in five minutes after which they were ſeized with a *tremor* and *ſubſultus tendinum*, and in 15 minutes they were dead. Their bodies were full of livid ſpots, like thoſe of *petecchiæ*, their faces ſwelled, colour blue, and eyes yellow, &c. Soon after he ſaw ſeven Malayans executed in the ſame way, and ſaw the ſame effects follow; on which he reſolved to try it on other animals, and found the operation ſimilar on three puppies, a cat, and a fowl, none of which ſurvived more than 13 minutes. He alſo tried its effects internally on a dog ſeven months old; the animal became delirious, was ſeized with convulſions, and died in half an hour. From all which our author concludes, that it is the moſt violent of all vegetable poiſons, and that it contributes greatly to the unhealthineſs of the iſland in which it grows. By means of it many cruel and treacherous murders are perpetrated. He adds, that there exiſts a ſort of cajoe-upas on the coaſt of Macaſſar, the poiſon of which, though not near ſo violent or malignant, operates nearly in the ſame manner.

To this account our readers will give ſuch a degree of credit as they think is due; it is our buſineſs however to add, that it has been controverted in all its parts in a memoir of Lambert Nolſt, M. D. fellow of the Batavian Experimental Society at Rotterdam, (ſee Gentleman's Mag. May 1794, p. 433.) This memoir was procured from John Matthew a Rhyn, who had been 23 years, from 1763 to 1786, reſident in the iſland, and therefore had every opportunity of informing himſelf on the ſpot. In this memoir we are told, that Foerſch's account of the tree is extremely ſuſpicious, from a variety of circumſtances: 1. Though he had letters of introduction, he went to no conſiderable houſe, and afterwards privately withdrew among the Engliſh. 2. When the emperor was aſked reſpecting Foerſch, and the facts he relates, he anſwered, that he had never heard either of him or of the tree. 3. The diſtances given to mark the ſituation of the tree are not accurate. 4. The execution of criminals is different from what he repreſents. 5. The circumſtance of ſeveral criminals returning when Foerſch was there has a ſuſpicious appearance. 6. There exiſts no ſuch tradition, as that the tree was placed there by Mahomet. 7. There were no ſuch diſturbances in 1775 as Foerſch repreſents, the tract to which he alludes having ſubmitted to the Dutch Eaſt India Company as early as 1756. 8. The iſland is not unhealthy, Foerſch aſſerts; nor are violent or premature deaths frequent.

9. The Javaneſe are a curious and intelligent people, and of courſe could not be ſo ignorant of this tree if it had any exiſtence. 10. The aſſertions and pretended facts of Foerſch have no collateral evidence; and every thing which we gather from the accounts of others, or from the hiſtory of the people, invalidates them. For theſe and other reaſons, Dr. Nolſt concludes, that very little credit is due to the repreſentations of Foerſch, and that the iſland of Java produces no ſuch tree, which, if it really grew there, would be the moſt remarkable of all trees.

POLA, in ichthyology, is the name of a flat fiſh, reſembling the ſoal, but ſomewhat ſhorter and ſmaller. It is called *cynogloſſus* and *linguatula*. It abounds in the Mediterranean, and is ſold both in Rome and in Venice for the table.

POLACRE, a ſhip with three maſts, uſually navigated in the Levant and other parts of the Mediterranean. Theſe veſſels are generally furniſhed with ſquare ſails upon the main-maſt, and *lateen* ſails upon the fore-maſt and mizen-maſt. Some of them, however, carry ſquare ſails upon all the three maſts, particularly thoſe of Provence in France. Each of their maſts is commonly formed of one piece, ſo that they have neither top-maſt nor top-gallant-maſt; neither have they any *horſes* to their yards, becauſe the men ſtand upon the top-ſail-yard to looſe or furl the top-gallant-ſail, and on the lower-yard to *reef*, to looſe, or furl, the top-ſail, whoſe yard is lowered ſufficiently down for that purpoſe.

POLAEDRASTYLA, in natural hiſtory, is the name of a genus of cryſtals, derived from the Greek πολυς *many*, εδρα *ſides*, the primitive particle α *not*, and ϛυλος *a column*; and means a cryſtal with many planes, and without a column.

The bodies of this genus are cryſtals of two octangular pyramids, with the baſes joined, the whole body conſiſting of 16 planes. Of this genus there are only two ſpecies known: 1. A brown kind with ſhort pyramids, found in great plenty in Virginia on the ſides of hills; and, 2. A colourleſs one, with longer pyramids. This has yet been found only in one place, which is the great mine at Goſſalaer, in Saxony.

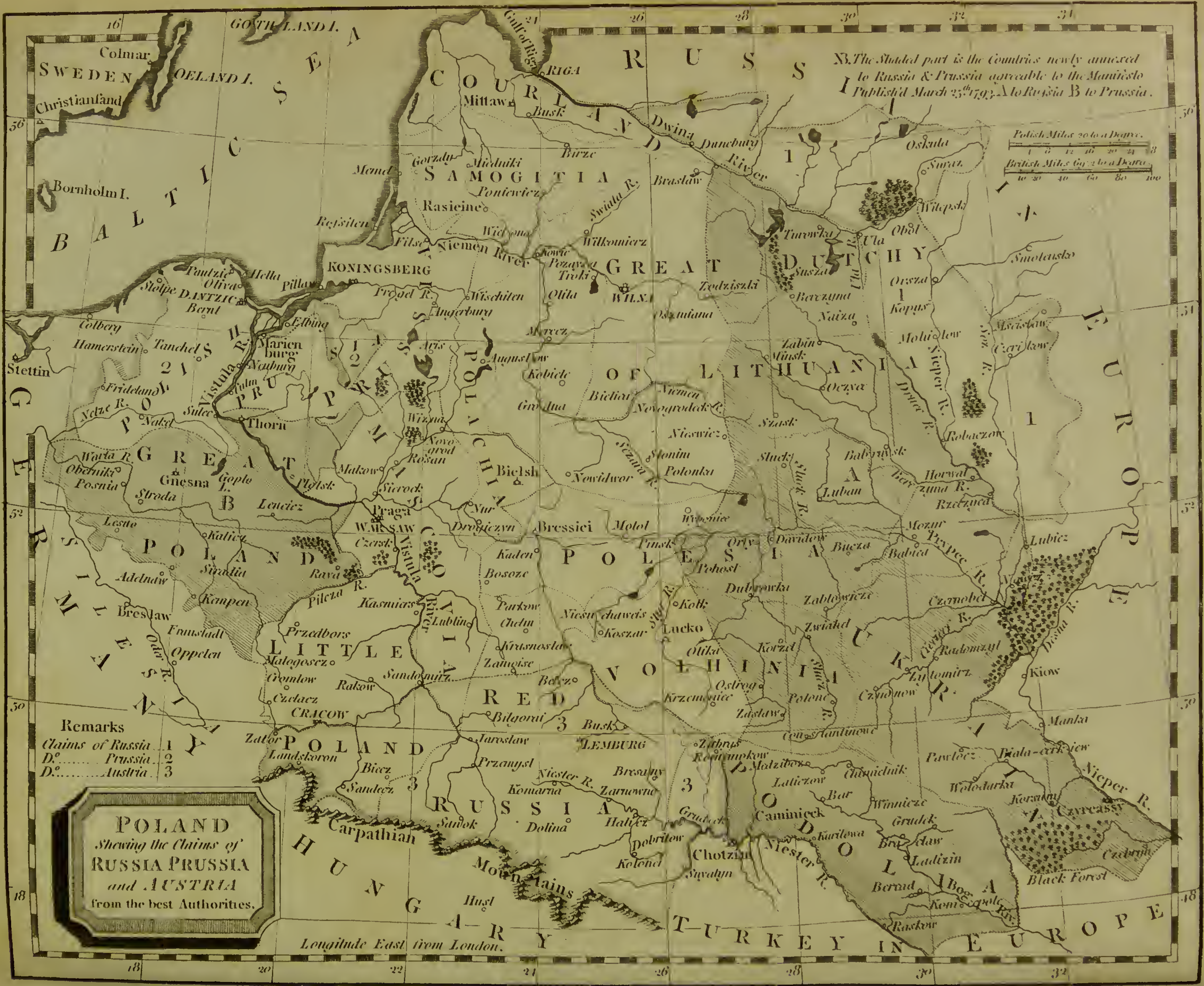
POLAND, a conſiderable country of Europe, bounded on the north by Pruſſia, Courland, and Ruſſia, on the eaſt by Ruſſia, on the ſouth by Hungary and Moldavia, and on the weſt by Sileſia, Pomerania, and Moravia; about 800 miles in length, and 560 in breath. Poland in its utmoſt latitude included thirteen provinces, or countries; 1. Great Poland, or Wielkopolſka Prowincya, called alſo Lower Poland, which included the palatinates of Poſen, or Poſnania, Kaliſh, Siradia, Lenczicz, and Rawa; 2. Cujavia, including the palatinates of Brſeſkie and Wladiſlaw; 3. Maſovia, containing the palatinates of Czerſk, and Ploczko; 4. Poliſh Pruſſia, including Pomerelia, the palatinate of Culm, the government of Marienberg and Ermeland; 5. Little Poland, containing the palatinates of Cracow, Sandomir, and Lublin; 6. Podlachia, or the palatinate of Bielſk; 7. Little Ruſſia, or Red Ruſſia, including the palatinates of Chelm, Belz, and Lemberg; 8. Podolia, in which are included the palatinates of Podolia and Braclaw; 9. Pálatinate of Kiov; 10. Volhynia. Beſides theſe, Lithuania has been conſidered a part of Poland; as likewiſe Samogitia and Courland. Of theſe, Great Poland, Poliſh Pruſſia and part of Lithuania have been ſeized by Pruſſia. Little Poland and Red Ruſſia were annexed to Auſtria: while the remainder and greater part of Lithuania Courland, Poleſia, Podolia, palatinate of Kiov and Volhynia, were ſeized by Ruſſia; ſo that, in the year 1793, only Samogitia, Maſovia, and Podlachia, were left to conſtitute the kingdom of Poland. The air is ſomething cold, but ſalubrious: and the country is, for the moſt part, level, and has but few hills. On the Krapack mountains, which ſeparate Poland from Hungary, the air is very cold; for it ſnows there frequently in the midſt of ſummer, and in ſome parts of them the ſnow never melts. The ſoil of this country is exceedingly fertile, and yields plenty of grain, of which there cannot be a greater proof than that near 4000 veſſels and floats, moſt of which are laden with corn, annually paſs down the Viſtula to Dantzick. In Podolia, Volhynia, the Ukraine, and the province of Ruſſia, corn grows in vaſt plenty, and with little culture or manure. In Great and Little Poland, agriculture requires more attention and labour; but the harveſts make ample amends for the pains of the induſtrious peaſant. The ſoil of Lithuania is as fruitful as that of Podolia; and Samogitia produces abundance of grain beſides hemp and flax. Poliſh Pruſſia is alſo a very fertile country: here are likewiſe excellent paſtures. The following is a remarkable inſtance of the fertility of the ſoil, and the plenty of all kinds of proviſions in this country; namely, that from the year 1701 to 1718, during which time there were ſeveral armies in Poland, there was not the leaſt ſcarcity of bread. Peat, oker of all kinds, chalk, helemnites, agate, chalcedony, cornelians, onyxes, opals, jaſper, fine rock cryſtal, amethyſts, granite, topázes, ſapphires, and even rubies and diamonds are found in Poland. This country likewiſe affords marienglas, or muſcovy glaſs, talc, alum, ſaltpetre, amber, pit-coal, and an inexhauſtible quantity of ſalt, which is hewn out of the rock in large blocks, and ſalt ſprings; alſo ſpar, quick-ſilver, lapis calaminaris, iron, lead, a ſmall quantity of tin, gold and ſilver; but there are no mines of the two laſt metals wrought in Poland. The Poliſh manna is produced by an herb that grows in the meadows and fenny grounds; and it is gathered, in great quantities, from the twentieth of June to the end of July. The Poliſh kermes-berries are always gathered in May, before they are quite ripe; for in the month of July they ſwarm with inſects, which leave a kind of protuberance behind them; ſo that the berries are rendered unfit either for dyeing or medicine. Here are ſeveral woods of oak, beech, pine, and fir-trees: Poland alſo yields abundance of honey and wax. Horned cattle are bred in this country in ſuch numbers, that 80,000 or 90,000 oxen are driven every year out of Poland. The Poliſh horſes are very ſtrong, ſwift, and beautiful. Of theſe there are great numbers in this country, and likewiſe of wild beaſts: as the elk, called in the Poliſh language, los, or a wild ram with one horn; the biſon, called zubr by the Poles; the hyena, in the Poliſh language called roſomak; the ſuhak, which reſembles a wild goat; and laſtly, the aurracks are very common in Poland. The Poles, when conſidered as members of the community, are either nobles, citizens (in which claſs, merchants, artiſts, and mechanics are included) or peaſants, who are moſtly vaſſals to the nobles. The Poliſh towns are for the moſt part built with wood; and the villages conſiſt of mean cottages, or huts. The nobles of Poland have, from time immemorial, reſided in the country. Every nobleman lives in his own village, ſeat, or caſtle; manages his eſtate by his vaſſals, or hired ſervants; and maintains himſelf and whole family by agriculture, breeding of bees, grazing, and hunting. Some of the nobility alſo ſpend part of their time in the cities or towns. A nobleman in the Poliſh language is called Szlakcic, and the dignity is termed Shlakelſtwo. There are among the Poliſh nobility certain gentes, or tribes, and theſe again are divided into diſtinct families: this diſtinction, however, is not owing to the different places or provinces where they live, but they are ranked according to the names and arms they bear. Though Poland has its princes, counts, and barons, yet the whole nobleſſe are naturally on a level, excepting the difference ariſing from the poſts ſome of them enjoy: hence all thoſe who are of noble birth call one another brothers. However, noblemen whoſe circumſtances are low, ſubmit to enter into the ſervice of the richer ſort, eſpecially if the latter are in any eminent poſts, either for a comfortable ſubſiſtence, or to learn politeneſs and addreſs, and, perhaps, to raiſe their fortunes;

and this is accounted no diſgrace. The Poliſh nobility enjoy a great many conſiderable privileges; and, indeed, the ſo much boaſted Poliſh liberty is properly limited to the nobles only: for they have the power of life and death over their vaſſals, who on that account groan under an oppreſſive vaſſalage, or rather ſlavery. Every nobleman is abſolute lord of his eſtates; ſo that the king can require no ſubſidy from him, nor is he obliged to maintain, or find quarter for any ſoldiers. If a foreigner dies on a nobleman's eſtate in Poland, without leaving any heirs, his effects fall to the lord of the manor, as an eſcheat; but on the demiſe of a nobleman without heirs, his eſtate does not eſcheat to the king, whilſt there are any perſons living who are related, in the eighth degree, to the deceaſed; and if a nobleman dies without heirs, or any ſuch relations, the king cannot appropriate his eſtate to himſelf, but is obliged to beſtow it on ſome other nobleman of merit. The houſe of a nobleman is a ſecure aſylum for perſons who have committed any crime; for none muſt preſume to take them from thence by force. The judges in the town dare not cauſe a nobleman's vaſſal to be arreſted, or his effects to be ſeized. Noblemen and their vaſſals pay no toll, or duty, for the cattle, corn, &c. which they ſend out of the kingdom for ſale: they have alſo the liberty of working any mines or ſalt works on their own eſtates. No magiſtrate, nor even the king himſelf, can cauſe a nobleman to be arreſted, without ſignifying the crime he is guilty of, and a previous citation; unleſs he be a robber, and have been three times impeached by his aſſociates: or be ſurpriſed in any other crime, *ipſo facto*; or laſtly, when he cannot, or will not, put in bail. A nobleman is ſubject to none but the king; however, he is not obliged to appear before his majeſty out of the kingdom, when cited on any cauſe, unleſs it relate to the royal treaſury, but muſt be judged in Poland. All eccleſiaſtical dignities, and civil poſts, in this kingdom, are to be held only by the nobility. None but noblemen are qualified to be proprietors of eſtates, except the burghers of the cities of Thorn, Cracow, Wilna, Lemberg, and Lublin, who have the privilege of purchaſing lands. Any nobleman may purchaſe a houſe, and live in a city, or town: but he muſt then ſubmit to ſerve municipal offices; and, if he is concerned in trade, or commerce, he forfeits the privileges of a noble Pole. Every nobleman has a vote in the election of a king; and is even qualified to wear the crown, if he be raiſed to it by the free choice of the reſt of the nobility. The Poliſh nobility has alſo ſome excluſive advantages in purchaſing ſalt: theſe, and other important privileges, the nobles of Poland enjoy, partly by the indulgence of their kings, and partly by ancient cuſtom or preſcription. A perſon deſcended from noble anceſtors is much more honoured than one newly ennobled. All civil cauſes relating to the nobility are tried in the provincial courts of judicature; but if a nobleman commence a ſuit with the farmers of the royal demeſnes, a commiſſorial court is appointed to terminate the diſpute. The Poliſh burghers alſo enjoy ſome valuable privileges. The Poliſh language is derived from the old Sclavonic; however, it differs extremely from all the other languages which come from the ſame ſource. The German language is very much in vogue in Poland. The Latin tongue is alſo commonly ſpoken in Poland, even by the lower claſs of people, but without any regard to accent, quantity, or purity of language. There are no manufactures in Poland; but all the commodities of the country are exported, unwrought, out of the kingdom. The Poles, indeed, export grain of all kinds, flax, hemp, linſeed, hops, honey, wax, tallow, hides, leather (dreſſed in the Ruſſian manner), pitch, pot-aſh, maſts, deal-boards, ſhip and houſe timber, horned cattle, horſes, and other home commodities; but theſe are greatly over-balanced by the imports, namely, wine (that of Hungary alone carrying ſome millions annually out of the kingdom), ſpices, cloths, ſilk ſtuffs, fine linen, pearls, precious ſtones, plate copper, braſs, ſteel, furs, &c. As for the religion profeſſed in this country, it was decreed by the Conſtitutions of the Pacification Diet, held in the year 1736, that no perſon ſhould be elected king of Poland, and great duke of Lithuania, without firſt making a ſolemn profeſſion of the Roman Catholic religion; and that the queen muſt either have been brought up in that communion, or publicly declare herſelf a member of it: hence it appears that the Roman Catholic is the eſtabliſhed religion. The diſſidents, i. e. the Lutherans, Calviniſts, and Greeks, by the treaties concluded with the ancient confederations, and particularly the conſtitution of the year 1717, are promiſed ſecurity as to their effects, and an equality with the other ſubjects as to their perſons; and, for this end, ſeveral other powers intereſted themſelves in their behalf. This procured them many fair promiſes; which, however, were not fulfilled. The Jews are indulged with great privileges, and are very numerous in Poland: hence this country is ſtyled the paradiſe of the Jews. It is ſuppoſed that there are, at leaſt, two millions of Jews only in the villages; and here it muſt be obſerved that there are, at leaſt, one, two, or three Jewiſh families in every village, excluſive of the great number of Jews in the towns. Their annual capitation, or poll-tax, amounts to 220,000 Poliſh guilders in the kingdom of Poland, and 120,000 in Lithuania, which makes, in the whole, the ſum of 56,666 rix-dollars; and this over and above the general impoſts and taxes. All the writers who have treated of the ancient hiſtory of Poland are of opinion, that the preſent inhabitants were not the original poſſeſſors of this country, but emigrated hither as colonies from other parts; it is alſo the general opinion, that they came from Sarmatia, and ſettled on the banks of the Viſtula. Poland was formerly an hereditary kingdom; but afterwards, the acceſſion of a new king to the government was always preceded by a declaration of the nobility: however, the kings did not only ſtyle themſelves ſovereigns of Poland by the conſent of the people, but alſo heirs to the kingdom and its dependencies, by right of ſucceſſion. Sigiſmund Auguſtus was the laſt who aſſumed this title. After his deceaſe it was enacted by a law, That no king ſhould in his life-time appoint or chooſe a ſucceſſor; nor convoke a diet for the election; nor, laſtly, in any manner intermeddle with the ſucceſſion to the crown: but that, on the deceaſe of a king, the choice ſhould perpetually remain free and open to all the nobles of the kingdom: this law has, accordingly, been hitherto obſerved: thus Poland became an elective kingdom. The place of election is in a common, or open field, near the village of Wola, not far from Warſaw. The ſovereign is elected by the ſpiritual and temporal counſellors of ſtate; by the nobles, who ſend their repreſentatives, or proxies, though every nobleman may attend in perſon if he pleaſes; by the cities of Cracow, Poſnan, Vilna, Lemberg, and Warſaw, whoſe choice always coincides with that of the nobility; and likewiſe by Thorn, Elbing, and Dantzic, the three principal cities of Poliſh Pruſſia: none but Roman Catholics dare appear at the election. The king elect is obliged, either perſonally, or by his ambaſſador or proxy, to ſwear to the obſervance of the Pacta Conventa, which are drawn up in the Poliſh language, and adminiſtered by the ſtates: after this he is proclaimed king, and crowned in the cathedral of Cracow, by the archbiſhop of Gneſna. Poland, in conjunction with the great duchy, which is annexed to it, conſtitutes a republic, of which, indeed, the king is conſidered as the head; but moſt of the power is lodged in the ſenate, or council of ſtate, and the nobleſſe. The king is not permitted to enter into a war, to aſſemble an army, to conclude a peace, or to make any public alliances; neither is he inveſted with the power of ſending envoys on important occaſions, impoſing taxes, contributions, or cuſtoms, or of coining money, without the conſent of the ſtates: he is to make no laws, determine no religious diſputes, nor to alienate any of the royal demeſnes; nor, laſtly, is he to undertake, and carry into execution, any matters of importance that concern the kingdom, without the conſent of the ſtates duly convened. Among his royal prerogatives, the chief is, that the king has the diſpoſal of the poſts of honour, and the royal demeſnes; but without the conſent of the ſtates, he is neither to diminiſh, or increaſe, the honorary poſts, nor to confer above one office on one perſon, nor to deprive any one of his poſt. The king of Poland has little or no property in what is called the royal eſtates, but is obliged to beſtow them on private perſons; and the conſideration-money does not come into the king's coffers, but is applied to the ſervice of the republic. The other royal prerogatives are as follows: the chief care of the public welfare is committed to the king, who is to conſult with the ſtates about every thing. The Poliſh ſenate, or council of ſtate, conſiſts of 144 members, who are all ſtyled ſenators of the kingdom, counſellors of ſtate, and have the title of excellency: however, they have no appointments or penſions as ſenators. The ſenate conſiſts of two archbiſhops, fifteen biſhops, thirty-ſeven woiewodas, or palatines, including the three caſtellans and the ſtaroſta of Samogitia, who rank with the palatines. The office of a woiewoda, or palatine, is to march at the head of the nobility of his woiewodzwo, or palatinate, in time of war. Every palatine is a prince by his office. Eighty-two caſtellani, or caſtellans, who in time of peace are only ſenators, without any juriſdiction; but in time of war, by general ſummons, they act as palatines, whoſe lieutenants they in ſome meaſure are, and march at the head of the nobility, under the woiewodas. The great caſtellans, together with the other ſpiritual and temporal ſenators, are admitted into the moſt ſecret councils, from which the others are ſometimes excluded: and, laſtly, the crown officers. The diets are uſually held on two accounts; namely, to conſider on the reſolutions of the ſenate relating to the public welfare, and for the adminiſtration of juſtice. No ſuch thing as a ſtanding army, kept in conſtant pay, was formerly known in this country; but all that were capable of bearing arms in the nation took the field on any emergency. In the year 1551, the Lithuanians firſt began, for the ſecurity of their frontiers, to keep on foot, and pay, a certain number of troops. Their example was followed by the Poles, who raiſed an army to defend their frontiers from the ravages of their roving, lawleſs neighbours, who live on plunder. The fourth part of the produce of the royal table lands, as they are called, are appropriated to maintain theſe troops; hence they are called quartians, and the money appointed for the payment of them is depoſited in the caſtle of Rawa. But as theſe quartians were found not to be ſufficient for the defence of the kingdom, the army was augmented, and divided into cavalry and infantry; but the former was more numerous than the foot. The troops are now divided into the crown army, and that of Lithuania; but ſome of the troops in both armies are clothed and exerciſed in the Poliſh, and others in the German manner. Beſides this ſtanding army, which receives conſtant pay, Poland, on any preſſing exigency, is provided with another, which can be ſpeedily got together, and is of no charge to the public. For, on any ſudden and imminent danger, the whole body of the nobility are ſummoned to appear in the field on horſeback; and ſuch a general ſummons of the nobles is, in the Poliſh language, called Poſpolite Ruſzenie. This is concluded upon in a diet, after having been previouſly propoſed in the provincial meetings; and is done by royal letters, with the ſeals of the kingdom and the great duchy of Lithuania. Theſe being faſtened to poles by the ſummoners, are carried to the principal noblemen, ſtate-officers, and perſons of rank, in every palatinate, and read in the market-places of the cities and towns. When this has been three times repeated, the nobility, after holding their aſſemblies in their palatinates and diſtricts, appear in the field on horſeback. The univerſities of Poland are Cracow, Wilna, and Poſen. The proteſtants and Greeks, under name of diſſidents, were deprived of many of their privileges by the Roman catholics, contrary to the treaty of Oliva; and notwithſtanding the remonſtrances of the court of London, Peterſburgh, Berlin, and Copenhagen, a diet aſſembled in the year 1766 did not ſeem inclined to reſtore them, or repeal ſome of the exceptionable laws. Such was the ſituation of the diſſidents at the election of Staniſlaus, in the year 1764, and was the occaſion of great diſturbances, and almoſt a civil war, and alſo cauſed the introducing troops of Ruſſia, Pruſſia, and Auſtria. The partition of Poland was firſt projected by the king of Pruſſia. Poliſh or Weſtern Pruſſia had long been an object of his ambition: excluſive of its fertility, commerce, and population, its local ſituation rendered it highly valuable to that monarch; it lay between his German dominions and Eaſtern Pruſſia, and, while poſſeſſed by the Poles, cut off, at their will, all communication between them. During the courſe of the laſt general war, he experienced the moſt fatal effects from this disjointed ſtate of his territories. By the acquiſition of Weſtern Pruſſia, his dominions would be rendered compact, and his troops, in time of war, be able to march from Berlin to Konigſberg without interruption. The period was now arrived, when the ſituation of Poland ſeemed to promiſe the attainment of this favourite object; and by political management he brought over Ruſſia and Auſtria to his ſcheme. By the firſt diſmemberment, in the year 1772, the portion taken by Ruſſia was the largeſt, the Auſtrian the moſt populous, and the Pruſſian the moſt commercial. The population of the whole amounts to near 5,000,000 of ſouls; the firſt containing 1,500,000, the ſecond 2,500,000, the third 860,000. Weſtern Pruſſia was the greateſt loſs to Poland, as, by the diſmemberment of that province, the navigation of the Viſtula entirely depends upon the king of Pruſſia: by the loſs, conſequently, of this diſtrict, a fatal blow was given to the trade of Poland: for his Pruſſian majeſty laid ſuch heavy duties upon the merchandize paſſing to Dantzic, as very greatly to diminiſh the commerce of that town, and to transfer a conſiderable portion of it to Memel and Konigſberg; and in the year 1793 the ſecond partition took place. Some attempts were made by a few patriotic noblemen to deliver their country from their oppreſſors, and they were at firſt ſucceſsful; but the brave Koſciuſko being taken priſoner, and his army defeated, no further efforts were made. Koſciuſko was carried into Ruſſia, and the king formally reſigned his crown at Grodno, in the year 1795.

POLAR, in general, ſomething relating to the poles of the world, or poles of the artificial globes. The POLAR *Regions* are thoſe parts of the world lying near the north and ſouth poles.

POLARITY, the quality of a thing conſidered as having poles, or a tendency to turn itſelf into one certain poſture; but chiefly uſed in ſpeaking of the magnet.

POLE (REGINALD), cardinal, and archbiſhop of Canterbury, a younger ſon of Sir Richard Pole, Lord Montague, was born at Stoverton caſtle, in Staffordſhire, in the year 1500. At ſeven years of age he was ſent to a Carthuſian monaſtery at Shene, near Richmond in Surry: and thence, when he was about 12 years old, removed to Magdalen college in Oxford, where, by the inſtructions of the celebrated Lineacre and Latimer, he made conſiderable progreſs in learning. In 1515 he took the degree of bachelor of arts, and was admitted to deacon's orders ſome time after: in 1517 he was made prebendary of Saliſbury, and in 1519 dean of Wimborne and dean of Exeter. We are not ſurpriſed at this young nobleman's early



Barlow sculp.

preferments, when we conſider him as the kinſman of Henry VIII. and that he was bred to the church by the king's ſpecial command.

Being now about the age of 19, he was ſent, according to the faſhion of the times, to finiſh his ſtudies at Padua in Italy, where he reſided ſome time in great ſplendor, having a handſome penſion from the king. He returned to England in 1525, where he was moſt graciouſly received at court, and univerſally admired for his talents and addreſs; but preferring ſtudy and ſequeſtration to the pleaſures of a court, he retired to the Carthuſian convent at Shene, where he had continued abont two years, when the pious king began to divulge his ſcruples of conſcience concerning his marriage with Catharine of Spain. Pole foreſaw that this affair would neceſſarily involve him in difficulties; he therefore determined to quit the kingdom, and accordingly obtained leave to viſit Paris. Having thus avoided the ſtorm for the preſent, he returned once more to his convent at Shene; but his tranquillity was again interrupted by the king's reſolution to ſhake off the pope's ſupremacy, of which Pole's approbation was thought indiſpenſably neceſſary. How he managed in this affair, is not very clear. However, he obtained leave to reviſit Italy, and his penſion was continued for ſome time.

The king, having now divorced Queen Catharine, married Anne Boleyn. and, being reſolved to throw off the papal yoke, ordered Dr. Richard Sampſon to write a book in juſtification of his proceedings, which he ſent to Pole for his opinion. To this Pole, ſecure in the pope's protection, wrote a ſcurrilous anſwer, entitled *Pro Unitate Eccleſiaſtica*, and ſent it to the king; who was ſo offended with the contents, that he withdrew his penſion, ſtripped him of all his preferments, and procured an act of attainder to be paſſed againſt him. In the mean time, Pole was created a cardinal, and ſent nuncio to different parts of Europe. King Henry made ſeveral attempts to have him ſecured and brought to England, but without effect. At length the pope fixed him as legate at Viterbo, where he continued till the year 1543, when he was appointed legate at the council of Trent, and was afterwards employed by the pope as his chief counſellor.

Pope Paul III. dying in 1549, Pole was twice elected his ſucceſſor, and, we are told, twice refuſed the papal dignity: firſt, becauſe the election was made in too great haſte; and the ſecond time, becauſe it was done in the night. This delicacy in a cardinal is truly wonderful: but the intrigues of the French party ſeem to have been the real cauſe of his miſcarriage; they ſtarted many objections to Pole, and by that means gained time to procure a majority againſt him. Cardinal Maria de Monte obtained the triple crown; and Pole, having kiſſed his ſlipper, retired to the convent of Magazune near Verona, where he continued till the death of Edward VI. in the year 1553. On the acceſſion of Queen Mary, Pole was ſent legate to England, where he was received by her majeſty with great veneration, and conducted to the archbiſhop's palace at Lambeth, poor Cranmer being at that time priſoner in the Tower. He immediately appeared in the Houſe of Lords, where he made a long ſpeech; which being reported to the commons by their ſpeaker, both theſe obſequious houſes concurred in an humble ſupplication to be reconciled to the ſee of Rome. They preſented it on their knees to her majeſty, who interceded with the cardinal, and he graciouſly condeſcended to give them abſolution. This buſineſs being over, the legate made his public entry into London, and immediately ſet about the extirpation of hereſy. The day after the execution of Cranmer, which he is ſaid, though we believe falſely, to have adviſed, he was conſecrated archbiſhop of Canterbury. In the ſame year, 1556, he was elected chancellor of the univerſity of Oxford, and ſoon after of Cambridge; both which he viſited by his commiſſioners. He died of a double quartan ague in the year 1558, about 16 hours after the death of the queen; and was buried in the cathedral of Canterbury.

As to his character, the Romiſh writers aſcribe to him every virtue under heaven: even Biſhop Burnet is extremely laviſh in his praiſe, and attributes the cruelties of Mary's reign to the advice of Gardiner. In this Mr. Hume agrees with the biſhop, and repreſents Pole as the advocate of toleration. By every impartial account he ſeems to have been a man of mild manners, and of real worth, though undoubtedly a zealous member of the church of Rome.—He wrote, *Pro unitate eccleſiaſtica*, *De ejuſdem poteſtate*, A treatiſe on Juſtification, and various other tracts.

Mr. Philips publiſhed a very well written, though a very partial account, of Pole's life, to which Gloceſter Ridley replied. This laſt work, which is entitled *A Review of Mr. Philips's Life of Reginald Pole*, was publiſhed in 1766. It is a complete confutation of the former, and is a very learned and temperate vindication of the doctrines of the Reformation.

Pole, in aſtronomy, that point in the heavens round which the whole ſphere ſeems to turn. It is alſo uſed for a point directly perpendicular to the centre of any circle's plane, and diſtant from it by the length of a radius.

Pole, in geography, one of the points on which the terraqueous globe turns; each of them being 90 degrees diſtant from the equator, and, in conſequence of their ſituation, the inclination of the earth's axis, and its paralleliſm during the annual motion of our globe round the ſun, having only one day and one night throughout the year.

It is remarkable, that though the *north* in Hebrew, Greek, Latin, and French, derives its name from gloom, obſcurity, and darkneſs, the poles enjoy more light than any other part of the world. The ancients believed the north to be covered with thick darkneſs; Strabo tells us, that Homer, by the word σοφος, which properly ſignifies *obſcurity* or *darkneſs*, meant the *north*; and thus Tibullus, ſpeaking of the north, ſays, "*Illic et denſa tellus abſconditur umbra.*" The Arabians call the northern ocean the *dark ſea*; the Latins gave the name of *Aquilo* to the north wind, becauſe *aquilus* ſignifies *black*; and the French call it *la biſe*, from *bis* "black." According to the ancients, the Cimmerians lived in darkneſs, becauſe they were placed near the north. But all this is mere prejudice; for there are no places in the world that enjoy light longer than the arctic and antarctic poles; and this is accounted for by conſidering the nature of twilight. In the torrid zone, and under the line, night immediately follows the ſetting of the ſun, without any ſenſible twilight; whereas the twilight begins and continues increaſing in proportion as places are diſtant from the equator or approach the pole. To this long twilight we muſt add the *aurora borealis*, which appears in the northern regions, Greenland, &c. in clear nights, at the beginning of the new moon, caſting a light equal to that of full moon. See Gaſſendi in the *Life of Peyreſc*, book iii. and La Perere in his *Account of Greenland*. There is alſo long moonlight at the poles during winter. See Astronomy. But though there is really more light in the polar regions than elſewhere; yet owing to the obliquity with which the rays of the ſun fall upon them, and the great length of winter night, the cold is ſo intenſe, that thoſe parts of the globe which lie near the poles have never been fully explored, though the attempt has been repeatedly made by the moſt celebrated navigators. Indeed their attempts have chiefly been confined to the northern regions; for, with regard to the ſouth pole, there is not the ſame incitement to attempt it. The great object for which navigators have ventured themſelves in theſe frozen ſeas, was to find out a more quick and more ready paſſage to the Eaſt Indies; (See Cook) and this hath been attempted three ſeveral ways: one by coaſting along the northern parts of Europe and Aſia, called the *north-eaſt paſſage*; another, by ſailing round the northern part of the American continent, called the *north-weſt paſſage*; and the third by ſailing directly over the pole itſelf.

We have already given a ſhort account of ſeveral unſucceſsful attempts which have been made from England to diſcover the firſt two of theſe. See North *Weſt Paſſage*, and North *Eaſt Paſſage*. But before we proceed to the third we ſhall make a few further obſervations on them, and mention the attempts of ſome other nations.

During the laſt century, various navigators, Dutchmen particularly, attempted to find out the *north-eaſt paſſage*, with great fortitude and perſeverance. They always found it impoſſible however to ſurmount the obſtacles which nature had thrown in the way. Subſequent attempts are thought by many to have demonſtrated the impoſſibility of ever ſailing eaſtward along the northern coaſt of Aſia; and this impoſſibility is accounted for by the increaſe of cold in proportion to the extent of land. This is indeed the caſe in temperate climates; but much more ſo in thoſe frozen regions where the influence of the ſun, even in ſummer, is but ſmall. Hence, as the continent of Aſia extends a vaſt way from weſt to eaſt, and has beſides the continent of Europe joined to it on the weſt, it follows, that about the middle part of that tract of land the cold ſhould be greater than anywhere elſe. Experience has determined this to be fact; and it now appears, that about the middle part of the northern coaſt of Aſia the ice never thaws; neither have even the hardy Ruſſians and Siberians themſelves been able to overcome the difficulties they met with in that part of their voyage. In order to make this the more plain, and the following accounts more intelligible, we ſhall obſerve, that from the north-weſtern extremity of Europe, called the *North Cape*, to the north-eaſtern extremity of Aſia, called the *Promontory of the Tſchutſki*, is a ſpace including about 160 degrees of longitude, *viz.* from 40 to 200 eaſt from Ferro: the port of Archangel lies in about 57 degrees eaſt longitude, Nova Zembla between 70 and 95; which laſt is alſo the ſituation of the mouth of the great river Oby. Still further eaſtward are the mouths of the rivers Jeniſey in 100°; Piaſida in 105°; Chatanga in 124°; Lena, which has many mouths, between 134° and 142°; Indigirka in 162°; and the Kovyma in 175°. The coldeſt place in all this tract, therefore, ought to be that between the mouths of the Jeniſey and the Chatanga; and indeed here the unſurmountable difficulty has always been, as will appear from the following accounts of the voyages made by the Ruſſians with a view to diſcover the north-eaſt paſſage.

In 1734, lieutenant Morzovieff ſailed from Archangel towards the river Oby, but could ſcarce advance 20 degrees of longitude during that ſeaſon. The next ſummer he paſſed through the ſtraits of Weygatz in the ſea of Kara; but did not double the promontory which ſeparates the ſea of Kara from the bay or mouth of Oby. In 1738, the lieutenants Malgyin and Shurakoff doubled that promontory with great difficulty, and entered the bay of Oby. Several unſucceſsful attempts were made to paſs from the bay of Oby to the Jeniſey; which was at laſt effected, in 1738, by two veſſels commanded by lieutenants Offzin and Koſkeleff. The ſame year the pilot Feodor Menin ſailed eaſtwards from the Jeniſey to the mouth of the Piaſida: but here he was ſtopped by the ice; and finding it impoſſible to force a paſſage, he was in conſequence obliged to return to the Jeniſey.

In July 1735, lieutenant Prontſhiſtcheff ſailed down the river Lena, in order to paſs by ſea to the mouth of the Jeniſey. The weſtern mouths of the Lena were ſo choaked up with ice, that he was obliged to paſs through the moſt eaſterly one, and was prevented by contrary winds from getting out till the 13th of Auguſt. Having ſteered north-weſt along the iſlands which lie ſcattered before the mouths of the Lena, he found himſelf in lat. 70. 4.; yet even here he ſaw pieces of ice from 24 to 60 feet in height, and in no place was there a free channel left of greater breadth than 100 or 200 yards. His veſſel being much damaged, he entered the mouth of the Olenek, a ſmall river near the weſtern mouth of the Lena; and here he continued till the enſuing ſeaſon, when he got out in the beginning of Auguſt. But before he could reach the mouth of the Chatanga, he was ſo entirely ſurrounded and hemmed in with ice, that it was with the utmoſt difficulty he could get looſe. Obſerving then a large field of ice ſtretching into the ſea, he was obliged to ſail up the Chatanga. Getting free once more, he proceeded northward, doubled the cape called *Taimura*, and reached the bay of that name, lying in about 115° eaſt from Ferro; from thence he attempted to proceed weſtward along the coaſt. Near the ſhore were ſeveral ſmall iſlands, between which and the ſhore the ice was immoveably fixed. He then directed his courſe towards the ſea, in order to paſs round the chain of iſlands. At firſt he found the ſea more free to the north of theſe iſlands, but obſerved much ice lying between them. At laſt he arrived at what he took to be the laſt of the iſlands, lying in lat. 77. 25. Between this iſland and the ſhore, as well as on the other ſide of the iſland which lay moſt to the north, the ice was firm and immoveable. He attempted, however, to ſteer ſtill more to the north; and having advanced about ſix miles, he was prevented by a thick fog from proceeding: this fog being diſperſed, he ſaw nothing everywhere but ice, which at laſt drove him eaſtward, and with much danger and difficulty he got to the mouth of the Olenek on the 29th of Auguſt.

Another attempt to paſs by ſea from the Lena to the Jeniſey was made in 1739 by Chariton Laptieff, but with no better ſucceſs than that juſt mentioned. This voyager relates, that between the rivers Piaſida and Taimura, a promontory ſtretches into the ſea, which he could not double, the ſea being entirely frozen up before he could paſs round.

Beſides the Ruſſians, it is certain that ſome Engliſh and Dutch veſſels have paſſed the iſland of Nova Zembla into the ſea of Kara: "But (ſays Mr. Coxe in his Account of the Ruſſian voyages) no veſſel of any nation has ever paſſed round that cape which extends to the north of the Piaſida, and is laid down in the Ruſſian charts in about 78° lat. We have already ſeen that no Ruſſian veſſel has ever got from the Piaſida to the Chatanga, or from the Chatanga to the Piaſida; and yet ſome authors have poſitively aſſerted that this promontory has been ſailed round. In order therefore to elude the Ruſſian accounts, which clearly aſſert the contrary, it is pretended that Gmelin and Muller have purpoſely concealed ſome parts of the Ruſſian journals, and have impoſed on the world by a miſrepreſentation of facts. But, without entering into any diſpute upon this head, I can venture to affirm, that no ſufficient proof has been as yet advanced in ſupport of this aſſertion; and therefore, until ſome poſitive information ſhall be produced, we cannot deny plain facts, or give the preference to hearſay evidence over circumſtantial and well atteſted accounts."

The other part of this north-eaſt paſſage, *viz.* from the Lena to Kamſchatka, though ſufficiently difficult and dangerous, is yet practicable; as having been once performed, if we may believe the accounts of the Ruſſians. According to ſome authors indeed, ſays Mr. Coxe, this navigation has been open a century and a half; and ſeveral veſſels at different times have paſſed round the north-eaſtern extremity of Aſia. But if we conſult the Ruſſian accounts, we ſhall find that frequent expeditions have been unqueſtionably made from the Lena to the Kovyma, but that the voyage from the Kovyma round Tſchutſkoi Noſs into the Eaſtern Ocean has been performed but once. According to Mr. Muller, this formidable cape was doubled in the year

1648. The material incidents of this remarkable voyage are as follow:

"In 1648 ſeven kotches, or veſſels, ſailed from the mouth of the river Kovyma, in order to penetrate into the Eaſtern Ocean. Of theſe, four were never more heard of: the remaining three were commanded by Simon Deſhneff, Geraſim Ankudinoff, and Fedot Alexeeff. Deſhneff and Ankudinoff quarrelled before their departure concerning the diviſion of profits and honours to be acquired by their voyage; which, however, was not ſo eaſily accompliſhed as they had imagined. Yet Deſhneff in his memorials makes no mention of obſtructions from the ice, nor probably did he meet with any; for he takes notice that the ſea is not every year ſo free from ice as it was at that time. The veſſels ſailed from the Kovyma on the 20th of June, and in September they reached the promontory of the Tſchutſki, where Ankudinoff's veſſel was wrecked, and the crew diſtributed among the other two. Soon after this the two veſſels loſt ſight of each other, and never joined again. Deſhneff was driven about by tempeſtuous winds till October, when he was ſhipwrecked conſiderably to the ſouth of the Anadyr. Having at laſt reached that river, he formed a ſcheme of returning by the ſame way that he had come; but never made the attempt. As for Alexeeff, after being alſo ſhipwrecked, he had died of the ſcurvy, together with Ankudinoff; part of the crew were killed by the ſavages, and a few eſcaped to Kamtſchatka, where they ſettled."

From Captain Cook's voyage towards the north-eaſtern parts of Aſia, it appears, that it is poſſible to double the promontory of Tſchutſki without any great difficulty: and it now appears, that the continents of Aſia and America are ſeparated from one another but by a narrow ſtrait, which is free from ice; but, to the northward, that experienced navigator was every where ſtopped by ice in the month of Auguſt, ſo that he could neither trace the American continent further than to the latitude of 70°, nor reach the mouth of the river Kovyma on the Aſiatic continent; though it is probable that this might have been done at another time when the ſituation of the ice was altered either by winds or currents.

On the whole, therefore, it appears that the inſurmountable obſtacle in the north-eaſt paſſage lies between the rivers Piaſida and Chatanga; and unleſs there be in that ſpace a connection between the Aſiatic and American continents, there is not in any other part. Ice, however, is as effectual an obſtruction as land: and though the voyage were to be made by accident for once, it never could be eſteemed a paſſage calculated for the purpoſes of trade, or any other beneficial purpoſe whatever.

With regard to the north-weſt paſſage, the ſame difficulties occur as in the other. Captain Cook's voyage has now aſſured us, that if there is any ſtrait which divides the continent of America into two, it muſt lie in a higher latitude than 70°, and conſequently be perpetually frozen up. If a north-weſt paſſage can be found, then, it muſt be by ſailing round the whole American continent, inſtead of ſeeking a paſſage through it, which ſome have ſuppoſed to exiſt in the bottom of Baffin's Bay. But the extent of the American continent to the northward is yet unknown; and there is a poſſibility of its being joined to that part of Aſia between the Piaſida and Chatanga, which has never yet been circumnavigated. It remains therefore to conſider, whether there is any poſſibility of attaining the wiſhed for paſſage by ſailing directly north, between the eaſtern and weſtern continents.

Of the practicability of this method, the Honourable Daines Barrington is very confident, as appears by ſeveral tracts which he publiſhed in the years 1775 and 1776, in conſequence of the unſucceſsful attempts made by Captain Phipps, now Lord Mulgrave. See NORTH *Eaſt Paſſage*. In theſe tracts he inſtances a great number of navigators who have reached very high northern latitudes; nay, ſome who have been at the pole itſelf, or gone beyond it.—Theſe inſtances are, 1. One Captain Thomas Robertſon aſſured our author, that he had been in latitude $82\frac{1}{2}$°, that the ſea was open, and he was certain that he could have reached the latitude of 83°.—2. From the teſtimony of Captain Cheyne, who gave anſwers to certain queries drawn up by Mr. Dalrymple concerning the polar ſeas, it appears that he had been in the latitude of 82°.—3. One Mr. Watt informed our author, that when he was 17 years of age, at that time making his firſt voyage with Captain M'Callam, a bold and ſkilful navigator, who commanded a Scotch whale-fiſhing ſhip, as during the time that the whales are ſuppoſed to copulate no fiſhing can be carried on, the captain reſolved to employ that interval in attempting to reach the north pole. He accordingly proceeded without the leaſt obſtruction to $83\frac{1}{2}$, when the ſea was not only open to the northward, but they had ſeen no ice for the laſt three degrees; but while he ſtill advanced, the mate complained that the compaſs was not ſteady, and the captain was obliged with reluctance to give over his attempt.—4. Dr. Campbell, the continuator of Harris's Voyages, informed Mr. Barrington, that Dr. Dallie, a native of Holland, being in his youth aboard a Dutch ſhip of war which at that time was uſually ſent to ſuperintend the Greenland fiſhery, the captain determined, like the Scotchman above mentioned, to make an attempt to reach the pole during the interval between the firſt and ſecond fiſheries. He penetrated, according to the beſt of Dr. Campbell's recollection, as far as 88°; when the weather was warm, the ſea free from ice, and rolling like the bay of Biſcay. Dallie now preſſed the captain to proceed: but he anſwered, that he had already gone too far, and ſhould be blamed in Holland for neglecting his ſtation; upon which account he would ſuffer no journal to be kept, but returned as ſoon as poſſible to Spitſbergen.—5. In the year 1662-3, Mr. Oldenburg, then ſecretary of the Royal Society, was ordered to regiſter a paper, entitled "Several inquiries concerning Greenland, anſwered by Mr. Gray, who had viſited theſe parts." The 19th of theſe queries is the following: How near hath any one been known to approach the pole?—The anſwer is, "I once met upon the coaſt of Greenland a Hollander that ſwore he had been half a degree from the pole, ſhowing me his journal, which was alſo atteſted by his mate; where they had ſeen no ice or land, but all water."—6. In Captain Wood's account of a voyage in queſt of the north-eaſt paſſage, we have the following account of a Dutch ſhip which reached the latitude of 89°. "Capt. Goulden, who had made above 30 voyages to Greenland, did relate to his majeſty, that being at Greenland ſome 20 years before, he was in company with two Hollanders to the eaſtward of Edge's iſland; and that the whales not appearing on the ſhore, the Hollanders were determined to go further northward; and in a fortnight's time returned, and gave it out that they had ſailed into the latitude 89°, and that they did not meet with any ice, but a free and open ſea, and that there ran a very hollow *grown* ſea like that of the Bay of Biſcay. Mr. Goulden being not ſatisfied with the bare relation, they produced him four journals out of the two ſhips, which teſtified the ſame, and that they all agreed within four minutes."—7. In the Philoſophical Tranſactions for 1675, we have the following paſſage: "For it is well known to all that ſail northward, that moſt of the northern coaſts are frozen up for many leagues, though in the open ſea it is not ſo, *no nor under the pole itſelf*, unleſs by accident." In which paſſage the having reached the pole is alluded to as a known fact, and as ſuch ſtated to the Royal Society.—8. Mr. Miller, in his Gardener's Dictionary, mentions the voyage of one Captain Johnſon, who reached 88 degrees of latitude. Mr. Barrington was at pains to find a full account of this voyage; but met only with the following paſſage in Buffon's Natural Hiſtory, which he takes to be a confirmation of it. "I have been aſſured by perſons of credit, that an Engliſh captain, whoſe name was Monſon, inſtead of ſeeking a paſſage to China between the northern countries, had directed his courſe to the pole, and had approached it within two degrees, where there was an open ſea, without any ice." Here he thinks that Mr. Buffon has miſtaken Johnſon for Monſon.—9. A map of the northern hemiſphere, publiſhed at Berlin (under the direction of the Academy of Sciences and Belles Lettres), places a ſhip at the pole, as having arrived there according to the Dutch accounts.—10. Moxon, hydrographer to Charles II. gives an account of a Dutch ſhip having been two degrees beyond the pole, which was much relied on by Wood. This veſſel found the weather as warm there as at Amſterdam.

Beſides theſe, there are a great number of other teſtimonies of ſhips which have reached the lat. of 81, 82, 83, 84,[*] &c.; from all which our author concludes, that if the voyage is attempted at a proper time of the year, there would not be any great difficulty of reaching the pole. Thoſe vaſt pieces of ice which commonly obſtruct the navigators, he thinks, proceed from the mouths of the great Aſiatic rivers which run northward into the frozen ocean, and are driven eaſtward and weſtward by the currents. But though we ſhould ſuppoſe them to come directly from the pole, ſtill our author thinks that this affords an undeniable proof that the pole itſelf is free from ice; becauſe, when the pieces leave it, and come to the ſouthward, it is impoſſible that they can at the ſame time accumulate at the pole.

The extreme cold of the winter air on the continents of Aſia and America has afforded room for ſuſpicion, that at the pole itſelf, and for ſeveral degrees to the ſouthward of it, the ſea muſt be frozen to a vaſt depth in one ſolid cake of ice; but this Mr. Barrington refutes from ſeveral conſiderations. In the firſt place, he ſays, that on ſuch a ſuppoſition, by the continual intenſity of the cold, and the accumulation of ſnow and frozen vapour, this cake of ice muſt have been increaſing in thickneſs ſince the creation, or at leaſt ſince the deluge; ſo that now it muſt be equal in height to the higheſt mountains in the world, and be viſible at a great diſtance. Beſides, the pieces broken off from the ſides of ſuch an immenſe mountain muſt be much thicker than any ice that is met with in the northern ocean; none of which is above two yards in height above the ſurface of the water, thoſe immenſe pieces called *ice-mountains* being always formed on land.

Again, the ſyſtem of nature is ſo formed, that all parts of the earth are expoſed for the ſame length of time, or nearly ſo, throughout the year, to the rays of the ſun. But, by reaſon of the ſpheroidal figure of the terraqueous globe, the poles and polar regions enjoy the ſun ſomewhat longer than others; and hence the Dutch who wintered in Nova Zembla in 1672 ſaw the ſun a fortnight ſooner than they ought to have done by aſtronomical calculations. By reaſon of this flatneſs about the poles, too, the ſun not only ſhines for a greater ſpace of time on theſe inhoſpitable regions, but with leſs obliquity in the ſummer-time, and hence the effect of his rays muſt be the greater. Now Mr. Barrington conſiders it as an abſurd ſuppoſition, that this glorious luminary ſhould ſhine for ſix months on a cake of barren ice where there is neither animal nor vegetable. He ſays that the polar ſeas are aſſigned by nature as the habitation of the whales, the largeſt animals in the creation; but if the greateſt part of the polar ſeas are for ever covered with an impenetrable cake of ice, theſe huge animals will be confined within very narrow bounds; for they cannot ſubſiſt without frequently coming to the top of the water to breathe.

Laſtly, the quantity of water frozen by different degrees of cold is by no means directly in proportion to the intenſity of the cold, but likewiſe to the duration of it. Thus, large bodies of water are never frozen in any temperature of ſhort duration, though ſhallow bodies often are. Our author obſerves, that as much of a given maſs of water was frozen in five hours of a temperature 12° below the freezing point, as was frozen in one hour of the temperature 50° below it; and that long duration of the temperature between 20 and 32 is, with regard to the congelation of water, equivalent to intenſity of cold ſuch as is marked 0 and below 0 in Fahrenheit, but of ſhort duration. See COLD and CONGELATION.

On the other hand, Mr. Forſter, in his Obſervations, takes the contrary ſide of the queſtion with no little vehemence. "I know (ſays he) that M. de Buffon, Lomonoſof, and Crantz, were of opinion, that the ice found in the ocean is formed near the lands only from the freſh water and ice carried down into the ſea by the many rivers in Siberia, Hudſon's Bay, &c.; and therefore, when we fell in with ſuch quantities of ice in December 1772, I expected we ſhould ſoon meet with the land from whence theſe ice maſſes had been detached. But being diſappointed in the diſcovery of this land, though we penetrated beyond 67° twice, and once beyond 71°, ſouth latitude, and having beſides ſome other doubts concerning the exiſtence of the pretended ſouthern continent, I thought it neceſſary to inquire what reaſons chiefly induced the above authors to form the opinion that the ice floating in the ocean muſt be formed near land, or that an auſtral land is abſolutely requiſite for that purpoſe; and having looked for their arguments, I find they amount chiefly to this: 'That the ice floating in the ocean is all freſh: that ſalt water does not freeze at all; or, if it does, it contains briny particles. They infer from thence, that the ice in the ocean cannot be formed in the ſea far from any land: there muſt therefore exiſt auſtral lands; becauſe, in order to form an idea of the original of the great ice-maſſes agreeably to what is obſerved in the northern hemiſphere, they find that the firſt point for fixing the high ice-iſlands is the land; and, ſecondly, that the great quantity of flat ice is brought down the rivers.' I have impartially and carefully conſidered and examined theſe arguments, and compared every circumſtance with what we ſaw in the high ſouthern latitude, and with other known facts; and will here inſert the reſult of all my inquiries on this ſubject.

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[*] See *M. Buache's Obſervations on the North or Ice Sea*, where he gives an account of various attempts made to reach the pole, from which he is convinced that the ſea is there open, and that the thing is practicable. M. de Pages, in his *Travels*, vol. iii. informs us, that he wiſhed to take a voyage to the north ſeas, for the purpoſe of bringing under one view the various obſtacles from the ice, which have impeded the reſearches of navigators in thoſe ſeas; and for this purpoſe he was prepared to continue his voyage to as high a latitude as poſſible, and that he might be able to ſay whether any land actually exiſts north from the coaſt of Greenland. He ſailed, without any encouragement from his court (France), on the 16th of April 1776 from the Texel, in a Dutch veſſel bound to Spitſbergen. On the 16th of May ſhe was a little way north of 81°, the higheſt latitude ſhe reached.

"Being now (ſays the author) leſs than 180 leagues from the pole, the idea of ſo ſmall a diſtance ſerved effectually to awaken my curioſity. Had I been able to inſpire my fellow-voyagers with ſentiments ſimilar to my own, the winds and currents which at this moment carried us faſt towards the pole, a region hitherto deemed inacceſſible to the eye of mortals, would have been ſaluted with acclamations of joy. This quarter, however, is not the moſt eligible for ſuch an enterpriſe: here the ſea, lying in the vicinity of thoſe banks of ice ſo frequent a little further to the weſt, is much too confined. Nevertheleſs, when I conſider the very changeable nature of the ſhoals under whatever form, even in their moſt crowded and compact ſtate; their conſtant changes and concuſſions, which break and detach them from one another; and the various expedients that may be employed for freeing the ſhip from confinement, as well as for obviating impending danger—I am far from viewing a voyage to the pole as a chimerical idea."

“ Firſt, they obſerve the ice floating in the ocean to yield, by melting, freſh water: which I believe to be true. However, hitherto it has by no means been generally allowed to be freſh: for Crantz ſays expreſsly, that ‘ the flat pieces (forming what they call the *ice-fields)* are ſalt, becauſe they were congealed from ſea water.' The ice taken up by us for watering the ſhip was of all kinds, and nevertheleſs we found it conſtantly freſh: which proves, either that the principle of analogy cannot be applied indiſcriminately in both hemiſpheres; and that one thing may be true in the northern hemiſphere which is quite otherwiſe in the ſouthern, from reaſons not yet known or diſcovered by us; or we muſt think that Crantz and others are miſtaken, who ſuppoſe the ice floating in the ocean to be ſalt.

“ The next remark is, That ſalt water does not freeze at all; or, if it does, it contains briny particles. M. de Buffon tells us, ‘ that the ſea between Nova Zembla and Spitſbergen, under the 79° north latitude, does not freeze, as it is there conſiderably broad: and that it is not to be apprehended to find the ſea frozen not even under the pole itſelf; for indeed there is no example of having ever found a ſea wholly frozen over, and at a conſiderable diſtance from the ſhores; that the only inſtance of a ſea entirely frozen is that of the Black Sea, which is narrow and not very ſalt, and receives a great many rivers coming from northern regions, and bringing down ice: that this ſea therefore ſometimes freezes to ſuch a degree, that its whole ſurface is congealed to a conſiderable thickneſs; and, if the hiſtorians are to be credited, was frozen, in the reign of the emperor Conſtantine Copronymus, 30 ells thick, not including 20 ells of ſnow which was lying on the ice. This fact, continues M. de Buffon, ſeems to be exaggerated: but it is true, however, that it freezes almoſt every winter; whilſt the high ſeas which are 1000 leagues nearer towards the pole do not freeze; which can have no other cauſe than the difference in ſaltneſs, and the little quantity of ice carried out by rivers, if compared to the enormous quantity of ice which the rivers convey into the Black Sea.' M. de Buffon is not miſtaken when he mentions that the Black Sea frequently freezes. Strabo informs us, that the people near the Boſphorus Cimmerius paſs this ſea in carts from Panticapæum to Phanagorea; and that Neoptolemus, a general of Mithridates Eupator, won a battle with his cavalry on the ice on the very ſpot where he gained a naval victory in the ſummer. Marcellinus Comes relates, that under the conſulſhip of Vincentius and Fravita, in the year 401 after Chriſt, the whole ſurface of the Pontus was covered with ice, and that the ice in ſpring was carried through the Propontis, during 30 days, like mountains. Zonaras mentions the ſea between Conſtantinople and Scutari frozen to ſuch a degree in the reign of Conſtantine Copronymus, that even loaded carts paſſed over it. The prince Demetrius Cantemir obſerves, that in the year 1620-1 there happened ſo intenſe a froſt, that the people walked over the ice from Conſtantinople to Iſkodar. All theſe inſtances confirm M. de Buffon's aſſertion. But as this great natural hiſtorian ſays, that the Black Sea is the only inſtance of a ſea being entirely frozen *, I muſt beg leave to diſſent from him; for it is equally well atteſted that the Baltic is ſometimes entirely frozen, according to Caſpar Schutz's account. In the year 1426, the winter was ſo ſevere, that people travelled over the ice acroſs the Baltic from Dantzic to Lubec; and the ſea was likewiſe paſſable from Denmark to Mecklenburgh: and in the year 1459 the whole Baltic was entirely frozen, ſo that perſons travelled, both on foot and on horſeback, over ice from Denmark to the Venedick Hans-towns, called *Lubec*, *Wiſmar*, *Roſtock*, and *Stralſund*, which had never happened before; people likewiſe travelled acroſs the Baltic over ice from Reval in Eſtland to Denmark and to Sweden, and back again, without the leaſt danger †. But, according to Sæmund Frode, even the great German Ocean between Denmark and Norway was frozen in the year 1048, ſo that the wolves frequently ran over the ice from one country to the other. The great northern ocean is likewiſe moſt certainly ſometimes frozen to a great diſtance from any land: for Muller relates, that in the year 1715 a Coſſack called *Markoff*, with ſome other perſons, was ſent by the Ruſſian government to explore the north ſea; but finding it next to impoſſible to make any progreſs during ſummer on account of the vaſt quantities of ice commonly filling this ocean, he at laſt determined to try the experiment during winter. He therefore took ſeveral ſledges drawn according to the cuſtom of the country by dogs, which commonly go about 80 or 100 verſts per day, 105 of which make a degree; and on March the 15th, old ſtyle, with this caravan of nine perſons, he left the ſhores of Siberia at the mouth of the river Yana, under the 71° of north latitude, and proceeded for ſeven days together northward, ſo that he had reached at leaſt the 77° or 78° north latitude, when he was ſtopped by the ice, which there began to appear in the ſhape of prodigious mountains. He climbed up to the top of ſome of theſe ice-mountains: but ſeeing from thence no land, nor any thing except ice as far as the eye could reach, and having beſides no more food for his dogs left, he thought it very neceſſary to return; which he with great difficulty performed, on April the 3d, as ſeveral of the dogs, which had periſhed for want, were employed to ſupport thoſe that remained alive. Theſe facts, I believe, will convince the unprejudiced reader, that there are other ſeas beſides the Black Sea which really do freeze in winter, and that the ice carried down the rivers could not at leaſt freeze the German Ocean between Norway and Denmark, becauſe the rivers there are ſo ſmall, and bear a very inconſiderable proportion to the immenſe ocean, which, according to experiments made by Mr. Wilke, is very ſalt, though near the land, in the Swediſh harbour of Landſcrona.

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* In the year 860 the Mediterranean was covered with ice, ſo that people travelled in carts and horſes acroſs the Ionian Sea to Venice; *(Hermænnus Contractus ap. Piſtor. Script.* t. ii. p. 236.) And in 1234 the Mediterranean was again thus frozen, that the Venetian merchants travelled over the ice with their merchandiſe to what place they choſe; *Matth. Paris*, p. 78.

† In 1296 the Baltic was frozen from Gothland to Sweden. *(Incerti auctoris Annales Denor. In Weſtphalii monument. Cimbr.* t. i. p. 1392.

In 1306 the Baltic was, during fourteen weeks, covered with ice between all the Daniſh and Swediſh iſlands. *(Ludwig. Reliquiæ, MSS.* t. ix. p. 170.)

In 1323 there was a road for foot-paſſengers and horſemen over the ice on the Baltic during ſix weeks. *(Id. ibid.)*

In 1349, people walked over the ice from Stralſund to Denmark. *(Incerti auct. cit. ap. Ludwig.* t. ix. p. 181.)

In 1408 the whole ſea between Gothland and Oeland, and likewiſe between Roſtock and Gezoer, was frozen. *(Id. ibid.)*

In 1423 the ice bore riding from Pruſſia to Lubec. *(Crantzii Vandal.* l. x. c. 40.) The whole ſea was covered with ice from Mecklenburg to Denmark. *(Incert. auct. ap. Ludwig.* t. ix. p. 125.)

In 1461 (ſays *Nicol. Marſchallus in Annal. Herul. ap. Weſtphal.* t. i. p. 261.) Tanta erat hyems, ut concreto gelu oceano plauſtris millia paſſuum ſupra CCC merces ad ultimam Thylen *(Iceland)* et Orcades veherentur *e Germania* tota pene bruma.

In 154 the ſea between Roſtock and Denmark, and likewiſe between Fionia and Sealand, was thus frozen, that the people travelled over the ice on foot, with ſledges to which horſes and oxen were put. *(Anonym. ap. Ludwig.* t. ix. p. 176.)

In 1294 the Cattegat or ſea between Norway and Denmark was frozen; that from Oxſlo in Norway, they could travel on it to Jutland. *(Strelow Chron. Juthiland,* p. 148.)

“ Now, if ſix or ſeven degrees of latitude, containing from 360 to 420 ſea-miles, are not to be reckoned a great diſtance from the land, I do not know in what manner to argue, becauſe no diſtance whatſoever will be reckoned far from any land. Nay, if the Coſſack Markoff, being mounted on one of the higheſt ice-mountains, may be allowed to ſee at leaſt to the diſtance of 20 leagues, the extent alluded to above muſt then be increaſed to 480 Engliſh ſea-miles; which certainly is very conſiderable, and makes it more than probable that the ocean is frozen in winter, in high northern latitudes, even as far as the pole. Beſides, it invalidates the argument which theſe gentlemen wiſh to infer from thence, *that the ocean does not freeze in high latitudes, eſpecially where there is a conſiderably broad ſea*; for we have ſhown inſtances to the contrary.

“ But M. de Buffon ſpeaks of ice carried down the rivers into the northern ocean, and forming there theſe immenſe quantities of ice. ‘ And in caſe, ſays he, we would ſuppoſe, againſt all probability, that at the pole it could be ſo cold as to congeal the ſurface of the ſea, it would remain equally incomprehenſible how theſe enormous floating ice-maſſes could be formed, if they had not land for a point to fix on, and from whence they are ſevered by the heat of the ſun. The two ſhips which the India Company ſent in 1739 upon the diſcovery of the auſtral lands, found ice in 47° or 48° ſouth latitude, but at no great diſtance from land; which they diſcovered, without being able to approach it. This ice, therefore, muſt have come from the interior parts of the lands near the ſouth pole; and we muſt conjecture, that it follows the courſe of ſeveral large rivers, waſhing theſe unknown lands in the ſame manner as the rivers Oby, the Yeniſea, and the other great rivers which fall into the northern ſea, carry the ice-maſſes, which ſtop up the ſtraits of Waigats for the greater part of the year, and render the Tartarian ſea inacceſſible upon this courſe.’ Before we can allow the analogy between the rivers Oby, Yeniſea, and the reſt which fall into the northern ocean, and thoſe coming from the interior parts of the auſtral lands, let us compare the ſituation of both countries, ſuppoſing the auſtral lands really to exiſt. The Oby, Yeniſea, and the reſt of the Siberian rivers, falling down into the northern ocean, have their ſources in 48° and 50° north latitude, where the climate is mild, and capable of producing corn of all kinds. All the rivers of this great continent increaſing, theſe great rivers have likewiſe their ſources in mild and temperate climates, and the main direction of their courſe is from ſouth to north; and the coaſt of the northern ocean, not reckoning its ſinuoſities, runs in general weſt and eaſt. The ſmall rivers which are formed in high latitudes have, properly ſpeaking, no ſources, no ſprings, but carry off only the waters generated by the melting of ſnow in ſpring, and by the fall of rain in the ſhort ſummer, and are for the greateſt part dry in autumn. And the reaſon of this phenomenon is obvious, after conſidering the conſtitution of the earth in thoſe high northern climates. At Yakutſk, in about 62° north latitude, the ſoil is eternally frozen, even in the height of ſummer, at the depth of three feet from the ſurface. In the years 1685 and 1686, an attempt was made to dig a well; and a man, by great and indefatigable labour, continued during two ſummer-ſeaſons, and ſucceeded ſo far in this laborious taſk, that he at laſt reached the depth of 91 feet; but the whole earth at this depth was frozen, and he met with no water; which forced him to deſiſt from ſo fruitleſs an attempt. And it is eaſy to infer from hence how impoſſible it is that ſprings ſhould be formed in the womb of an eternally frozen ſoil.

“ The argument, therefore, is now reduced to this, *That ſalt water does not freeze at all*; or, *if it does, the ice contains briny particles*. But we have already produced numberleſs inſtances, that the ſea does freeze; nay, Crantz allows, *that the flat pieces of ice are ſalt, becauſe they were congealed from ſea-water*. We beg leave to add a few deciſive facts relative to the freezing of the ſea. Barentz obſerves in the year 1596, September the 16th, the ſea froze two fingers thick, and next night the ice was as thick again. This happened in the midſt of September; what effect then muſt the intenſe froſt of a night in January not produce? When Captain James wintered in Charleton's Iſle, the ſea froze in the middle of December 1631. It remains, therefore, only to examine, whether the ice formed in the ſea muſt neceſſarily contain briny particles. And here I find myſelf in a very diſagreeable dilemma; for during the intenſe froſt of the winter in 1776, two ſets of experiments were made on the freezing of ſea-water, and publiſhed, contradicting one another almoſt in every material point: the one by Mr. Edward Nairne, F. R. S. an ingenious and accurate obſerver; the other by Dr. Higgins, who reads lectures on chemiſtry and natural philoſophy, and conſequently muſt be ſuppoſed to be well acquainted with the ſubject. I will therefore ſtill venture to conſider the queſtion as undecided by theſe experiments, and content myſelf with making a few obſervations on them: but previouſly I beg leave to make this general remark, that thoſe who are well acquainted with mechanics, chemiſtry, natural philoſophy, and the various arts which require a nice obſervation of minute circumſtances, need not be informed, that an experiment or machine ſucceeds often very well when made upon a ſmaller ſcale, but will not anſwer if undertaken at large; and, *vice verſa*, machines and experiments executed upon a ſmall ſcale will not produce the effect which they certainly have when made in a more enlarged manner. A few years ago an experiment made on the dyeing of ſcarlet, did not ſucceed when undertaken on a ſmall ſcale, whereas it produced the deſired effect when tried at a dyer's houſe with the large apparatus; and it evidently confirms the above aſſertion, which I think I have a right to apply to the freezing of ſalt-water. It is therefore probable, that the ice formed in the ocean at large, in a higher latitude, and in a more intenſe degree of cold, whereof we have no idea here, may become ſolid, and free from any briny particles, though a few experiments made by Dr. Higgins, in his houſe, on the freezing of ſalt-water, produced only a looſe ſpongy ice filled with briny particles.

“ The ice formed of ſea-water by Mr. Nairne was very hard, 3½ inches long, and 2 inches in diameter: it follows from thence, that the waſhing the outſide of this ice in freſh water, could not affect the inſide of a hard piece of ice. This ice when melted yielded freſh water, which was ſpecifically lighter than water which was a mixture of rain and ſnow-water, and next in lightneſs to diſtilled water. Had the ice thus obtained not been freſh, the reſiduum of the ſea-water, after this ice had been taken out, could not have been ſpecifically heavier than ſea-water, which, however, was the caſe in Mr. Nairne's experiment. It ſeems, therefore, in my opinion, evident from hence, that ſalt-water does freeze, and has no other briny particles than what adhere to its outſide. All this perfectly agrees with the curious fact related by Mr. Adanſon, in his ſecond Supplement to the Probability of reaching the North Pole, p. 119. who had brought to France two bottles of ſea-water, taken up in different parts of the ocean, in order to examine it, and to compare its ſaltneſs, when more at leiſure; but both the bottles containing the ſalt-water were burſt by being frozen, and

and the water produced from melting the ice proved perfectly freſh. This fact is ſo fairly ſtated, and ſo very natural, that I cannot conceive it is neceſſary to ſuppoſe, without the leaſt foundation for it, *that the bottles were changed, or that Mr. Adanſon does not mention the circumſtance by which the ſea-water was thus altered upon its being diſſolved:* for, as he expreſsly obſerves the bottles to have been burſt, it is obvious that the concentrated briny parts ran out, and were entirely drained from the ice, which was formed of the freſh water only.

“ The ice formed by Dr. Higgins from ſea-water *conſiſted of thin laminæ, adhering to each other weakly.* Dr. Higgins took out the frozen ice from the veſſels wherein he expoſed the ſea-water, and continued to do ſo till the remaining concentrated ſea-water began to form cryſtals of ſea-ſalt. Both theſe experiments, therefore, by no means prove what the Doctor intended to infer from thence; for it was wrong to take out ſuch ice, which only *conſiſted of thin laminæ, adhering to each other weakly.* Had he waited with patience, he would have obtained a hard ice as well as Mr. Nairne, which, by a more perfect congelation, would have excluded the briny particles intercepted between the *thin laminæ, adhering to each other weakly*; and would have connected the laminæ by others formed by freſh water. The Doctor found afterwards, it is true, thicker and ſomewhat more ſolid ice: but the ſea-water had already been ſo much concentrated by repeated congelations, that it is no wonder the ice formed in it became at laſt brackiſh: it ſhould ſeem, then, that no concluſive arguments can be drawn from theſe experiments.

“ There are two other objections againſt the formation of the ice in the great ocean. The *firſt* is taken from the immenſe bulk and ſize of the ice maſſes formed in the ocean, which is *the deepeſt maſs of water we know of.* But it has been experimentally proved, that in the midſt of ſummer, in the latitudes of 55°, 55° 26′, and 64° ſouth, at 100 fathoms depth, the thermometer ſtood at 34°, 34½° and 32°; and that in all inſtances, the difference between the temperature at top and 100 fathoms depth never exceeded four degrees of Fahrenheit's thermometer, or that the temperature of the air did not differ five degrees from that of the ocean at 100 fathoms deep. If we now add to this, that beyond the 71° ſouth the temperature of the air and ocean muſt be ſtill colder, and that the rigours of an antarctic winter are certainly more than ſufficient to cool the ocean to 28½°, which is requiſite for congealing the aqueous particles in it; if we moreover conſider, that theſe ſevere froſts are continued during ſix or eight months of the year, we may eaſily conceive that there is time enough to congeal large and extenſive maſſes of ice. But it is likewiſe certain, that there is more than one way by which thoſe immenſe ice maſſes are formed. We ſuppoſe very juſtly, that the ocean does freeze, having produced ſo many inſtances of it; we allow likewiſe, that the ice thus formed in a calm, perhaps does not exceed three or four yards in thickneſs; a ſtorm probably often breaks ſuch an ice-field, which Crantz allows to be 200 leagues one way and 80 the other; the preſſure of the broken fragments againſt one another frequently ſets one upon the other piece, and they freeze in that manner together; ſeveral ſuch double pieces, thrown by another preſſure upon one another, form at laſt large maſſes of miles extent, and of 20, 40, 60, and more fathoms thickneſs, or of a great bulk or height. Martens, in his deſcription of Spitſbergen, remarks, that the pieces of ice cauſe ſo great a noiſe by their ſhock, that the navigators in thoſe regions can only with difficulty hear the words of thoſe that ſpeak; and as the ice-pieces are thrown one upon another, ice-mountains are formed by it. And I obſerved very frequently, in the years 1772 and 1773, when we were among the ice, maſſes which had the moſt evident marks of ſuch a formation, being compoſed of ſtrata of ſome feet in thickneſs. This is in ſome meaſure confirmed by the ſtate in which the Coſſack Markoff found the ice at the diſtance of 420 miles north from the Siberian coaſts. The high maſſes were not found formed, as is ſuſpected in the *Second ſupplement to the probability of reaching the north pole*, p. 143-145, near the land, under the high cliffs, but far out at ſea; and when theſe ice mountains were climbed by Markoff, nothing but ice, and no veſtiges of land, appeared as far as the eye could reach. The high climates near the poles are likewiſe ſubject to heavy falls of ſnow, of ſeveral yards in thickneſs, which grow more and more compact, and by thaws and rain are formed into ſolid ice, which increaſe the ſtupendous ſize of the floating ice mountains.

“ The *ſecond* objection againſt the freezing of the ocean into ſuch ice as is found floating in it, is taken from the *opacity* of ice formed in ſalt water; becauſe the largeſt maſſes are commonly tranſparent like cryſtal, with a fine blue tint, cauſed by the reflection of the ſea. This argument is very ſpecious, and might be deemed unanſwerable by thoſe who are not uſed to cold winters and their effects. But whoſoever has ſpent ſeveral winters in countries which are ſubject to intenſe froſts, will find nothing extraordinary or difficult in this argument: for it is a well-known fact in cold countries, that the ice which covers their lakes and rivers is often opaque, eſpecially when the froſt ſets in accompanied by a fall of ſnow; for, in thoſe inſtances, the ice looks, before it hardens, like a dough or paſte, and when congealed it is opaque and white: however, in ſpring, a rain and the thaw, followed by froſty nights, change the opacity and colour of the ice, and make it quite tranſparent and colourleſs like a cryſtal: but, in caſe the thaw continues, and it ceaſes entirely to freeze, the ſame tranſparent ice becomes ſoft and porous, and turns again entirely opaque. This I believe may be applicable to the ice ſeen by us in the ocean. The field-ice was commonly opaque; ſome of the large maſſes, probably drenched by rain, and frozen again, were tranſparent and pellucid; but the ſmall fragments of looſe ice, formed by the decay of the large maſſes, and ſoaked by long-continued rains, we found to be porous, ſoft, and opaque.

“ It is likewiſe urged as an argument againſt the formation of ice in the ocean, that it always requires land, in order to have a point upon which it may be fixed. Firſt, I obſerve, that in Mr. Nairne's experiments, the ice was generated on the ſurface, and was ſeen ſhooting cryſtals downwards: which evidently evinces, in my opinion, that ice is there formed or generated where the intenſeſt cold is: as the air ſooner cools the ſurface than the depth of the ocean, the ice ſhoots naturally downwards, and cools the ocean more and more, by which it is prepared for further congelation. I ſuppoſe, however, that this happens always during calms, which are not uncommon in high latitudes, as we experienced in the late expedition. Nor does land ſeem abſolutely neceſſary in order to fix the ice; for this may be done with as much eaſe and propriety to the large ice mountains which remain undiſſolved floating in the ocean in high latitudes; or it may, perhaps, not be improper to ſuppoſe, that the whole polar region, from 80° and upwards, in the ſouthern hemiſphere, remains a ſolid ice for ſeveral years together, to which yearly a new circle of ice is added, and of which, however, part is broken off by the winds and the return of the mild ſeaſon. Wherever the ice floats in large maſſes, and ſometimes in compact bodies formed of an infinite number of ſmall pieces, there it is by no means difficult to freeze the whole into one piece; for amongſt the ice the wind has not a power of raiſing high and great waves. This circumſtance was not entirely unknown to the ancients; and it is probable they acquired this information from the natives of ancient Gaul, and from the Britons and other northern nations, who ſometimes undertook long voyages. The northern ocean was called by the ancients the *frozen*, the *dead*, the *lazy*, and *immoveable ſea*: ſometimes they gave it the name of *mare cronium*, the concrete ſea, and *morimaruſa*, the dead ſea. And, what is very remarkable, in all the northern cold countries the froſt ſometimes is ſo intenſe, that all the waters become ſuddenly coagulated into a kind of paſte or dough, and thus at once congeal."

On this reaſoning of Mr. Forſter's, however, we muſt obſerve, that it cannot poſſibly invalidate any fact which Mr. Barrington has advanced. The beſt concerted and moſt plauſible theory in the world muſt yield to experience; for this is in fact what muſt judge all theories. Now, from what we have already related, it is demonſtrated, that in the ſpace between the mouths of the rivers Piaſida and Chatanga more ice muſt be formed, and more intenſe colds generated, than in any other part of the world; conſequently, for a conſiderable ſpace both on the eaſt and weſt ſide of that, the ſea muſt be more full of ice than anywhere elſe. Now, between theſe two rivers there is the promontory of Taimura, which runs out to the latitude of 78°, or near it, and which of neceſſity muſt obſtruct the diſperſion of the ice; and that it actually does ſo is in ſome degree probable, becauſe in one of the Ruſſian voyages above mentioned, the eaſtern mouth of the Lena was quite free, when the weſtern ones were entirely choaked up with ice. Now the mouth of the Yana lies ſeveral degrees to the eaſtward of the Lena: conſequently, when the ice comes eaſtward from the Cape of Taimura, it muſt neceſſarily fill all that ſea to the latitude of 78° and upwards; but the Coſſack Markoff, if he proceeded directly north, could not be further than the promontory of Taimura, and conſequently ſtill enveloped among the ice. Beſides, we are certain, that the ſea in 78° is not at all frozen into a ſolid cake in ſome places, ſince Lord Mulgrave, in 1773, reached 81°. Mr. Forſter's argument, therefore, either proves nothing, or it proves too much. If it proves, that about the middle of the eaſtern continent the cold is ſo intenſe, that a ſufficient quantity of ice is formed to obſtruct the navigation for ſeveral hundred miles round, this proves nothing; becauſe we knew before that this muſt be the caſe: But if it proves, that the ſea muſt be unnavigable by reaſon of ice all round the globe at 78° N. lat. this is too much; becauſe we certainly know, that in 1773 Lord Mulgrave reached the latitude of 81°. However, though it ſhould be allowed that the ſea is quite clear all the way to the pole, it muſt be a very great uncertainty whether any ſhip could by that way reach the Eaſt Indies; becauſe we know that it muſt ſail down between the continents of Aſia and America, through that ſtrait whoſe mouth muſt often be blocked up with ice driving eaſtward along the continent of Aſia.

The ſouth pole is ſtill more inacceſſible than the north pole; for the ice is found in much lower ſouthern than northern latitudes. Upon this ſubject M. Pages ſpeaks thus: "Having in former voyages (ſays he) viſited many parts of the terraqueous globe in different latitudes, I had opportunites of acquiring a conſiderable knowledge of climate in the torrid as well as in the temperate diviſions of the earth. In a ſubſequent voyage I made it my buſineſs to be equally well informed reſpecting the reputed inhoſpitable genius of the South Seas; and upon my return from that expedition I entertained not the ſmalleſt doubt that there exiſts a peculiar and perpetual rigour in the ſouthern hemiſphere." (See his *Travels round the World*, vol. iii. tranſlated from the French, and printed at London, 1792, for Murray.) This ſuperior degree of cold has by many been ſuppoſed to proceed from a greater quantity of land about the ſouth than the north pole; and the notion of a vaſt continent in theſe regions prevailed almoſt univerſally, inſomuch that many have ſought for it, but hitherto in vain. See the articles COOK's *Diſcoveries*, SOUTH-*Sea*, and TERRA *Auſtralis*.

Magnetic POLE. See MAGNET, MAGNETISM, and VARIATION.

North POLE. See POLE.

POLE-*Axe*, a ſort of hatchet nearly reſembling a battle-axe, having a handle about 15 inches in length, and being furniſhed with a ſharp point or claw, bending downwards from the back of its head; the blade whereof is formed like that of any other hatchet. It is principally employed in ſea-fights to cut away and deſtroy the rigging of any adverſary who endeavours to board. *Pole-axes* are alſo ſaid to have been ſucceſsfully uſed on ſome occaſions in boarding an enemy, whoſe ſides were above thoſe of the boarder. This is executed by detaching ſeveral gangs to enter at different parts of the ſhip's length, at which time the pole-axes are forcibly driven into her ſide, one above another, ſo as to form a ſort of ſcaling-ladders.

POLE-*Cat*. See MUSTELA.

POLE-*Star*. See ASTRONOMY.

POLEIN, in Engliſh antiquity, is a ſort of ſhoe, ſharp or picked at the point. This faſhion took its riſe in the time of king William Rufus; and the picks were ſo long, that they were tied up to the knees with ſilver or golden chains. They were forbidden by ſtat. an. 4 Edw. IV. cap. 7. *Tunc fluxus crinium, tunc luxus veſtium, tunc uſus calceorum cum arcuatis aculeis inventus eſt*. Malmſb. in Will. ii.

POLEMARCHUS was a magiſtrate at Athens, who had under his care all the ſtrangers and ſojourners in the city, over whom he had the ſame authority that the archon had over the citizens. It was his duty to offer a ſolemn ſacrifice to Enyalus (ſaid to be the ſame with Mars, though others will have it that he was only one of his attendants), and another to Diana, ſurnamed Αγροτερα, in honour of the famous patriot Harmodius. It was alſo his buſineſs to take care that the children of thoſe that had loſt their lives in the ſervice of their country ſhould be provided for out of the public treaſury.

POLEMICAL, in matters of literature, an appellation given to books of controverſy, eſpecially thoſe in divinity.

POLEMO, who ſucceeded Xenocrates in the direction of the academy, was an Athenian of diſtinguiſhed birth, and in the earlier part of his life a man of looſe morals. The manner in which he was reclaimed from the purſuit of infamous pleaſures, and brought under the diſcipline of philoſophy, affords a memorable example of the power of eloquence employed in the cauſe of virtue. His hiſtory is thus related by Dr. Enfield: "As he was, one morning about the riſing of the ſun, returning home from the revels of the night, clad in a looſe robe, crowned with garlands, ſtrongly perfumed, and intoxicated with wine, he paſſed by the ſchool of Xenocrates, and ſaw him ſurrounded with his diſciples. Unable to reſiſt ſo fortunate an opportunity of indulging his ſportive humour, he ruſhed without ceremony into the ſchool, and took his place among the philoſophers. The whole aſſembly was aſtoniſhed at this rude and indecent intruſion, and all but Xenocrates diſcovered ſigns of reſentment. Xenocrates, however, preſerved the perfect command of his countenance; and with great preſence of mind turned his diſcourſe from the ſubject on which he was treating to the topics of temperance and modeſty, which he recommended with ſuch ſtrength of argument and energy of language, that Polemo was conſtrained to yield to the force of conviction. Inſtead of turning the philoſopher and his doctrine to ridicule, as he at firſt intended, he became ſenſible of the folly of his former conduct; was heartily aſhamed of the contemptible figure which he had made in ſo reſpectable an aſſembly; took his garland from his head; concealed his naked arm under his cloak; aſſumed a ſedate and thoughtful aſpect; and, in ſhort, reſolved from that hour to relinquiſh his licentious pleaſures, and devote himſelf to the purſuit of wiſdom. Thus was this young man, by the powerful energy of truth and eloquence, in an inſtant converted from an infamous libertine to a reſpectable philoſopher. In ſuch a ſudden change of character it is difficult to avoid paſſing from one extreme to another. Polĕmo after his reformation, in order to brace up his mind to the tone of rigid virtue, conſtantly practiſed the ſevereſt auſterity and moſt hardy fortitude. From the thirtieth year of his age to his death he drank nothing but water. When he ſuffered violent pain he ſhowed no external ſign of anguiſh. In order to preſerve his mind undiſturbed by paſſion, he habituated himſelf to ſpeak in an uniform tone of voice, without elevation or depreſſion. The auſterity of his manners was, however, tempered with urbanity and generoſity. He was fond of ſolitude, and paſſed much of his time in a garden near his ſchool. He died, at an advanced age, of a conſumption. Of his tenets little is ſaid by the ancients, becauſe he ſtrictly adhered to the doctrine of Plato."

POLEMONIUM, Greek Valerian, or *Jacob's Ladder*: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 29th order, *Campanaceæ*. The corolla is quinquepartite; the ſtamina inſerted into ſcales, which cloſe the bottom of the corolla; the ſtigma is trifid: the capſule bilocular ſuperior. There are two ſpecies, of which the moſt remarkable is the cœruleum, with an empalement longer than the flower. It grows naturally in ſome places of England: however, its beauty has obtained it a place in the gardens. There are three varieties; one with a white, another with a blue, and another with a variegated flower; alſo a kind with variegated leaves. They are eaſily propagated by ſeeds; but that kind with variegated leaves is preſerved by parting its roots, becauſe the plants raiſed from ſeeds would be apt to degenerate and become plain.

POLEMOSCOPE, in optics, the ſame with Opera-glass. See Dioptrics.

POLENBURG (Cornelius), an excellent painter of little landſcapes and figures, was born at Utrecht in 1586, and educated under Blomaert, whom he ſoon quitted to travel into Italy; and ſtudied for a long time in Rome and Florence, where he formed a ſtyle entirely new, which, though preferable to the Flemiſh, is unlike any Italian, except in his having adorned his landſcapes with ruins. There is a varniſhed ſmoothneſs and finiſhing in his pictures that render them always pleaſing, though ſimple and too nearly reſembling one another. The Roman cardinals were charmed with the neatneſs of his works, as was alſo the great duke; but could not retain him. He returned to Utrecht, and pleaſed Rubens, who had ſeveral of his performances. King Charles I. invited him to London, where he generally painted the figures in Steenwyck's perſpectives: but the king could not prevail on him to fix here; for after ſtaying only four years, and being handſomely rewarded by his majeſty for ſeveral pieces which he performed for him, he returned to Utrecht, and died there at the age of 74. His works are very ſcarce and valuable.

POLERON, one of the Banda or nutmeg iſlands in the Eaſt Indies. This was one of thoſe ſpice iſlands which put themſelves under the protection of the Engliſh, and voluntarily acknowledged James I. king of England for their ſovereign; for which reaſon the natives of this and the reſt of the iſlands were murdered or driven thence by the Dutch, together with the Engliſh.

POLESIA, a province of Poland, bounded by Polachio and Proper Lithuania on the north, and by Volhinia on the ſouth. It is one of the palatinates of Lithuania, and is commonly called *Breſcia*, and its capital is of this name. It is full of foreſts and lakes.

POLESINO-de-Rovigo, a province of Italy, in the republic of Venice, lying to the north of the river Po; and bounded on that ſide by the Paduan, on the ſouth by the Ferrareſe, on the eaſt by Degado, and on the weſt by the Veroneſe. It is 45 miles in length, and 17 in breadth, and is a fertile country. Rovigo is the capital

POLETÆ were ten magiſtrates of Athens, who, with three that had the management of money allowed for public ſhows, were empowered to let out the tribute-money and other public revenues, and to ſell confiſcated eſtates; all which bargains were ratified by their preſident, or in his name. They were by their office alſo bound to convict ſuch as had not paid the tribute callled *μετοικιον*, and ſell them in the market by auction. The market where theſe wretches were ſold was called *πωλητηριον τȣ μετοικιȣ*.

POLIANTHES, the Tuberose: A genus of the monogynia order, belonging to the hexandria claſs of plants; and in the natural method ranking under the 10th order, *Coronariæ*. The corolla is funnel-ſhaped, incurvated, and equal; the filaments are inſerted into the throat of the corolla; in the bottom of which the germen is ſituated. There is but one ſpecies, conſiſting of ſome varieties; all of which being exotics of tender quality, require aid of artificial heat, under ſhelter of frames and glaſſes, &c. to bring them to flower in perfection in this country. The polianthes, or tuberoſe, hath an oblong, bulblike, tuberous, white root; crowned with a few long very narrow leaves; amidſt them an upright, ſtraight, firm ſtem, three or four feet high, terminated by a long ſpike of large white flowers arranged alternately. The varieties are the common tuberoſe, with ſingle flowers,—double flowered,—dwarf-ſtalked,—variegated leaved. They all flower here in June, July, and Auguſt: the flowers are funnel or bell-ſhaped; garniſh the upper part of the ſtem in a long ſpike, conſiſting of from 10 to 20 or more ſeparate in alternate arrangements, the lower flowers opening firſt, which are ſucceeded by thoſe above, in regular order, making in the whole a moſt beautiful appearance, highly enriched with a moſt fragrant odour. The common ſingle-flowered tuberoſe is the ſort the moſt commonly cultivated, as it generally blows the moſt freely, and poſſeſſes the fineſt fragrance. The double-flowered kind alſo highly merits culture, as when it blows fair it makes a ſingularly fine appearance. The dwarf and the variegated kinds are inferior to the other two, but may be cultivated for variety.

All the varieties being exotics from warm countries, although they are made to flower in great perfection in our gardens by the aſſiſtance of hot-beds, they will not proſper in the open ground, and do not increaſe freely in England; ſo that a ſupply of the roots is imported hither annually from Genoa, and other parts of Italy, by moſt of the eminent nurſery- and ſeedſmen, and the Italian warehouſe-keepers; generally arriving in February or March, time enough for the enſuing ſummer's bloom; and are ſold commonly at the rate of twelve or fifteen ſhillings per hundred, being careful always to procure as large roots as poſſible, for on this depends the ſucceſs of having a complete blow. They, requiring artificial heat to blow them in this country, are planted in pots, and plunged in a hot-bed, under a deep frame furniſhed with glaſs lights; or placed in a hot-houſe, where they may be blowed to great perfection with little trouble. The principal ſeaſon for planting them is March and April: obſerving, however, that in order to continue a long ſucceſſion of the bloom, it is proper to make two or three different plantings, at about a month interval; one in March, another in April, and a third the beginning of May, whereby the blow may be continued from June until September; obſerving, as above mentioned, they may be flowered either by aid of a common dung or bark hot-bed, or in a hot-houſe.

With reſpect to the propagation of theſe plants, it is principally by offſets of the roots. The blowing roots that are brought annually from abroad for ſale are often furniſhed with offſets, which ought to be ſeparated previous to planting, Thoſe alſo that are planted here in our gardens frequently furniſh offsets fit for ſeparation in autumn when the leaves decay: they muſt then be preſerved in ſand all winter in a dry ſheltered place; and in the beginning of March, plant them either in a bed of light dry earth, in the full ground; or, to forward them as much as poſſible, allow them a moderate hot-bed; and in either method indulge them with a ſhelter in cold weather, either of a frame and lights, or arched with hoops and occaſionally matted; but let them enjoy the full air in all mild weather, giving alſo plenty of water in dry weather during the ſeaſon of their growth in ſpring and ſummer. Thus let them grow till their leaves again decay in autumn: then take them up, clean them from earth, and lay them in ſand till ſpring; at which time ſuch roots as are large enough to blow may be planted and managed as already directed, and the ſmaller roots planted again in a nurſery-bed, to have another year's growth; afterwards plant them for flowering. The Egyptians put the flowers of tuberoſe into ſweet oil; and by this means give it a moſt excellent flavour, ſcarce inferior to oil of jaſmine.

POLICANDRO, a ſmall iſland in the Archipelago, ſeated between Milo and Morgo. It has no harbour, but has a town about three miles from the ſhore near a huge rock. It is a ragged ſtony iſland, but yields as much corn as is ſufficient for the inhabitants, who conſiſt of about 120 Greek families, all Chriſtians The only commodity is cotton; of which they make napkins, a dozen of which are ſold for a crown. E. lon. 35. 25. N. lat. 36. 36.

POLICASTRO, an epiſcopal town of Italy, in the kingdom of Naples, and in the Hither Principato; but now almoſt in ruins, for which reaſon the biſhop reſides in another town. E. lon. 15. 46. N. lat. 40. 26.

POLICY, or POLITY, in matters of government. See POLITY.

POLICY *of Inſurance*, or *Aſſurance*, of ſhips, is a contract or convention, whereby a perſon takes upon himſelf the riſks of a ſea-voyage; obliging himſelf to make good the loſſes and damages that may befall the veſſel, its equipage, tackle, victualling, lading, &c. either from tempeſts, ſhipwrecks, pirates, fire, war, repriſals, in part or in whole; in conſideration of a certain ſum of ſeven, eight, or ten *per cent.* more or leſs according to the riſk run; which ſum is paid down to the aſſurer by the aſſuree upon his ſigning the policy. See INSURANCE.

POLIDORO DA CARAVAGGIO, an eminent painter, born at Caravaggio in the Milaneſe in 1492. He went young to Rome, where he worked as a labourer in preparing ſtucco for the painters; and was ſo animated by ſeeing them at work in the Vatican, that he ſolicited ſome of them to teach him the rules of deſigning. He attached himſelf particularly to Maturino, a young Florentine; and a ſimilarity in talents and taſte producing a diſintereſted affection, they aſſociated like brothers, laboured together, and lived on one common purſe, until the death of Maturino. He underſtood and practiſed the chiaroſcuro in a degree ſuperior to any in the Roman ſchool; and finiſhed an incredible number of pictures both in freſco and in oil, few of the public buildings at Rome being without ſome of his paintings. Being obliged to fly from Rome when it was ſtormed and pillaged, he retired to Meſſina, where he obtained a large ſum of money with great reputation, by painting the triumphal arches for the reception of Charles V. after his victory at Tunis; and when he was preparing to return to Rome, he was murdered, for the ſake of his riches, by his Sicilian valet with other aſſaſſins, in the year 1543.

POLIFOLIA. See ANDROMEDA.

POLIGNAC (MELCHIOR DE), an excellent French genius and a cardinal, was born of an ancient and noble family at Puy, the capital of Velay, in 1662. He was ſent by Louis XIV. ambaſſador extraordinary to Poland, where, on the death of Sobieſki, he formed a project of procuring the election of the prince of Conti. But failing, he returned home under ſome diſgrace; but when reſtored to favour, he was ſent to Rome as auditor of the Rota. He was plenipotentiary during the congreſs at Utrecht, at which time Clement I. created him a cardinal; and upon the acceſſion of Louis XV. he was appointed to reſide at Rome as miniſter of France. He remained there till the year 1732, and died in the year 1741. He left behind him a MS. poem entitled *Anti-Lucretius, ſeu de Deo et Natura*; the plan of which he is ſaid to have formed in Holland in a converſation with Mr. Bayle. This celebrated poem was firſt publiſhed in the year 1749, and has ſince been ſeveral times printed in other countries beſides France. He had been received into the French Academy in 1704, into the Academy of Sciences in 1715, into that of the Belles Lettres in 1717: and he would have been an ornament to any ſociety, having all the accompliſhments of a man of parts and learning.

POLISHER, or BURNISHER, among mechanics, an inſtrument for poliſhing and burniſhing things proper to take a poliſh. The gilders uſe an iron-poliſher to prepare their metals before gilding, and the blood-ſtone to give them the bright poliſh after gilding. The poliſhers, among *cutlers*, are a kind of wooden wheels made of walnut-tree, about an inch thick, and of a diameter at pleaſure, which are turned round by a great wheel; upon theſe they ſmooth and poliſh their work with emery and putty. The poliſhers for *glaſs* conſiſt of two pieces of wood; the one flat, covered with old hat: the other long and half-round, faſtened on the former, whoſe edge it exceeds on both ſides by ſome inches, which ſerves the workmen to take hold of, and to work backwards and forwards by. The poliſhers uſed by *ſpectacle-makers* are pieces of wood a foot long, ſeven or eight inches broad, and an inch and a half thick, covered with old beaver hat, whereon they poliſh the ſhell and horn frames their ſpectacle-glaſſes are to be ſet in.

POLISHING, in general, the operation of giving a gloſs or luſtre to certain ſubſtances, as metals, glaſs, marble, &c. The operation of poliſhing optic-glaſſes, after being properly ground, is one of the moſt difficult points of the whole proceſs. See TELESCOPE.

POLITENESS means elegance of manners or good breeding: Lord Cheſterfield calls it the art of pleaſing. It has alſo been called an artificial good nature; and indeed good nature is the foundation of true politeneſs; without which art will make but a very indifferent figure, and will generally defeat its own ends. "Where compliance and aſſent, caution and candour, ſays Dr. Knox, ariſe from a natural tenderneſs of diſpoſition and ſoftneſs of nature, as they ſometimes do, they are almoſt amiable, and certainly excuſable; but as the effects of artifice, they muſt be deſpiſed. The perſons who poſſeſs them are, indeed, often themſelves the dupes of their own deceit, when they imagine others are deluded by it. For exceſſive art always betrays itſelf; and many, who do not openly take notice of the deceiver, from motives of delicacy and tenderneſs for his character, ſecretly deride and warmly reſent his ineffectual ſubtilty."

The following obſervations perhaps contain the ſum of the art of pleaſing: 1. A fixed and habitual reſolution of endeavouring to pleaſe, is a circumſtance which will ſeldom fail of effect, and its effect will every day become more viſible as this habit increaſes in ſtrength. 2. This reſolution muſt be regulated by a very conſiderable degree of good ſenſe. 3. It is a maxim of almoſt general application, that what pleaſes us in another will alſo pleaſe others in us. 4. A conſtant and habitual attention to the different diſpoſitions of mankind, to their ruling paſſions, and to their peculiar or occaſional humours, is abſolutely neceſſary. 5. A man who would pleaſe, muſt poſſeſs a firm, equal, and ſteady temper. And, 6. An eaſy and graceful manner, as diſtant from baſhfulneſs on the one hand as from impudence on the other. "He who thinks himſelf ſure of pleaſing (ſays Lord Cheſterfield), and he who deſpairs of it, are equally ſure to fail." And he is undoubtedly in the right. The one, by his aſſuming vanity, is inattentive to the means of pleaſing; and the other, from fear, is rendered incapable of employing them.

A variety of excellent rules for acquiring politeneſs, with ſtrictures on particular kinds of impoliteneſs, may be found in the *Spectator*, *Rambler*, *Idler*, *Lounger*, *Mirror*, and other periodical works of that kind; in *Knox's Eſſays*, and among *Swift's Works*; ſee *Good* MANNERS. *Cheſterfield's Art of Pleaſing*, and his *Letters*, are alſo worthy of peruſal, provided the reader be on his guard againſt the inſincerity and other vices which thoſe books are calculated to infuſe, and provided he always bear in mind, that true politeneſs does not conſiſt in ſpecious manners and a diſſimulating addreſs, but that it muſt always be founded on *real worth* and *intrinſic virtue*.

POLITIAN (ANGELO), was born at Monte Pulciano in Tuſcany in 1454. He learned the Greek tongue, of which he became a complete maſter, under Andronicus of Theſſalonica. He is ſaid to have written verſes both in Greek and Latin when he was not more than 12 years of age. He ſtudied alſo the Platonic philoſophy under Marſilius Ficinus, and that of Ariſtotle under Argyropylus. He was one of the moſt learned and polite writers of his time. The firſt work which gained him a reputation was a poem on the tournament of Julian de Medicis. The account he wrote ſome time after of the conſpiracy of the Pazzis was very much eſteemed. He wrote many other pieces which have merited approbation; and had he lived longer, he would have enriched the republic of letters with many excellent works; but he died at the age of 40 years. His morals anſwered the homelineſs of his face rather than the beauty of his genius; for Paul Jovius informs us, "he was a man of awkward and perverſe manners, of a countenance by no means open and liberal, with a noſe remarkably large, and ſquinting eyes. He was crafty, ſatirical, and full of inward malice: for his conſtant way was, to ſneer at and ridicule the productions of other men, and never to allow any criticiſm, however juſt, upon his own."

He was, neverthelefs, as all acknowledge, a man of moſt conſummate erudition; and not only ſo, but a very polite and elegant writer. Eraſmus, in his *Ciceronianus*, calls him a rare miracle of nature, on account of his excelling in every kind of writing: his words are remarkable: "*Fateor Angelum prorſus angelica fuiſſe mente, rarum naturæ miraculum, ad quodcunque ſcripti genus applicaret animum.*" Some of his poems were ſo much admired, that ſeveral learned men have made it their buſineſs to conmment on them. It has been often reported that he ſpoke of the Bible with great contempt; and that, having read it but once, he complained he had never ſpent his time ſo ill. But this is not probable, for it muſt be remembered that he was a prieſt and canon of Florence; and we learn from one of his epiſtles that he preached a whole Lent. It does not indeed follow hence, that he did not think contemptuouſly of the Bible, becauſe many of his church, eſpecially among the better ſort, have not been very good believers, and he might be one of them: but it is not likely he would ſpeak out ſo freely. "I could (as Bayle ſays) much more eaſily believe the judgment he is ſaid to have made on the Pſalms of David and the Odes of Pindar: he did not deny that there are many good and fine things in the Pſalms; but he pretended that the ſame things appear in Pindar with more brightneſs and ſweetneſs." The two Scaligers have ſpoken highly of Politian: the elder has preferred a conſolatory elegy of his to that which Ovid ſent to Livia upon the death of Druſus, and ſays he had rather have been the author of it: the younger calls him an excellent poet, but thinks the ſtyle of his epiſtles too elated and declamatory.

His works have been printed at various times, and in various places: his epiſtles have probably been moſt read, becauſe theſe are things which the generality of people are beſt pleaſed with.

POLITICAL, from ϖολις "a city," ſignifies any thing that relates to policy or civil government.

POLITICAL *Arithmetic*, is the art of reaſoning by figures upon matters relating to government, ſuch as the revenues, number of people, extent and value of land, taxes, trade, &c. in any nation. Theſe calculations are generally made with a view to aſcertain the comparative ſtrength, proſperity, &c. of any two or more nations. With this view, Sir William Petty, in his *Political Arithmetic*, p. 74, &c. computes the land of Holland and Zealand to be about 1,000,000 acres, and that of France to be 8,000,000; and yet the former is one third part as rich and ſtrong as the latter. The ſhipping of Europe he computes to be about 2,000,000, of which Britain has 500,000; Holland 900,000; France 100,000; Hamburgh, Denmark, Sweden, and Dantzic 250,000; and Spain, Portugal, Italy, &c. the reſt. The exports of France he computes at 5,000,000l. of which one-fourth came to Britain; of Holland 18,000,000l. of which 300,000l. came to Britain. The money raiſed yearly by the king of France was about 6,500,000l. ſterling; that of all the Dutch provinces 3,000,000l. of which 2,100,000l. was raiſed in Holland and Zealand. The number of people in England he computed to be ſix millions, and their expences at 7l. *per annum* a head 42,000,000l.; the rent of land 8,000,000l.; and the intereſts, &c. of perſonal eſtates as much, the rents of houſes 4,000,000l. and the profits of labour 26,000,000l. The people of Ireland he reckoned 1,200,000. The corn ſpent in England, at 5s. a buſhel for wheat, and 2s. 6d. for barley, amounts to 10,000,000l. a-year. The navy of England then required 36,000 men to man it, and other trade and ſhipping 48,000. In France, to manage the whole ſhipping trade, there were then required only 1500 men. The whole people of France were 13,500,000; and thoſe of England, Scotland, and Ireland, about 9,500,000. In the three kingdoms are about 20,000 churchmen, and in France more than 270,000. In the dominions of England were above 40,000 ſeamen, and in France not more than 10,000. In England, Scotland, and Ireland, and all their dependencies, there was then about 60,000 ton of ſhipping, worth about 4,500,000l. in money. The ſea-line round England, Scotland and Ireland, and the adjacent iſles, is about 3800 miles. In the whole world he reckoned about 350,000,000 of people; and thoſe with whom the Engliſh and Dutch have any commerce, not more than eighty millions; and the value of commodities annually traded for in the whole not above 45,000,000l. That the manufactures exported from England amounted to about 5,000,000l. *per annum*; lead, tin, and coals, to 500,000l. *per annum*. The value of the French commodities then brought into England did not exceed 1,200,000l. *per annum*; and the whole caſh of England in current money was then about 6,000,000l. ſterling.

With theſe calculations Dr. Davenant was diſſatisfied; and therefore, from the obſervations of Mr. Greg. King, he advanced others of his own. He reckons the land of England 39 millions of acres; the number of people 5 millions and a half, increaſing 9000 a year, making allowance for wars, plagues, and other accidents. He reckons the inhabitants of London 530,000; of other cities and market-towns in England 870,000; and thoſe of villages, &c. 4,100,000. The yearly rent of land he reckons 10,000,000l.; of houſes, &c. 2,000,000l.; the produce of all kinds of grain in a tolerable year 9,075,000l.; the annual rent of corn lands 2,200,000l.

and their net produce 9,000,000l.; the rent of paſture, meadows, woods, foreſts, commons, heaths, &c. 7,000,000l.; the annual produce by cattle in butter, cheeſe, and milk, about 2,500,000l.; the value of the wool yearly-ſhorn about 2,000,000l.; of horſes yearly bred about 250,000l.; of the fleſh yearly ſpent as food about 3,350,000l.; of the tallow and hides about 600,000l.; of the hay yearly conſumed by horſes about 1,300,000l.; of the hay conſumed by other cattle 1,000,000l; of the timber yearly felled for building 500,000l.; and of the wood yearly ſpent in firing, &c. about 500,000l. The proportion of the land of England to its inhabitants is now about 7¼ acres per head; the value of the wheat, rye, and barley, neceſſary for the ſuſtenance of England, amounts to at leaſt 6,000,000l. ſterling *per annum*; of the woollen manufacture about 8,000,000l. *per annum*; and exports of all kinds of the woollen manufacture amount to above 2,000,000l. *per annum*; the annual income of England, on which the whole people ſubſiſt, and out of which all taxes are paid, is reckoned to be about 43,000,000l. that of France 81,000,000l. and of Holland 18,250,000l. See Davenant's *Eſſay on Trade*, in vol. vi. of his works. For calculations reſpecting mortality, ſee Major Grant's *Obſervations on the Bills of Mortality*, and our article *Bills of* MORTALITY.

In vol. xlix. of the Philoſophical Tranſactions we have an eſtimate of the number of people in England by Dr. Brakenridge, from conſidering the number of houſes and quantity of bread conſumed. On the former principle he computes the number of people to be 6,257,418 of all ages, counting in England and Wales 911,310 houſes, and allowing ſix perſons to a houſe. From a ſurvey of the window-lights after the year 1750, the number of houſes charged in England and Wales were 690,000, beſides 200,000 cottages that pay nothing; the whole number therefore was 890,000, and the number of people, allowing ſix to a houſe, 5,340,000. On the latter principle, he eſtimates the number of quarters of wheat conſumed at home to be 2,026,100; and allowing a quarter for three perſons in a year, or ſeven ounces a day for each perſon, he concludes the number of people to be 6,078,300. Of this number, according to Dr. Halley's rule, he ſuppoſes about 1,500,000 men able to carry arms. The country he ſuppoſes capable of ſupporting one half more inhabitants, or 9,000,000; for, according to Mr. Templeman's ſurvey, England contains 49,450 ſquare miles, that is, 31,648,000 acres, of which 25,300,000 acres are proper to be cultivated; and allowing three acres, well manured, for the maintenance of one perſon, there will be maintenance in England for 8,430,000 people; to which add the produce of fiſhing, and it will enable the country to ſupport 9,000,000. In Ireland, Mr. Templeman reckons 17,536,000 acres, of which Dr. Brakenridge thinks 12,000,000 are capable of cultivation; and allowing four acres to each perſon, and the number of inhabitants to be only 1,000,000, Ireland could maintain 2,000,000 more people than it has now. In Scotland, containing 1,500,000 people, and 17,728,000 acres of land, of which there are 11,000,000 good acres, allowing five for each perſon, he ſuppoſes there may be proviſion for 2,200,000 people, or for 700,000 more than there are at preſent. Hence he infers, that were both the Britiſh iſles properly cultivated, there is a proviſion for 6,000,000 inhabitants beyond the preſent number. Extending his ſurvey to the whole globe, he ſuppoſes the whole ſurface to be to the quantity of land as 8 to 3, *i. e.* as 197,819,550 to 74,182,331 ſquare miles; out of which deducting one third for waſte ground, there will be 49,454,887 ſquare miles, or 31,651,127,680 good acres. And ſtating the whole number of inhabitants on the globe to be 400,000,000, there will be 79 good acres to each perſon. See Dr. Halley's *Calculations* on the ſame ſubject, and *Dr. Price's* (for a liſt of whoſe works ſee his life at the word PRICE), and King *on the National Debt*.

POLITICS, the firſt part of economy or ethics, conſiſting in the well governing and regulating the affairs of a ſtate for the maintenance of the public ſafety, order, tranquillity, and morals. Lord Bacon divides politics into three parts, viz. the *preſervation* of the ſtate, its *happineſs* and *flouriſhing*, and its *enlargement*. Of the firſt two, he informs us, various authors have treated, but the laſt has never been handled; and he has given a ſpecimen of an eſſay to ſupply the want.

POLITY, or POLICY, denotes the peculiar form and conſtitution of the government of any ſtate or nation; or the laws, orders, and regulations, relating thereto. — See GOVERNMENT. Polity differs only from politics, as the theory from the practice of any art.

Of the nature of our ſocial duties, both private and political, we have already ſpoken at ſome length (ſee MORAL *Philoſophy*); and we ſhall have occaſion to take a view of the origin and nature of the ſeveral political eſtabliſhments of Europe, &c. hereafter. (See *Civil* SOCIETY.) We ſhall only further remark in this place upon the neceſſity of always joining politics and morality together. This view of the ſubject is indeed antiquated and neglected; but the connection has always been externally reſpected even by thoſe who have ſeparated them the moſt widely. Politics and morality, far from ſtanding in oppoſition to each other, have the moſt intimate connection, and exhibit the relation which the *part* bears to the *whole*; that is to ſay, that politics are only a part or a branch of morality. No truth can be more evident than this; for, as morality is the guide of human life, the principle of order, and the univerſal ſource of real improvement and genuine happineſs to all mankind, every thing relative to the direction of individuals, or the government of nations, muſt be comprehended within its ſphere, and be ſubſervient to its laws. All the ſchemes and projects of pretended political wiſdom, that deviate from or violate the rules of this maſter-ſcience, turn out in the iſſue often to the detriment of their contrivers, always to that of the nation; and it is a palpable and abſurd error to think of advancing the happineſs of one country at the expence of the general good of mankind. The experience of ages, and the hiſtory of the world, confirm theſe aſſertions; from which, and from daily obſervation, we obtain a convincing proof of the wiſdom of the good old maxim, both in its application to individuals and to nations, "that honeſty is the beſt policy." See Baron Dahlberg's *Conſiderations on the Connection between Morality and Politics*, read by himſelf to the Academy of Sciences at Erfurt.

POLL, a word uſed in ancient writings for the head: hence to poll, is either to vote, or to enter down the names of thoſe perſons who give their votes at an election.

POLL-*Evil*. See FARRIERY.

POLL-*Money*, or *Capitation*, a tax impoſed by authority of parliament on the perſon or head; either on all indifferently, or according to ſome known mark or diſtinction, as quality, calling, &c. Thus, by the ſtatute 18 Car. II. every ſubject in the kingdom was aſſeſſed by the head or poll, according to his degree; every duke 100l. marquis 80l. baronet 30l. knight 20l. eſquire 10l. &c. and every ſingle private perſon 12d. This was no new tax, as appears by former acts of parliament.

POLLACHIUS, or POLLACK. See GADUS.

POLLARD, or CROCARD, the name of a ſort of baſe money current in Ireland in the time of Edward I. See *Simon's Hiſtory of Iriſh Coins*.

POLLEN, the fecundating or fertilizing duſt contained within the antheræ or tops of the ſtamina, and diſperſed upon the female organ when ripe for the purpoſes of impregnation. See

BOTANY. This duſt, correſponding to the ſeminal fluid in animals, is commonly of a yellow colour; and is very conſpicuous in the ſummits of ſome flowers, as the tulip and lily. Its particles are very minute, and of extreme hardneſs. Examined by the microſcope, they are generally found to aſſume ſome determinate form, which often predominates, not only through all the ſpecies of a particular genus, but alſo through the genera of a natural family or order. The powder in queſtion being triturated, and otherwiſe prepared in the ſtomach of the bees, by whom great quantities are collected in the hairy bruſhes with which their legs are covered, is ſuppoſed by ſome authors to produce the ſubſtance known by the name of *wax*; a ſpecies of vegetable oil, rendered concrete by the preſence of an acid, which muſt be removed before the ſubſtance can be rendered fluid.

POLLENTIA, a town or colony of Roman citizens in the Balearis Major. It is now ſaid to be Alcudia, ſituated on the north-eaſt ſide of the iſland Majorca. There was another *Pollentia* of the Picenum, likewiſe a colony. It is thought to be either the ſame with or near to the Urbs Salvia, but is now extinct. There was a third of Liguria, ſituated at the confluence of the Stura and Tanarus. Suetonius calls it a municipium, and the people *Pollentina Plebs*. It was famous for its abundance of black fleeces; but was afterwards, under Arcadius and Honorius, ſtained with a defeat, rather of the Romans under Stilico than of the Goths under Alaricus, though palliated by Claudian the poet, after which Rome was taken and ſet on fire. It is now called *Solenza*, a ſmall town of Piedmont, not far from Aſti.

POLLEX, in anatomy, denotes either the thumb or great-toe, according as *manus* or *pedis* is added to it.

POLLICHIA, in botany: A genus of the monogynia order, belonging to the monandria claſs of plants; and in the natural method ranking with thoſe that are doubtful. Of this there is only one ſpecies, *viz.* the *campeſtris*, or whorl-leaved pollichia, which is a native of the Cape of Good Hope, and flowers in September.

POLLICIPES, the TOE-SHELL, in natural hiſtory, is the name of a genus of ſhells, the characters of which are theſe: they are multivalve flat ſhells, of triangular figure, each being compoſed of ſeveral laminæ, which end in a ſharp point. They ſtand upon pedicles, and are furniſhed with a great number of hairs. We have only one known ſpecies of this genus, which is always found in large cluſters.

POLLICIS PRESSIO, and POLLICIS' VERSIO, were uſed at the combats of gladiators as ſignals of life or death to the vanquiſhed combatant; or to the victor to ſpare or take the life of his antagoniſt. The *pollicis preſſio*, by which the people granted life to the proſtrate gladiator, was no more than the clenching of the fingers of both hands together, and ſo holding the two thumbs upright cloſe together. The *pollicis verſio*, which authoriſed the victor to kill the other as a coward, was the bending back of the thumbs. Such is Dacier's opinion; but others ſay the *pollicis preſſio* was when the people held up one hand with the thumb bent, and the *pollicis verſio* when they ſhowed the hand with the thumb raiſed. Authors, however, are not perfectly agreed, though the phraſes *pollicem premere*, and *pollicem vertere*, frequently occur in the Latin claſſics as indications of the people's will that a gladiator ſhould live or die.

POLLIO (CAIUS ASINIUS), a celebrated Latin poet and orator, was of conſular dignity, and compoſed ſome tragedies which were eſteemed, but are now loſt. He was the firſt who opened at Rome a library for the uſe of the public. He was the friend of Mark Antony; which prevented his complying with the ſolicitations of Auguſtus, who preſſed him to embrace his party. At length Auguſtus having written ſome verſes againſt Pollio, he was urged to anſwer them: on which he ſaid, "I ſhall take care of writing againſt a man who has the power of preſcribing us." He is praiſed by Virgil and Horace, whoſe patron he was.

There was another *Pollio*, a friend of Auguſtus, who uſed to feed his fiſhes with human fleſh. This cruelty was diſcovered when one of his ſervants broke a glaſs in the preſence of Auguſtus, who had been invited to a feaſt. The maſter ordered the ſervant to be ſeized, but he threw himſelf at the feet of the emperor, and begged him to interfere, and not to ſuffer him to be devoured by fiſhes. Upon this the cauſes of his apprehenſion were examined; and Auguſtus, aſtoniſhed at the barbarity of his favourite, cauſed the ſervant to be diſmiſſed, all the fiſh ponds to be filled up, and the cryſtal glaſſes of Pollio to be broken to pieces.

POLLUTION, in general, ſignifies defilement, or the rendering a perſon or place unclean or unholy. For the Jewiſh pollutions, ſee the article IMPURITY. The Romaniſts hold a church to be polluted by the effuſion of blood or of ſeed therein: and that it muſt be conſecrated anew. And the Indians are ſo ſuperſtitious on this head, that they break all the veſſels which thoſe of another religion have drunk out of, or even only touched; and drain all the water out of a pond in which a ſtranger has bathed.

POLLUTION, in medicine, a diſeaſe which conſiſts in an involuntary emiſſion of ſeed in time of ſleep. This, in different perſons, is very different in degree; ſome being affected with it only once in a week, a fortnight, three weeks, or a month, and others being ſubject to it almoſt every night. The perſons moſt ſubject to it, are young men of a ſanguineous temperament, who feed high and lead a ſedentary life. When this happens to a perſon but once in a fortnight or a month, it is of no great conſequence; but when it happens almoſt every night, it greatly injures the health; the patient looks pale and ſickly; in ſome the eyes become weak and inflamed, are ſometimes affected with violent defluctions, and are uſually at laſt encircled with a livid appearance of the ſkin. This diſeaſe is to be cured rather by a change of life than by medicines. When it has taken its riſe from a high diet and a ſedentary life, a coarſer food and the uſe of exerciſe will generally cure it. Perſons ſubject to this diſeaſe ſhould never take any ſtimulating purges, and muſt avoid as much as poſſible all violent paſſions of the mind: and though exerciſe is recommended in moderation, yet if this be too violent, it will rather increaſe the diſorder than contribute to its cure.

Self POLLUTION. See ONANISM.

POLLUX (JULIUS), a Greek writer of antiquity, flouriſhed in the reign of the emperor Commodus, and was born at Naucrates, a town in Egypt. He was educated under the ſophiſts, and made great progreſs in grammatical and critical learning. He taught rhetoric at Athens, and became ſo famous that he was made preceptor of the emperor Commodus. He drew up for his uſe, and inſcribed to him, while his father Marcus Antoninus was living, an *Onomaſticon* or Greek Vocabulary, divided into ten books. It is extant, and contains a vaſt variety of ſynonomous words and phraſes, agreeably to the copiouſneſs of the Greek tongue, ranged under the general claſſes of things. It was intended to facilitate the knowledge of the Greek language to the young prince; and it is ſtill very uſeful to all who have a mind to be perfect in it. The firſt edition of it was printed at Venice by Aldus in 1502, and a Latin verſion was afterwards made and publiſhed with it: but there was no correct and handſome edition of it till that of Amſterdam, 1706, in folio, by Lederlinus and Hemſterhuſius. Lederlinus went through the firſt ſeven books, correcting the text and verſion, and ſubjoining his own, with the notes of Salmaſius, If. Voſſius, Valeſius, and of Kuhnius, whoſe ſcholar he had been and whom he ſucceeded in the profeſſorſhip of the oriental languages in the univerſity of Straſbourg. Hemſterhuſius continued the ſame method through the three laſt books; this learned man has ſince diſtinguiſhed himſelf by an excellent edition of Lucian, and other monuments of ſolid and profound literature. Pollux wrote many other things, none of which remain. He lived to the age of 58. Philoſtratus and Lucian have treated him with much contempt and ridicule. *Philoſtrat. de vit. Sophiſt.* lib. ii. and *Lucian in Rhetorum præceptore.*

Pollux. See Castor and Pollux.

Pollux, in aſtronomy, a fixed ſtar of the ſecond magnitude in the conſtellation Gemini, or the Twins. See Castor.

Pollux, *and Caſtor*, a fiery meteor. See Castor *and Pollux*.

POLOCSKI, a palatinate in the duchy of Lithuania, bounded on the north by the palatinate of Weytepſki, on the ſouth by the Dwina, on the north by Muſcovy, and on the weſt by Livonia. It is a deſert country full of wood, and had formerly its own dukes.

Polocski, a town of Lithuania, and capital of a palatinate of the ſame name, with two caſtles to defend it. It was taken by the Muſcovites in 1563, and retaken the ſame year. It is ſeated on the river Dwina, 50 miles ſouth-weſt of Weytepſki, and 80 eaſt of Bracklaw. E. lon. 29. 0. N. lat. 56. 4.

POLTROON, or Poltron, a coward or daſtard, wanting courage to perform any thing great or noble. The word is borrowed from the French, who, according to Salmaſius, derive it *a pollice truncato*; becauſe anciently thoſe who would avoid going to the wars cut off their thumb. But Menage, with more probability, derives it from the Italian *paltrone*, and that from *paltro* a "bed;" becauſe timorous, puſillanimous people take pleaſure in lying a-bed. Others chooſe to derive the word from the Italian *paltro* a "colt;" becauſe of that creature's readineſs to run away.

POLVERINE, the calcined aſhes of a plant; of a ſimilar nature with our pot-aſhes or pearl-aſhes. It is brought from the Levant and Syria; and in the glaſs-trade it is always to be preferred to any other aſhes. The barilla, or pot-aſhes of Spain, yield more pure ſalt than the polverine of the Levant, but the glaſs made with it has always ſome blue tinge; that made with the polverine is perfectly white, which ought always to be uſed for the fineſt cryſtal.

POLYADELPHIA (from *ϖολυς many*, and *αδελφια brotherhood)*, many brotherhoods. The name of the 18th claſs of Linnæus's ſexual ſyſtem, conſiſting of plants with hermaphrodite flowers in which ſeveral ſtamina or male organs are united by their filaments into three or more diſtinct bundles.

POLYÆNUS, the name of many famous men recorded in ancient writers. Among them was Julius Polyænus, of whom we have ſome Greek epigrams extant in the firſt book of the *Anthologia*. The Polyænus whom it moſt concerns us to know about, is the author of the eight books of the Stratagems of illuſtrious Commanders in War. He was probably a Macedonian, and perhaps a ſoldier in the early part of his life; but of this there is no certainty. He was undoubtedly a rhetorician and a pleader of cauſes; and appears, from the dedication of his work to the emperors Antoninus and Verus, to have lived towards the latter part of the ſecond century. The *Stratagemata* were publiſhed in Greek by Iſaac Caſaubon, with notes, in 1589, 12mo; but no good edition of them appeared till that of Leyden, 1690, in 8vo. The title-page runs thus: *Polyæni Stratagematum libri octo, Juſto Vultcio interprete, Pancratius Maaſvicius recenſuit, Iſaaci Caſauboni nec non ſuas notas adjecit.*

We have in this work the various ſtratagems of above 300 captains and generals of armies, chiefly Greeks and barbarians: for the Romans ſeldom uſed ſuch fineſſes; and Polyænus has ſhown further, that he was not well verſed in Roman affairs. A great number of theſe ſtratagems appear to us to be ridiculous or impracticable; and neither the generals, nor even common ſoldiers of our days, would be found ſimple enough to be caught by them. Few of this order are capable of reading *Polyænus's Stratagems*; and if they were, they would reap little benefit from it. The book is uſeful to ſuch as ſtudy the Greek language and antiquity; for many things will be found in it, illuſtrating the cuſtoms and opinions of ancient times. The ſixth and ſeventh books are imperfect.

Polyænus compoſed other works beſides the *Stratagemata*. Stobæus has produced ſome paſſages out of a book *De Republica Macedonum*; and Suidas mentions a piece concerning the Thebans and three books of Tacitus. If death had not prevented, he would have written *Memorabilia of the Emperors Antoninus and Verus*: for he makes a promiſe of this in the preface to his ſixth book of *Stratagems*. Caſaubon, in the dedication of Polyænus to Mornæus, calls him *an elegant, acute, and learned writer.*

POLYANDRIA (from *ϖολυς many*, and *ανηρ* a *man* or *huſband)*, many huſbands. The name of the 1 th claſs in Linnæus's ſexual method, conſiſting of plants with hermaphrodite flowers, which are furniſhed with ſeveral ſtamina, that are inſerted into the common receptacle of the flower.

POLYANTHEA, a collection of common-places in alphabetical order, for the uſe of orators, preachers, &c. The word is formed from the Greek *ϖολυς much*, and *ανθος flower*; and has much the ſame meaning with *anthology* or *florilege*. The firſt author of the polyanthea was Dominic Nanni de Mirabellio, whoſe labour has been improved on by Barth. Amantius, and Franc. Torſius; and ſince theſe, by Joſ. Langius, under the title of *Polyanthea nova*, 1613.

POLYANTHUS, in botany. See Primula.

POLYBIUS, a famous Greek hiſtorian was born at Megalopolis, a city of Arcadia, 20 years before Chriſt; and was the ſon of Lycortas, chief of the republic of the Achæans. He was trained to arms under the celebrated Philopœmen, and is deſcribed by Plutarch carrying the urn of that great but unfortunate general in his funeral proceſſion. He roſe to conſiderable honours in his own country, but was compelled to viſit Rome with other principal Achæans, who were detained there as pledges for the ſubmiſſion of their ſtate. From hence he became intimate with the ſecond Scipio Africanus, and was preſent with him at the demolition of Carthage. He ſaw Corinth alſo plundered by Mummius, and thence paſſing through the cities of Achaia, reconciled them to Rome. He extended his travels into Egypt, France, and Spain, that he might avoid ſuch geographical errors as he has cenſured in others.

It was in Rome that he compoſed his excellent hiſtory, for the ſake of which his travels were undertaken. The hiſtory was divided into 40 books; but there only remain the five firſt, with extracts of ſome parts of the others. It has had ſeveral editions in Greek and Latin; and there is an Engliſh tranſlation by Mr. Hampton. He died at the age of 82.

POLYCARP, one of the moſt ancient fathers of the Chriſtian church, was born towards the end of the reign of Nero, probably at Smyrna; where he was educated at the expenſe of Caliſta, a noble matron diſtinguiſhed by her piety and charity. He was unqueſtionably a diſciple of St. John the Evangeliſt, and converſed familiarly with others of the apoſtles. When of a proper age, Bucolus ordained him a deacon and catechiſt of his church; and upon his death he ſucceeded him in the biſhopric, to which he is ſaid to have been conſecrated by St. John, who alſo directed his Apocalypſe, among others, to him, under the title of the *Angel of the Church of Smyrna*. At length the controverſy about the obſervation of Eaſter beginning to grow high between the eaſtern and weſtern churches, he went to Rome to diſcourſe with thoſe who were of the oppoſite party. The ſee was then poſſeſſed by Anicetus, with whom he had many conferences, that were carried on in the moſt peaceable and amicable manner; and though neither of them could bring the other to embrace his opinion, they both retained their own ſentiments without violating that charity which is the great law of their religion.

Whilſt at Rome he particularly oppoſed the hereſies of Marcion and Valentinus. His conduct on this occaſion is related by Irenæus; who informs us, that when Polycarp paſſed Marcion in the ſtreet without ſpeaking, Marcion ſaid, "Polycarp, own us!" To which he replied with indignation, "I own thee to be the firſt-born of Satan." Irenæus adds, that when any heretical doctrines were ſpoken in his preſence, he would ſtop his ears and ſay, "Good God! to what times haſt thou reſerved me, that I ſhould hear ſuch things!" and immediately left the place. He was wont to tell, that St. John, going into a bath at Epheſus, and finding Cerinthus the heretic in it, immediately ſtarted back without bathing, crying out, "Let us run away, leſt the bath ſhould fall upon us while Cerinthus the enemy of truth is in it." Polycarp governed the church of Smyrna with apoſtolic purity, till he ſuffered martyrdom in the 7th year of Marcus Aurelius; the manner of which is thus related.

The perſecution waxing hot at Smyrna, and many having ſealed their faith with their blood, the general cry was, "Away with the impious; let Polycarp be ſought for." Upon which he privately withdrew into a neighbouring village, where he continued for ſome time praying night and day for the peace of the church. He was thus employed, when one night he fell into a trance. and dreamed that his pillow took fire, and was burnt to aſhes; which, when he awoke, he told his friends was a preſage that he ſhould be burnt alive for the cauſe of Chriſt. Three days afterwards, in order to eſcape the inceſſant ſearch for him, he retired into another village: his enemies, however, were at hand, who ſeized upon two youths (one of whom they forced by ſtripes to a confeſſion), by whom they were conducted to his lodging. He might have ſaved himſelf by getting into another houſe; but he ſubmitted, ſaying, "The will of the Lord be done." He therefore came down from his bed-chamber, and ſaluting his perſecutors with a ſerene and chearful countenance, he ordered a table to be ſet with proviſions, invited them to partake of them, and only requeſted for himſelf one hour for prayer; after which he was ſet upon an aſs, and conducted to Smyrna. On the road he met Herod, an irenarch or juſtice of the province, and his father, who were the principal inſtigators of the perſecution. Herod took him up into his chariot, and ſtrenuouſly endeavoured to undermine his conſtancy; but having failed in the attempt, he thruſt him out of the chariot with ſo much violence and indignation, that he bruiſed his thigh with the fall. When at the place of execution, there came, as is ſaid, a voice from heaven, ſaying, "Polycarp, be ſtrong, and quit thyſelf like a man." Before the tribunal he was urged to ſwear by the genius of Cæſar. "Repent (ſays the proconſul), and ſay with us, take away the impious." Whereupon the martyr looking round at the crowd with a ſevere and angry countenance, beckoned with his hand, and looking up to heaven, ſaid with a ſigh, in a very different tone from what they meant, "Take away the impious." At laſt, confeſſing himſelf to be a Chriſtian, the crier thrice proclaimed his confeſſion, and the people ſhouted, "This is the great doctor of Aſia, and the father of the Chriſtians; this is the deſtroyer of our gods, that teaches men not to do ſacrifice, or worſhip the deities." When the fire was prepared, Polycarp requeſted not to be nailed, as uſual, but only tied to the ſtake: and after a ſhort prayer, which he pronounced with a clear and audible voice, the executioner blew up the fire, which increaſing to a mighty flame, "Behold a wonder ſeen (ſays my author), by us who were purpoſely reſerved, that we might declare it to others; the flames diſpoſing themſelves into the reſemblance of an arch, like the ſails of a ſhip ſwelled with the wind, gently encircled the body of the martyr, who ſtood all the while in the midſt, not like roaſted fleſh, but like the gold or ſilver purified in the furnace, his body ſending forth a delightful fragrancy, which, like frankincenſe or ſome other coſtly ſpices, preſented itſelf to our ſenſes. The infidels, exaſperated by the miracle, commanded a ſpearman to run him through with a ſword; which he had no ſooner done, but ſuch a vaſt quantity of blood flowed from the wound as extinguiſhed the fire; when a dove was ſeen to fly from the wound, which ſome ſuppoſe to have been his ſoul, clothed in a viſible ſhape at the time of its departure*." The Chriſtians endeavoured to carry off his body entire, but were not allowed by the irenarch, who commanded it to be burned to aſhes. The bones, however, were gathered up, and decently interred by the Chriſtians.

Thus died St. Polycarp, the 7th of the kalends of May, A. C. 167. The amphitheatre on which he ſuffered was moſtly remaining not many years ago; and his tomb, which is in a little chapel in the ſide of a mountain, on the ſouth-eaſt of the city, was ſolemnly viſited by the Greeks on his feſtival day; and for the maintenance and repairing of it, travellers were wont to throw a few aſpers into an earthen pot that ſtands there for the purpoſe. He wrote ſome homilies and epiſtles, which are now loſt, except that to the Philippians, which is a truly pious and Chriſtian piece, containing ſhort and uſeful precepts and rules of life, which St. Jerome informs us was even in his time read in the public aſſemblies of the Aſiatic churches. It is ſingularly uſeful in proving the authenticity of the books of the New Teſtament; for he has ſeveral paſſages and expreſſions from Matthew, Luke, the Acts, St. Paul's Epiſtles to the Philippians, Epheſians, Galatians, Corinthians, Romans, Theſſalonians, Coloſſians, 1ſt Timothy, 1ſt Epiſtle of St. John, and 1ſt of Peter; and makes particular mention of St. Paul's Epiſtle to the Epheſians. Indeed his whole Epiſtle conſiſts of phraſes and ſentiments taken from the New Teſtament †.

POLYCARPON, in botany: a genus of the trigynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 22d order, *Caryophyllei*. The calyx is pentaphyllous; there are five very ſmall ovate petals; the capſule is unilocular and trivalved.

POLYCHREST, in pharmacy, ſignifies a medicine that ſerves for many uſes, or that cures many diſeaſes.

Sal POLYCHREST, a compound ſalt made of equal parts of ſaltpetre and ſulphur, deflagrated in a red-hot crucible.

POLYCNEMUM, in botany: a genus of the monogynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. The calyx is triphyllous; and there are five calciform petals, with one ſeed almoſt naked.

POLYCRATES, was a tyrant of Samos, famous for the good fortune which always attended him. He became very powerful; and got poſſeſſion not only of the neighbouring iſlands, but alſo of ſome cities on the coaſt of Aſia. He had a fleet of 100 ſhips of war, and was ſo univerſally eſteemed, that Amaſis the king of Egypt made a treaty of alliance with him. The Egyptian king was, however, afraid of his continued pro-

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[*] The miraculous part of this account is ridiculed by Dr. Middleton in his Free Enquiry and Defence of it; but ſomething is offered in its favour by Mr. Jortin, who obſerves, "the circumſtances are ſufficient only to create a pauſe and a doubt." *Remarks on Eccl. Hiſt.* vol. i.

[†] Jortin, vol. i. p. 68. who to the particulars made out by Cotelerius, had added one from Galat. iv. 26. and another from Hebr. iv. 12, 13.

ſperity, and adviſed him to chequer his enjoyments, by relinquiſhing ſome of his moſt favorite objects. Polycrates, in compliance, threw into the ſea a beautiful ſeal, the moſt valuable of his jewels. The loſs of ſo precious a ſeal afflicted him for ſome time: but ſoon after he received as a preſent a large fiſh, in whoſe belly it was found. Amaſis no ſooner heard this, than he gave up all alliance with the tyrant of Samos, and obſerved, that ſooner or later his good fortune would vaniſh. Some time after Polycrates viſited Magneſia on the Mæander, where he had been invited by Orontes the governor. Here he was ſhamefully put to death, merely becauſe the governor wiſhed to terminate his proſperity. The daughter of Polycrates had diſſuaded her father from going to the houſe of Orontes, on account of the bad dreams which ſhe had, but in vain.

POLYCROTA, in the naval architecture of the ancients, is a word uſed to expreſs ſuch of their galleys as had three, four, five, or more tiers of rowers, ſeated at different heights; they were diſtinguiſhed by this term from the *monocrota*, or thoſe which had only ſingle rows of oars. The number of rows of rowers in the polycrote galleys has given occaſion to ſome to ſuppoſe thoſe veſſels of ſuch a height from the water as is ſcarce credible. Commentators are not at all agreed upon the conſtruction of theſe veſſels.

POLYDAMAS, was a famous athlete, who imitated Hercules in whatever he did. He killed a lion with his fiſt, and it is reported he could ſtop a chariot with his hand in its moſt rapid courſe. He was one day with ſome of his friends in a cave, when on a ſudden a large piece of rock came tumbling down, and while all fled away he attempted to receive the falling fragment in his arms. His prodigious ſtrength, however, was inſufficient, and he was inſtantly cruſhed to pieces under the rock.

POLYDECTES, a ſon of Magnes, was king of the iſland of Seriphos. He received with great kindneſs Danaë and her ſon Perſeus, who had been expoſed on the ſea by Acriſius. He took great care of the education of Perſeus; but becoming enamoured of Danaë, he removed her from his kingdom, apprehenſive of his reſentment. He afterwards paid his addreſſes to Danaë; and being rejected, he prepared to offer her violence. Danaë fled to the altar of Minerva for protection; and Dictys, the brother of Polydectes, who had himſelf ſaved her from the ſea waters, oppoſed her raviſher, and armed himſelf in her defence. At this critical moment Perſeus arrived; and with Meduſa's head he turned into ſtones Polydectes, with the aſſociates of his guilt. The crown of Seriphos was given to Dictys, who had ſhown himſelf ſo active in the cauſe of innocence.

POLYDORE VIRGIL. See VIRGIL.

POLYDORUS, a ſon of Priam by Hecuba, or, according to others, by Laothoë, the daughter of Altes, king of Pedaſus. Being young and inexperienced when Troy was beſieged by the Greeks, his father removed him to the court of Polymneſtor, king of Thrace, to whoſe care he entruſted the greateſt part of his treaſures till his country ſhould be freed from foreign invaſion. On the death of Priam, Polymneſtor made himſelf maſter of the riches which were in his poſſeſſion; and to inſure them the better, he murdered the young prince, and threw his body into the ſea, where it was found by Hecuba. According to Virgil, his body was buried near the ſhore by his aſſaſſin; and there grew on his grave a myrtle, whoſe boughs dropped blood, when Æneas going to Italy attempted to tear them from the tree.

POLYGALA, MILKWORT: A genus of the octandria order, belonging to the diadelphia claſs of plants; and in the natural method ranking under the 33d order, *Lomentaceæ*. The calyx is pentaphyllous, with two of its leaflets wing-ſhaped and coloured; the legumen is obcordate and bilocular. There are 24 ſpecies; of which the moſt remarkable are,

1. The *vulgaris*, or common milkwort, is a native of the Britiſh heaths and dry paſtures. The ſtalks are about five or ſix inches long, ſeveral ariſing from the ſame root: the leaves are firm, ſmooth, entire, and grow alternate upon the ſtalks, which are terminated with ſpikes of flowers, moſt commonly blue, but often red or white: the calyx conſiſts of five leaves, three of which are ſmall and green, two below and one above the corolla; the other two intermediate ones are large, oval, flat, coloured, veined, and reſemble petals, which at length turn greeniſh, and remain a defence to the ſeed-veſſel; the corolla conſiſts of three petals folded together, and forming a tube: the carina is terminated by a kind of heart-ſhaped concave appendage, fringed at the extremity. The root of this plant has a bitter taſte, and has been found to poſſeſs the virtues of the American rattleſnake-root. It purges without danger, and is alſo emetic and diuretic: ſometimes operating all the three ways at once. A ſpoonful of the decoction made by boiling an ounce of the herb in a pint of water till one half has exhaled, has been found ſerviceable in pleuriſies and fevers, by promoting a diaphoreſis and expectoration; and three ſpoonfuls of the ſame, taken once an hour, has proved beneficial in the dropſy and anaſarca. It has alſo been found ſerviceable in conſumptive complaints.

2. The *ſenega*, or ſeneka, rattleſnake-wort, grows naturally in moſt parts of North America. This hath a perennial root compoſed of ſeveral fleſhy fibres, from which ariſe three or four branching ſtalks which grow erect, garniſhed with ſpear-ſhaped leaves placed alternately. The flowers are produced in looſe ſpikes at the end of the branches: they are ſmall, white, and ſhaped like thoſe of the common ſort. It flowers here in July, but the plants do not produce ſeeds. The root of this ſpecies operates more powerfully than the laſt; but beſides the virtues of a purgative, emetic, and diuretic, it has been recommended as an antidote againſt the poiſon of a rattleſnake; but this opinion is now exploded. It ſtill, however, maintains its character in ſeveral diſorders. Its efficacy, particularly in pleuriſies, is moſt fully eſtabliſhed in Virginia: formerly near 50 out of 100 died of that diſtemper, but by the happy uſe of this root hardly three out of the ſame number have been loſt.

As the ſeeds of the rattleſnake-wort ſeldom ſucceed even in the countries where the plant is a native, the beſt method of propagating it is to procure the roots from America, and plant them in a bed of light earth in a ſheltered ſituation, where they will thrive without any other culture than keeping them free from weeds. But though the plant will ſtand out ordinary winters, it will be proper to cover it during that ſeaſon with old tanner's bark, or other mulch, to keep out the froſt.

POLYGAMIA (ϖολυς *many*, and γαμος *marriage*). This term, expreſſing an intercommunication of ſexes, is applied, by Linnæus, both to plants and flowers. A polygamous plant is that which bears both hermaphrodite flowers and male or female, or both.

POLYGAMY, a plurality of wives or huſbands, in the poſſeſſion of one man or woman at the ſame time. Polygamy is ſo univerſally eſteemed unlawful, and even unnatural, through Europe, and in all Chriſtian countries, that we have generally reaſoned upon this conviction. Both religion and reaſon appear at firſt ſight at leaſt to condemn it; and with this view of the ſubject mankind in general reſt ſatisfied: but ſome bolder geniuses have taken the oppoſite ſide of the queſtion; have caſt off the prejudices of education, and attempted to ſhow that polygamy is not unlawful, but that it is juſt and neceſſary, and would be a public benefit. Such writers, to uſe the words of an intelligent critic, "recur to the common ſubterfuge, of which every *ſetter up of ſtrange gods*, and every CONSCIENTIOUS troubler of the public peace, have artfully availed themſelves to ſilence the clamour of expoſtulation. 'TRUTH! TRUTH!' is their general cry: and with this hopeful pretence, prudence and humility, and every amiable and uſeful virtue, are left behind; while CONSCIENCE *(conſcience!)* blindly ruſhes forward to oppoſe order, inſult authority, and overturn the cuſtoms of ages."

But, notwithſtanding theſe fair pretences, it will, we doubt not, be eaſy to ſhow that truth is not upon their ſide; prudence and delicacy are certainly at open war with them: for Dr. Percival, Phil. Tranſ. vol. lxvi. part i. p. 163. has very juſtly obſerved, that the practice is brutal, deſtructive to friendſhip and moral ſentiment, inconſiſtent with one great end of marriage, the education of children, and ſubverſive of the natural rights of more than half of the ſpecies. Beſides, it is injurious to population, and therefore can never be countenanced or allowed in a well-regulated ſtate; for, though the number of females in the world may conſiderably exceed the number of males, yet there are more men capable of propagating their ſpecies than women capable of bearing children; and it is a well known fact, that Armenia, in which a plurality of wives is not allowed, abounds more with inhabitants than any other province of the Turkiſh empire.

Indeed it appears that in ſome countries where it is allowed the inhabitants do not take advantage of it. "The Europeans (ſays M. Niebuhr) are miſtaken in thinking the ſtate of marriage ſo different among the Muſſulmans from what it is with Chriſtian nations. I could not diſcern any ſuch difference in Arabia. The women of that country ſeem to be as free and as happy as thoſe of Europe can poſſibly be. Polygamy is permitted, indeed, among Mahometans, and the delicacy of our ladies is ſhocked at this idea; but the Arabians rarely avail themſelves of the privilege of marrying four lawful wives, and entertaining at the ſame time any number of female ſlaves. None but rich voluptuaries marry ſo many wives, and their conduct is blamed by all ſober men. Men of ſenſe, indeed, think this privilege rather troubleſome than convenient. A huſband is by law obliged to treat his wives ſuitably to their condition, and to diſpenſe his favours among them with perfect equality: but theſe are duties not a little diſagreeable to moſt Muſſulmans; and ſuch modes of luxury are too expenſive to the Arabians, who are ſeldom in eaſy circumſtances. I muſt, however, except one caſe; for it ſometimes happens that a man marries a number of wives in the way of commercial ſpeculation. I know a Mullah, in a town near the Euphrates, who had married four wives, and was ſupported by the profits of their labour."

See a curious kind of polygamy under the article NAYRES. The ancient Britons, too, had a kind of polygamy among them, 12 women being common to 12 men.

Selden has proved, in his *Uxor Hebraica*, that plurality of wives was allowed of, not only among the Hebrews, but alſo among all other nations, and in all ages. It is true, the ancient Romans were more ſevere in their morals, and never practiſed it, though it was not forbidden among them: and Mark Antony is mentioned as the firſt who took the liberty of having two wives.

From that time it became pretty frequent in the empire till the reigns of Theodoſius, Honorius, and Arcadius, who firſt prohibited it by expreſs law in 393. After this the emperor Valentinian, by an edict, permitted all the ſubjects of the empire, if they pleaſed, to marry ſeveral wives; nor does it appear, from the eccleſiaſtical hiſtory of thoſe times, that the biſhops made any oppoſition to this introduction of polygamy. In effect, there are ſome even among the Chriſtian caſuiſts who do not look on polygamy as in itſelf criminal. Jurieu obſerves, that the prohibition of polygamy is a poſitive law; but from which a man may be exempted by ſovereign neceſſity. Baillet adds, that the example of the patriarchs is a very powerful argument in favour of polygamy: of theſe arguments we ſhall ſpeak hereafter.

It has been much diſputed among the doctors of the civil law whether polygamy be adultery. In the Roman law it is called *ſtuprum*, and puniſhed as ſuch, that is, in ſome caſes, capitally. But a ſmaller puniſhment is more conſiſtent with the Jewiſh law, wherein the prohibition of adultery is perpetual, but that of polygamy temporary only.

In Germany, Holland, and Spain, this offence is differently puniſhed. By a conſtitution of Charles V. it was a capital crime. By the laws of ancient and modern Sweden it is puniſhed with death. In Scotland it is puniſhed as perjury.

In England it is enacted by ſtatute 1 Jac. I. cap. 11. that if any perſon, being married, do afterwards marry again, the former huſband or wife being alive, it is felony, but within the benefit of clergy. The firſt wife in this caſe ſhall not be admitted as an evidence againſt her huſband, becauſe ſhe is the true wife; but the ſecond may, for ſhe is indeed no wife at all; and ſo *vice verſa* of a ſecond huſband. This act makes an exception to five caſes, in which ſuch ſecond marriage, though in the three firſt it is void, is, however, no felony. 1. Where either party hath been continually abroad for ſeven years, whether the party in England had notice of the other's being living or not. 2. Where either of the parties hath been abſent from the other ſeven years within this kingdom, and the remaining party hath had no notice of the other's being alive within that time. 3. Where there is a divorce or ſeparation *a menſa et thoro* by ſentence in the eccleſiaſtical court. 4. Where the firſt marriage is declared abſolutely void by any ſuch ſentence, and the parties looſed *a vinculo*. Or, 5. Where either of the parties was under the age of conſent at the time of the firſt marriage; for in ſuch caſe the firſt marriage was voidable by the diſagreement of either party, which this ſecond marriage very clearly amounts to. But if at the age of conſent the parties had agreed to the marriage, which completes the contract, and is indeed the real marriage, and afterwards one of them ſhould marry again, judge Blackſtone apprehends that ſuch ſecond marriage would be within the reaſon and penalties of the act.

Bernardus Ochinus, general of the order of Capuchins, and and afterwards a Proteſtant, publiſhed, about the middle of the 16th century, Dialogues in favour of Polygamy, which were anſwered by Theodore Beza. And about the concluſion of the laſt century we had at London an artful treatiſe publiſhed in behalf of a plurality of wives, under the title of *Polygamia Triumphatrix*: the author whereof aſſumes the name of *Theophilus Aletheus*; but his true name was *Lyſerus*. He was a native of Saxony. It has been anſwered by ſeveral.

A new argument in favour of polygamy has been adduced by Mr. Bruce, on this principle, that in ſome parts of the world the proportion of female children is much greater than that of the males. "From a diligent inquiry (ſays he) into the ſouth and ſcripture-part of Meſopotamia, Armenia, and Syria, from Mouſul or Nineveh to Aleppo and Antioch, I find the proportion to be fully two women to one man. There is indeed a fraction over, but it is not a conſiderable one. From Latikea, Laodicea *ad mare*, down the coaſt of Syria to Sidon, the number is nearly three, or two and three-fourths, to one man. Through the Holy Land, the country called *Horan*, in the Iſthmus of Suez, and the parts of the Delta unfrequented by ſtrangers, it is ſomething leſs than three. But from Suez to the Straits of Babelmandel, which contains the three Arabias, the proportion is fully four women to one man; which I have reaſon to believe holds as far as the line, and 30° beyond it. The Imam of Sana was not an old man when I was in Arabia Felix in 1769; but he had 88 children then alive, of whom 14 only were ſons. The prieſt of the Nile had 70 and odd children; of whom, as I remember, above 50 were daughters.

"It may be objected, that Dr. Arbuthnot, in quoting the bills of mortality for 20 years, gave the moſt unexceptionable grounds for his opinion: and that my ſingle aſſertion of what happens in a foreign country, without further foundation, cannot be admitted as equivalent teſtimony: and I am ready to admit this objection, as there are no bills of mortality in any of theſe countries. I ſhall therefore ſay in what manner I attained the knowledge which I have juſt mentioned. Whenever I went into a town, village, or inhabited place, dwelt long in a mountain, or travelled journeys with any ſet of people, I always made it my buſineſs to inquire how many children they had, or their fathers, their next neighbours or acquaintance. I then aſked my landlord at Sidon, ſuppoſe him a weaver, how many children he had? He tells me how many ſons and how many daughters. The next I aſk is a tailor, a ſmith, &c. in ſhort, every man who is not a ſtranger, from whom I can get the proper information. I ſay, therefore, that a medium of both ſexes ariſing from three or four hundred families, indiſcriminately taken, ſhall be the proportion in which one differs from the other; and this, I am confident, will give the reſult to be three women in 50° of the 90° under every meridian of the globe."

Our author corroborates this argument by ſuppoſing that Mahomet perceived this diſproportion, and that upon it he founded his inſtitution allowing one man to have four wives. "With this view he enacted, or rather revived, the law which gave liberty to every individual to marry four wives, each of whom was to be equal in rank and honour, without any preference but what the predilection of the huſband gave her."

Having thus eſtabliſhed, as he ſuppoſes, the neceſſity of polygamy in the Eaſt, Mr. Bruce proceeds to conſider whether there be not ſome other reaſons why it ſhould not be practiſed in Britain further than the mere equality in numbers of the ſexes to one another. This reaſon he finds in the difference between the conſtitutions of the Europeans and Eaſtern nations. "Women in England (ſays he) are capable of child-bearing at 14; let the other term be 48, when they bear no more; 34 years therefore an Engliſh woman bears children. At the age of 14 or 15 they are objects of our love; they are endeared by bearing us children after that time; and none, I hope, will pretend, that at 48 and 50 an Engliſhwoman is not an agreeable companion. The Arab, on the other hand, if ſhe begin to bear children at 11, ſeldom or never has a child after 20. The time, then, of her child-bearing is nine years; and four women, taken altogether, have then the term of 36. So that the Engliſh woman who bears children for 34 years has only two years leſs than the term enjoyed by the four wives whom Mahomet has allowed; and if it be granted that an Engliſh wife may bear at 50, the terms are equal. But there are other grievous differences. An Arabian girl, at 11 years old, by her youth and beauty, is the object of man's deſire: being an infant, however, in underſtanding, ſhe is not a rational companion for him. A man marries there, ſay at 20; and before he is 30, his wife, improved as a companion, ceaſes to be an object of his deſires and a mother of children: ſo that all the beſt and moſt vigorous of his days are ſpent with a woman he cannot love; and with her he would be deſtined to live 40, or 45 years, without comfort to himſelf by increaſe of family, or utility to the public. The reaſons, then, againſt polygamy, which ſubſiſt in England, do not by any means ſubſiſt in Arabia; and that being the caſe, it would be unworthy of the wiſdom of God, and an unevenneſs in his ways, which we ſhall never ſee, to ſubject two nations under ſuch different circumſtances abſolutely to the ſame obſervances."

To all this argumentation, however, it may be replied, that whatever we may now ſuppoſe to be the conſtitution of nature in the warmer parts of the globe, it was certainly different at the beginning. We cannot indeed aſcertain the exact poſition of the Garden of Eden; but it is with reaſon ſuppoſed not to have been far from the ancient ſeat of Babylon. In that country, therefore, where Mr. Bruce contends that *four* women are neceſſary to the comfort of one man, it pleaſed God to grant only *one* to the firſt man; and that, too, when there was more occaſion for population than ever there has been ſince, becauſe the whole earth was be peopled from a ſingle pair. Matters were not altered at the flood; for Noah had but one wife. And this is the very argument uſed by our Saviour himſelf when ſpeaking of divorce without any ſufficient cauſe, and then marrying another woman, which is a ſpecies of polygamy.— Again, with reſpect to the alleged multiplicity of females in the eaſtern part of the world, it is by no means probable that the calculations of Mr. Bruce or any other perſon can be admitted in this caſe. Hiſtory mentions no ſuch thing in any nation; and, conſidering the vaſt deſtruction among the male part of the human ſpecies more than of the females by war and other accidents, we may ſafely ſay that if *four* women-children were born for every ſingle male, there would in ſuch countries be five or ſix grown up women for every man; a proportion which we may venture to affirm does not, nor ever did, exiſt anywhere in the world. That it was not ſo in former times we can only judge from the particular examples recorded in hiſtory, and theſe are but few. We read in the Greek hiſtory, indeed, of the *fifty* daughters of Danaus; but theſe were matched by as many *ſons* of another man. Job had only one wife, yet had *ſeven* ſons and but *three* daughters. Jacob had two wives, who bore *twelve* ſons, and only one daughter. Abraham had only one child by his firſt wife, and that was a ſon. By his ſecond wife Keturah he had ſix ſons; and conſidering his advanced age at the time he married her, it is by no means probable that he could have 24 daughters; nay, if, as Mr. Bruce tells us, the women in the eaſtern countries bear children only for nine years, it was impoſſible ſhe could have ſo many. Gideon, who had many wives, had no fewer than ſeventy ſons by theſe wives, and even his concubine had a ſon; ſo that if all theſe women had produced according to Mr. Bruce's proportion, of nearly three females to one male, he muſt have had almoſt 284 children; a better family than any of Mr. Bruce's eaſtern acquaintances can probably boaſt of.

With regard to this ſubject, however, it muſt be obſerved, that the procreation of male or female children depends in ſome degree on the health and vigour of the parents. It is by no means improbable, therefore, that the eaſtern voluptuaries, whoſe conſtitutions are debilitated by their exceſſes, may have many more female than male children born to them. The women themſelves, by premature enjoyment, will alſo be inclined to produce females inſtead of males; but neither of theſe circumſtances can prove this to be an original law of nature. Something like this may be gathered from ſacred hiſtory. Gideon above-mentioned, who was a hardy and active warrior, had many ſons. The ſame was the caſe with David, who led an active and laborious life; while Solomon, who was a voluptuary, had only one ſon, notwithſtanding his multitude of wives.

The moſt barefaced defence of polygamy that has appeared in modern times is by the Rev. Mr. Madan, who publiſhed a treatiſe, artfully vindicating, and ſtrongly recommending it, under the title of *Thelyphthora*; or, *A Treatiſe on Female Ruin, in its Cauſes, Effects, Conſequences, Prevention, and Remedy*, &c. Marriage, according to this writer, ſimply and wholly conſiſts in the act of perſonal union, or *actus coitus*. Adultery, he ſays, is never uſed in the ſacred writings but to denote the defilement of a betrothed or married woman, and to this ſenſe he reſtricts the uſe of the term; ſo that a married man, in his opinion, is no adulterer, if his commerce with the ſex be confined to ſingle women, who are under no obligations by eſpouſals or marriage to other men: but, on the other hand, the woman who ſhould dare to have even but once an intrigue with any other man beſides her huſband (let him have as many wives as Solomon), would, *ipſo facto*, be an adultreſs, and ought, together with her gallant, to be puniſhed with immediate death. This, he boldly ſays, is the law of God: and on this foundation he limits the privilege of polygamy to the man; in ſupport of which he refers to the polygamous connections of the patriarchs and ſaints of the Old Teſtament, and infers the lawfulneſs of their practice from the bleſſings which attended it, and the laws which were inſtituted to regulate and ſuperintend it. He contends for the lawfulneſs of Chriſtians having, like the ancient Jews, more wives than one; and labours much to reconcile the genius of the evangelical diſpenſation to an arrangement of this ſort. With this view he aſſerts, that there is not one text in the New Teſtament that even hints at the criminality of a polygamous connection; and he would infer from St. Paul's direction that biſhops and deacons ſhould have but one wife, that it was lawful for laymen to have more. Chriſt, he ſays, was not the giver of a new law; but the buſineſs of marriage, polygamy, &c. had been ſettled before his appearance in the world, by an authority which could not be revoked. Beſides, this writer not only thinks polygamy lawful in a religious, but advantageous in a civil light, and highly politic in a domeſtic view.

In defence of his notion of marriage, which, he ſays, conſiſts in the union of man and woman as one body, the effects of which in the ſight of God no outward forms or ceremonies of man's invention can add to or detract from, he grounds his principal argument on the Hebrew words made uſe of in Gen. ii. 24. to expreſs the primitive inſtitution of marriage, viz. דבק באשתו, rendered by the LXX. *ϖροσκολληθησεται ϖρος την γυναικα αυτȣ*, which tranſlation is adopted by the evangeliſt (Mat. xix. 5.) with the omiſſion only of the ſuperfluous prepoſition (*ϖρος*) after the verb. Our tranſlation, "ſhall cleave to his wife," doth not, he ſays, convey the idea of the Hebrew, which is literally, as Montanus renders the words, "ſhall be joined or cemented *in* his woman, and they ſhall become (*i. e.* by this union) one fleſh." But on this criticiſm it is well remarked, that both the Hebrew and Greek terms mean ſimply and literally attachment or adherence; and are evidently made uſe of in the ſacred writings to expreſs the whole ſcope of conjugal fidelity and duty, though he would reſtrain them to the groſſer part of it.

With reſpect to the Moſaic law, for which Mr. Madan is a warm advocate, it was certainly a local and temporary inſtitution, adapted to the ends for which it was appointed, and admirably calculated, in its relation to marriage, to maintain and perpetuate the ſeparation of the Jewiſh people from the Gentiles. In attempting to depreciate the outward forms of marriage, this writer would make his readers believe that becauſe none are explicitly deſcribed, therefore none exiſted; and conſequently that they are the ſuperfluous ordinances of human policy. But it is evident, from comparing Ruth iv. 10. 13. with Tobit vii. 13. 14. and from the caſe of Dinah, related Gen. xxxiv. that ſome forms were deemed eſſential to an honourable alliance by the patriarchs and ſaints under the Old Teſtament, excluſive of the carnal knowledge of each other's perſons. It is alſo evident in the caſe of the woman of Samaria, whoſe connection with a man not her huſband is mentioned in John iv. that ſomething beſides cohabitation is neceſſary to conſtitute marriage in the ſight of God.

Having ſtated his notion of marriage, he urges in defence of polygamy, that, notwithſtanding the ſeventh commandment, it was allowed by God himſelf, who made laws for the regulation of it, wrought miracles in ſupport of it by making the barren woman fruitful, and declared the iſſue legitimate to all intents and purpoſes. God's allowance of polygamy is argued from Exod. xxi. 10. and particularly from Deut. xxi. 15. which he ſays amounts to a demonſtration. This paſſage, however, at the utmoſt, only preſuppoſes that the practice might have exiſtence among ſo hard-hearted and fickle a people as the Jews; and therefore wiſely provides againſt ſome of its more unjuſt and pernicious conſequences, ſuch as tended to affect the rights and privileges of heirſhip. Laws enacted to regulate it cannot be fairly urged in proof of its lawfulneſs on the author's own hypotheſis; becauſe laws were alſo made to regulate divorce, which Mr. Madan condemns as abſolutely unlawful, except in caſes of adultery. Beſides, it is more probable that the "hated wife" had been diſmiſſed by a bill of divorcement, than that ſhe was retained by her huſband: and moreover, it is not certain but that the two wives, ſo far from living with the ſame huſband at the ſame time, might be dead; for the words may be rendered thus, "if there *ſhould have been* to a man two wives, &c." The words expreſſing the original inſtitution of marriage, Gen. ii. 24. compared with Mat. xix. 4, 5, 8. afford inſuperable objections againſt Mr. Madan's doctrine of polygamy.

If we appeal on this ſubject from the authority of Scripture to the writings of the earlieſt fathers in the Chriſtian church, there is not to be found the fainteſt trace of any thing reſembling a teſtimony to the lawfulneſs of polygamy; on the contrary, many paſſages occur, in which the practice of it is ſtrongly and explicitly condemned.

We ſhall cloſe this article with the words of an excellent anonymous writer already quoted, and to whoſe critique on Mr. Madan's work, we are indebted for the above remarks: "In a word, when we reflect that the primitive inſtitution of marriage limited it to one man and one woman; that this inſtitution was adhered to by Noah and his ſons, amidſt the degeneracy of the age in which they lived, and in ſpite of the examples of polygamy which the accurſed race of Cain had introduced; when we conſider how very few (comparatively ſpeaking) the examples of this practice were among the faithful; how much it brought its own puniſhment with it; and how dubious and equivocal thoſe paſſages are in which it appears to have the ſanction of divine approbation; when to theſe reflections we add another, reſpecting the limited views and temporary nature of the more ancient diſpenſations and inſtitutions of religion—how often the imperfections and even vices of the patriarchs and people of God in old time are recorded, without any expreſs notification of their criminality—how much is ſaid to be commanded, which our reverence for the holineſs of God and his law will only ſuffer us to ſuppoſe were, for wiſe ends, permitted—how frequently the meſſengers of God adapted themſelves to the genius of the people to whom they were ſent, and the circumſtances of the times in which they lived:—above all, when we conſider the purity, equity, and benevolence of the Chriſtian law; the explicit declarations of our Lord, and his apoſtle St. Paul, reſpecting the inſtitution of marriage, its deſign and limitation;—when we reflect, too, on the teſtimony of the moſt ancient fathers, who could not poſſibly be ignorant of the general and common practice of the apoſtolic church; and, finally, when to theſe conſiderations we add thoſe which are founded on juſtice to the female ſex, and all the regulations of domeſtic economy and national policy—we muſt wholly condemn the revival of polygamy; and thus bear our honeſt teſtimony againſt the leading deſign of this dangerous and ill-adviſed publication."

We would adviſe our readers to read the whole criticiſms on Madan's book in the Monthly Review, together with their account of the ſeveral anſwers to it. The reverend author of the Thelyphthora has here met with a moſt able antagoniſt, who traces him through all his deceitful windings, and expoſes the futility and falſehood of his arguments with ſingular ability See *Monthly Review*, vol. lxiii. p. 273, &c.; ſee alſo *Paley's Moral Philoſophy*, 4to. p. 262.

POLYGARS, are natives of Hindoſtan. They inhabit almoſt impenetrable woods, and are under the abſolute direction of their own chieftains. In time of peace they are profeſſionally robbers, but in times of war are the guardians of the country. The general name of theſe people is *Polygar*. Their original inſtitution, for they live in diſtinct clans, is not very well underſtood. It probably took its riſe from the municipal regulations relative to the deſtruction of tygers and other ferocious beaſts. Certain tracts of woodland were indiſputably allotted as rewards to thoſe who ſhould ſlay a certain number of thoſe animals; and thoſe lands approximating, probably laid the foundation of the ſeveral confederacies of Polygars.

“ The Pollams, or woods, from which is derived the word *Polygar*, lying in profuſion through all the ſouthern parts of Hindoſtan, the ravages committed in the open countries by theſe adventurous clans, are both frequent and deſtructive. Cattle and grain are the conſtant booty of the Polygars. They not unfrequently even deſpoil travellers of their property, and ſometimes murder, if they meet with oppoſition: yet theſe very Polygars are the hands into which the aged and infirm, the wives, children, and treaſure, of both Hindoos and others are entruſted, when the circumjacent country unfortunately happens to be the ſeat of war. The protection they afford is paid for; but the price is inconſiderable, when the helpleſs ſituation of thoſe who fly to them for ſhelter is conſidered, and eſpecially when their own very peculiar character is properly attended to. The native governments of Hindoſtan are under the neceſſity of tolerating this honourable banditti. Many of them are ſo formidable as to be able to bring 15,000 and 20,000 men into the field.

“ The Hindoo code of laws, in ſpeaking of robberies, hath this remarkable clauſe—‘ The mode of ſhares amongſt robbers ſhall be this:—If any thief or thieves, by the command of the magiſtrate, and with his aſſiſtance, have committed depredations upon, and brought away any booty from another province, the magiſtrate ſhall receive a ſhare of one-ſixth part of the whole. If they received no command or aſſiſtance from the magiſtrate, they ſhall give the magiſtrate in that caſe one-tenth part for his ſhare, and of the remainder their chief ſhall receive four ſhares; and whoſoever among them is perfect maſter of his occupation, ſhall receive three ſhares: alſo, whichever of them is remarkably ſtrong and ſtout, ſhall receive two ſhares, and the reſt ſhall receive each one ſhare.’ Here, then, we ſee not only a ſanction, but even an inducement, to fraudulent practices.—Another ſingular inconſiſtency among a people who, in many periods of their hiſtory, have been proverbial for innocency of manners, and for uncommon honeſty in their conduct towards travellers and ſtrangers.

“ At the firſt ſight, it would appear that the toleration of the Polygars, owing to their great numbers, and to the ſecurity of their fortreſſes, which are in general impenetrable but to Polygars, that the government licence, in this manner given to them, to live on the ſpoils of the induſtrious, might have originally occaſioned the formal diviſion, and encouragement to perſeverance, which we have juſt quoted: but the cauſe I ſhould rather ſuppoſe to lie in the nature of certain governments, than to have ariſen from any accidental circumſtance afterwards; and I am the more inclined to this opinion from the ſituation of the northern parts of Hindoſtan, which are, and always have been, uninfected by theſe freebooters.

“ The dominion of the Eaſt was, in former days, moſt probably divided and ſubdivided into all the various branches of the feodal ſyſtem. The veſtiges of it remain to this hour: rajahs and zemindars are nothing more than chieftains of a certain degree of conſequence in the empire. If, then, experience has ſhown, in other parts of the world, that clans have always been obſerved to commit the moſt pernicious acts of depredation and hoſtility on each other, and that the paramount lord has ſeldom been able effectually to cruſh ſo general and ſo complicated a ſcene of miſchief—may we not reaſonably venture to ſuppoſe, that the Hindoo legiſlature paſſed this ordinance for the ſuppreſſion of ſuch provincial warfare, and for the wholeſome purpoſe of drawing the people, by unalarming degrees, more immediately under the controul of the one ſovereign authority? The concluſion, I own, appears to me ſatisfactory. Moreover, Polygars cannot but be of modern growth; for the law relative to thefts is antecedent to the mention of Polygars in hiſtory.” Sullivan's *Philoſophical Rhapſodies*.

POLYGLOT, among divines and critics, chiefly denotes a Bible printed in ſeveral languages. See BIBLE, and PRINTING.

POLYGLOTTUS, in ornithology. See TURDUS.

POLYGNOTUS, a famous painter of Thaſos, flouriſhed about 422 years before the Chriſtian æra, and was the ſon and ſcholar of Aglaophon. He adorned one of the public porticoes of Athens with his paintings, in which he had repreſented the moſt ſtriking events of the Trojan war. The Athenians were ſo pleaſed with him that they offered to reward his labours with whatever he pleaſed to accept; but he declined the offer; and the Amphictyonic council, which was compoſed of the repreſentatives of the principals of the principal cities of Greece, ordered that Polygnotus ſhould be maintained at the public expenſe wherever he went.

Of the talents of Polygnotus much honourable mention is made by many of the beſt authors of antiquity, as Ariſtotle and Plutarch, Dionyſius Halicarnaſſenſis, &c. Pauſanias ſpeaks of his pictures of the events of the Trojan war, and, in his Tenth Book, introduces a very long deſcription of other pictures by the ſame artiſt, painted alſo from Homer in the temple at Delphos. The paſſage, however, gives but a confuſed and imperfect idea of the painter's performance. How much the art is indebted to this ancient maſter, what grace and ſoftneſs he gave to the human countenance, what embelliſhments he added to the female figure and dreſs, are much more happily deſcribed by Pliny. “ Primus mulieres lucida veſte pinxit, capita earum mitris verſicoloribus operuit, plurimumque picturæ primus contulit: ſiquidem inſtituit os adaperire, dentes oſtendere, vultum ab antiquo rigore variare.”—The ſame author likewiſe bears honourable teſtimony to the liberal ſpirit of this great artiſt, who refuſed any reward for his ingenious labours in the portico.——“ Porticum gratuito, cum partem ejus Mycon mercede pingeret.” Plin. *lib.* 35. *cap.* 8.

POLYGON, in geometry, a figure with many ſides, or whoſe perimeter conſiſts of more than four ſides at leaſt; ſuch are the pentagon, hexagon, heptagon, &c.

POLYGONUM, KNOT-GRASS: A genus of the trigynia order, belonging to the octandria claſs of plants; and in the natural method ranking under the 12th order, *Holoraceæ*. There is no calyx; the corolla is quinquepartite, and calycine, or ſerving inſtead of a calyx; there is one angulated ſeed. There are 27 ſpecies; but the moſt remarkable are, 1. The *biſtorta*, biſtort, or greater ſnakeweed, hath a thick oblique intorted root, blackiſh without, and red within; a ſimple, round, ſlender ſtem, near two feet high; oval leaves, having decurrent foot-ſtalks, and the ſtalk terminated by thick ſhort ſpikes of whitiſh-red flowers. 2. *The viviparum*, or ſmaller biſtort, hath a thickiſh root, a ſimple ſlender ſtem half a foot high, ſpear-ſhaped leaves, and the ſtalks and branches terminated by long ſpikes of whitiſh-red flowers. Both theſe perennials flower in May and June, ſucceeded by ripe ſeeds in Auguſt. They grow wild in England, &c. the firſt in moiſt, the other in mountainous, ſituations. 3. *Oriental* polygonum, commonly called *perſicaria*, hath fibrous roots; an upright, robuſt, ſtrong, jointed ſtem, riſing eight or ten feet high, dividing at top into ſeveral branches; very large oval-lanceolate alternate leaves, on broad foot-ſtalks half ſurrounding the ſtem ; and all the branches terminated by long, ſlender, hanging ſpikes of reddiſh-purple heptandrous and digynious flowers, from July till October. 4. *Fagopyrum*, buck-wheat, or brank, riſes with an upright, ſmooth, branchy ſtem from about a foot and a half to a yard high, heart-ſhaped ſagittated leaves, and the branches terminated by cluſters of whitiſh flowers, ſucceeded by large angular ſeeds; excellent for feeding pigeons and moſt ſorts of poultry.

All theſe plants are hardy, and ſucceed in almoſt any ſoil and ſituation : the two firſt are perennial in root; and the third and fourth are annual, wholly decay at the end of ſummer, or early in winter. The firſt two ſorts are retained in ſome curious gardens for variety ; but their chief merit is for medical purpoſes; they are powerful aſtringents, and are uſed both internally and externally ; eſteemed very efficacious in hæmorrhagies and other fluxes, and good to heal ſore mouths. The third ſort, Oriental polygonum, or perſicaria, is a moſt elegant annual for the embelliſhment of pleaſure-ground; aſſuming a majeſtic tree-like growth by its erect luxuriant ſtem, and branchy head ; which being garniſhed with noble large foliage, and numerous pendulous ſpikes of flowers, in conſtant ſucceſſion three or four months, exhibits a very ornamental appearance from June or July until October, and is ſo eaſy of culture, that from its ſcattered ſeeds in autumn, young plants riſe ſpontaneouſly in abundance the enſuing ſpring, and ſhoot up ſo rapidly as to attain ſix or eight feet in height by July, when they generally begin flowering, and continue till attacked by the froſt, when they totally periſh ; ſo that a freſh ſupply muſt be raiſed from ſeed annually. The fourth ſort (buck-wheat) is a ſort of corn, and is frequently cultivated both by way of fodder, cutting its ſtalks while young and green to feed cattle, and for its grain to feed pigeons, poultry, hogs, &c. It flouriſhes in any ſoil and ſituation, but generally thrives beſt in a light dry earth ; and the drieſt ſeaſons ſeldom retard its growth. The firſt and ſecond ſorts are eaſily propagated in plenty, by parting the roots in autumn. The third ſort, Oriental polygonum, being annual, is always propagated from ſeed annually, either in the full ground, or by means of hot-beds.

The root of a kind of biſtort, according to Gmelin, is uſed in Siberia for ordinary food. This ſpecies is by Haller called *biſtorta foliis ad oram nervoſis*, and by ſome other botaniſts *biſtorta montana minor*. The natives call it *mouka :* and ſo indolent are they, that, to ſave themſelves the trouble of digging it out of the earth, they go in ſpring and pillage the holes of the mountain rats, which they find filled with theſe roots. In our country, biſtort is uſed as a medicine. All the parts of biſtort have a rough auſtere taſte, particularly the root, which is one of the ſtrongeſt of the vegetable aſtringents. It is employed in all kinds of immoderate hæmorrhagies and other fluxes, both internally and externally, where aſtringency is the only indication. It is certainly a very powerful ſtyptic, and is to be looked on ſimply as ſuch ; the ſudorific, antipeſtilential, and other like virtues aſcribed to it, it has no other claim to than in conſequence of its aſtringency, and of the antiſeptic power which it has in common with other vegetable ſtyptics. The largeſt doſe of the root in powder is a ſingle dram.

POLYGRAPHY, Polygraphia, or *Polygraphice*, the art of writing in various unuſual manners or ciphers ; as alſo of deciphering the ſame. The word is formed from the Greek, πολυ *multum*, and γραφη *ſcriptura*, " writing." The ancients ſeem to have been very little acquainted with this art ; nor is there any mark of their having gone beyond the Lacedæmonian ſcytala. Trithemius, Porta, Vigenere, and father Niceron, have written on the ſubject of polygraphy or ciphers. See Cipher.

POLYHEDRON, in geometry, denotes a body or ſolid comprehended under many ſides or planes.

Polyhedron, in optics, is a multiplying glaſs or lens conſiſting of ſeveral plane ſurfaces diſpoſed into a convex form. See Optics.

POLYHYMNIA, in the pagan mythology, one of the nine muſes, thus named from the Greek words Πολυς " much," and μνεια " memory." She preſided over hiſtory, or rather rhetoric ; and is repreſented with a crown of pearls and a white robe; her right hand in action as if haranguing, and holding in her left a caduceus or ſceptre to ſhow her power.

POLYMATHY, denotes the knowledge of many arts and ſciences. The word is derived from the Greek ϖολυ *multum*, and μανθανω *diſco*.

POLYMNESTOR, was a king of the Thracian Cherſoneſus. He married Ilione, Priam's eldeſt daughter ; and for the ſake of the treaſure with which he was entruſted by Priam during the ſiege of Troy, he murdered Polydorus (ſee Polydorus). The fleet in which the victorious Greeks returned, together with their Trojan captives, among whom was Hecuba, ſtopped on the coaſts of Thrace, where one of the female captives diſcovered on the ſhore the body of Polydorus, whom Polymneſtor had thrown into the ſea. The dreadful intelligence was immediately communicated to Hecuba his mother, who recollecting the frightful dreams ſhe had the preceding night, did not doubt but Polymneſtor was the cruel aſſaſſin. Reſolved to revenge her ſon's death, ſhe immediately called out Polymneſtor, as if to impart to him ſomething of importance. He was drawn into the ſnare; and no ſooner was he introduced into the apartment of the Trojan princeſs, than the female captives ruſhing upon him, put out his eyes with their pins, while Hecuba murdered his two children, who had accompanied him. Euripides informs us, that the Greeks condemned Polymneſtor to be baniſhed into a diſtant iſland for his perfidy. Hyginus, however, relates the whole differently, and tells us, that when Polydorus was ſent to Thrace, Ilione his ſiſter took him inſtead of her ſon Deiphilus, who was of the ſame age, being fearful of her huſband's cruelty. The monarch, unacquainted with the impoſition, looked upon Polydorus as his own ſon, and treated Deiphilus as her brother. After the deſtruction of Troy, the conquerors wiſhed the houſe and family of Priam to be extirpated, and therefore offered Electra, the daughter of Agamemnon to Polymneſtor, if he would deſtroy Ilione and Polydorus. He accepted the offer, and immediately diſpatched his own ſon Deiphilus, whom he took for Polydorus. Polydorus, who paſſed as the ſon of Polymneſtor, conſulted the oracle after the murder of Deiphilus ; and being informed that his father was dead, his mother a captive in the hands of the Greeks, and his country in ruins, he communicated the anſwer to Ilione, whom he had always regarded as his mother. She told him the meaſures ſhe had purſued to ſave his life ; upon which he avenged the perfidy of Polymneſtor by putting out his eyes.

POLYMNIA, in botany : A genus of the polygamia neceſſaria order, belonging to the ſyngeneſia claſs of plants ; and in the natural method ranking under the 49th order, *Compoſitæ*. The receptacle is paleaceous ; there is no pappus ; the exterior calyx is tetraphyllous, or pentaphyllous ; the interior decaphyllous, and compoſed of concave leaflets.

POLYNICES, the ſon of Œdipus by his mother Jocaſta. See Jocasta, Œdipus, and Eteocles.

POLYPE. See Polypus.

POLYPETALOUS, among botaniſts, an epithet applied to ſuch flowers as conſiſt of ſeveral petals or flower-leaves.

POLYPHEMUS (fab. hiſt.), a celebrated Cyclops, and king of all the Cyclops in Sicily, was the ſon of Neptune and Thooſa the daughter of Phorcys. He is ſaid to have been a monſter of great ſtrength, very tall, and with one eye in the middle of the forehead. He ate human fleſh, and kept his flocks on the coaſts of Sicily, when Ulyſſes, at his return from the Trojan war, was driven there. Ulyſſes, together with 12 of his companions, viſited the coaſt, and with them was ſeized by the Cyclops, who confined them in his cave, and daily devoured two of them. Ulyſſes would have ſhared the fate of the reſt had he not intoxicated the Cyclops, and put out his eye with a firebrand when he was aſleep. Polyphemus was awakened by the ſudden pain, and ſtopped the entrance of his cave; but Ulyſſes eſcaped, by creeping between the legs of the rams of the Cyclops, as they were led out to feed on the mountains. Polyphemus became enamoured of Galatæa; but his addreſſes were diſregarded, and the nymph ſhunned his preſence. The Cyclops was ſtill more earneſt; and when he ſaw Galatæa ſurrender herſelf to the pleaſures of Acis, he cruſhed his rival with a piece of a broken rock.

POLYPODIUM, in botany; a genus of the order of filices, belonging to the cryptogamia claſs of plants. The fructifications are in roundiſh points, ſcattered over the inferior diſc of the frons or leaf.—There are 65 ſpecies, of which the moſt remarkable is the filix mas, or common male fern. This grows in great plenty throughout Britain in woods and ſtony uncultivated ſoils. The greateſt part of the root lies horizontally, and has a great number of appendages placed cloſe to each other in a vertical direction, while a number of ſmall fibres ſtrike downwards. The leaves are a cubit high, and grow in circular tufts. They are at firſt alternately pinnate, the pinnæ increaſing in ſize from the baſe towards the middle, and afterwards gradually decreaſing upwards to the ſummit of the leaf. Theſe pinnæ are again pinnatifid, or ſubdivided almoſt to the nerve into obtuſe parallel lobes, crenated on the edges. The ſtalks are covered with brown filmy ſcales. The fructifications are kidney-ſhaped, and covered with a permanent ſcaly ſhield or involucrum. The capſules are of a pale brown, ſurrounded with a ſaffron-coloured elaſtic ring.

This fern has nearly the ſame qualities, and is uſed for moſt of the ſame intentions, as the pteris aquilina. They are both burnt together for the ſake of their aſhes, which are purchaſed by the ſoap and glaſs-makers. In the iſland of Jura are exported annually 150l. worth of theſe aſhes.

Gunner relates, in his *Flor. Noveg.* that the young curled leaves, at their firſt appearance out of the ground, are by ſome boiled and eaten like aſparagus; and that the poorer Norwegians cut off thoſe ſucculent laminæ, like the nails of the finger at the crown of the root, which are the baſes of the future ſtalks, and brew them into beer, adding thereto a third portion of malt, and in times of great ſcarcity mix the ſame in their bread. The ſame author adds, that this fern cut green, and dried in the open air, affords not only an excellent litter for cattle, but, if infuſed in hot water, becomes no contemptible fodder to goats, ſheep, and other cattle, which will readily eat and ſometimes grow fat upon it: a circumſtance well worth the attention of the inhabitants of the Highlands and Hebrides, as great numbers of their cattle, in hard winters, frequently periſh for want of food.

But the anthelmintic quality of the root of the male fern is that for which it is chiefly to be valued, and of which an account is given in the French publications of madame Nouffer, who employed this remedy with great ſucceſs. Dr. Simmons alſo has deſcribed the mode of adminiſtering the fern root in his treatiſe on the Tape Worm.

The polypodium oreopteris is only remarkable becauſe it has been confounded by moſt of the Engliſh botaniſts with the ſpecies which we have now deſcribed, and the polypodium thelypteris. It has a large ſcaly root, wrapped and tied together with ſmall ſtrong fibres, not to be ſeparated without difficulty. The fructifications are on the margins both when young and old, and never run into one another: the lobes are oval and plain. It is four times as large as the thelypteris, and grows in dry woods, moors, or hills, and very ſeldom near water; all which characters are widely different from thoſe of the ſpecies with which it has been confounded. It is to be found both in England and Scotland, in the latter place very plentifully. See *Linnæan Tranſactions*, vol. i. p. 181.

POLYPREMUM, in botany: A genus of the monogynia order, belonging to the tetrandria claſs of plants; and in the natural method ranking under the 22d order, *Caryophyllei.* The calyx is tetraphyllous; the corolla quadrifid and rotaceous, with its lobes obcordate; the capſule compreſſed, emarginated, and bilocular.

POLYPUS, a ſpecies of freſh-water inſects, belonging to the genus of hydra, of the order of zoophytes, and claſs of vermes. (See ANIMALCULE.) The name of *hydra* was given them by Linnæus on account of the property they have of reproducing themſelves when cut in pieces, every part ſoon becoming a perfect animal. Dr. Hill called them *biota*, on account of the ſtrong principle of life with which every part of them is endowed.

Theſe animals were firſt diſcovered by Leeuwenhoek, who gave ſome account of them in the Philoſophical Tranſactions for 1703; but their wonderful properties were not thoroughly known till the year 1740, when Mr. Trembley began to inveſtigate them. Previous to his diſcoveries, indeed, Leibnitz and Boerhaave, by reaſonings *a priori*, had concluded that animals might be found which would propagate by ſlips like plants; and their conjectures were ſoon verified by the obſervations of the gentleman above mentioned. At firſt, however, Trembley was uncertain whether he ſhould reckon theſe creatures animals or plants; and, while thus uncertain, he wrote a letter on the ſubject to Mr. Bonnet in January 1741; but in March the ſame year he had ſatisfied himſelf that they were real animals. The ſurpriſe of Mr. Trembley and of others, on diſcovering the true nature of theſe animals, was very great. When Mr. Reaumur ſaw for the firſt time two polypes formed from one which he had divided into two parts, he could hardly believe his own eyes; and even after having repeated the operation a hundred times, he ſaid that the ſight was by no means familiar to him. On the eighteenth of July 1741, M. Buffon wrote to Martin Folkes, Eſq. preſident of the Royal Society, acquainting him with "the diſcovery of a ſmall inſect called a *polypus*, which is found about the common duck-weed; and which, being cut in two, puts forth from the upper part a tail, and from the lower end a head, ſo as to become two animals inſtead of one. If it be cut into three parts, the middlemoſt alſo puts out from one end a head, and from the other a tail, ſo as to become three diſtinct animals, all living like the firſt, and performing the various offices of their ſpecies."—In September the ſame year, a letter was communicated from C. Bentinck, Eſq. at the Hague, deſcribing the inſects diſcovered by Mr. Trembley, adding, that he himſelf had ſeen them; and in November that year, a letter was read before the Society from Gronovius at Leyden, giving an account of a water inſect, which, ſays he, if cut into five or ſix pieces, in a few hours there will be as many animals exactly ſimilar to their parent. Theſe accounts, however, were all deemed ſo extraordinary, that they were not credited, until profeſſors Albinus and Muſchenbroeck provided themſelves with them, and found every thing related concerning them to be exactly true. In March 1742, Mr. Folkes gave an account of them to the Royal Society, from ſome obſervations made on ſeveral polypes which Mr. Trembley had ſent from Holland. They were ſoon after found in England, and the obſervations made upon them were publiſhed by ſeveral perſons; ſo that no doubt remained concerning the reality of what had been related concerning them.

The general character of the polype is, that it fixes itſelf by its baſe, is gelatinous, linear, naked, contractile; and can change its place. The mouth, which is placed at one end, is ſurrounded by hair-like feelers. The young ones grow out from its ſides; but in autumn it produces eggs from its ſides. There are ſix varieties: 1. The *viridis*, or green polype, has commonly ten ſhort arms. 2. The *fuſca* has frequently eight arms ſeveral times longer than the body. 3. The *griſea* is of a yellowiſh colour, ſmall towards the bottom, and has long arms, generally about ſeven in number. 4. The *pallens* has generally about ſix arms of a moderate length. 5. The *hydatula* has a veſicular body, and four obſolete arms. It is found in the abdomen of ſheep, ſwine, &c. 6. The *ſtentorea* has been called the *funnel-ſhaped*, and has a mouth ſurrounded with a row of hairs. 7. The *ſocialis* is bearded, thick, and wrinkled.

The three firſt ſpecies are thoſe on which the greateſt number of experiments have been made; and their ſhapes are ſo various, that it is by no means eaſy to deſcribe them. They are generally found in ditches. Whoever has carefully examined theſe when the ſun is very powerful, will find many little tranſparent lumps of the appearance of a jelly, and ſize of a pea, and flatted upon one ſide. The ſame kind of ſubſtances are likewiſe to be met with on the under ſide of the leaves of plants which grow in ſuch places. Theſe are the polypes in a quieſcent ſtate, and apparently inanimate. They are generally fixed by one end to ſome ſolid ſubſtance, with a large opening, which is the mouth, at the other; having ſeveral arms fixed round it, projecting as rays from the centre. They are ſlender, pellucid, and formed of a tender ſubſtance like the horns of a ſnail, and capable of contracting themſelves into a very ſmall compaſs, or of extending to a conſiderable length. The arms are capable of the ſame contraction and expanſion as the body; and with theſe they lay hold of minute worms and other inſects, bringing them to the mouth and ſwallowing them; the indigeſtible parts are again thrown out by the mouth.

The green polype was that firſt diſcovered by Mr. Trembley; and the firſt appearances of ſpontaneous motion were perceived in its arms, which it can contract, extend, and twiſt about in various directions. On the firſt appearance of danger they contract to ſuch a degree that they appear little bigger than a grain of ſand, of a fine green colour, the arms diſappearing entirely. Soon after he found the griſea, and afterwards the fuſca.

The bodies of the viridis and griſea diminiſh almoſt inſenſibly from the anterior to the poſterior extremity; but the fuſca is for the moſt part of an equal ſize for two-thirds of its length from the anterior to the poſterior extremity, from which it becomes abruptly ſmaller, and then continues of a regular ſize to the end. Theſe three kinds have at leaſt ſix, and at moſt 12 or 13 arms, though ſometimes the griſea is met with having 18 arms. They can contract themſelves till their bodies do not exceed one-tenth of an inch in length, and they can ſtop at any intermediate degree of contraction or extenſion. They are of various ſizes, from half an inch to an inch and a half long; their arms are ſeldom longer than their bodies, though ſome have them an inch, and ſome even eight inches long. The thickneſs of their bodies decreaſes as they extend themſelves, and *vice verſa*; and they may be made to contract themſelves either by agitating the water in which they are contained, or by touching the animals themſelves. When taken out of the water, they all contract ſo much that they appear only like a little lump of jelly. The arms have the ſame power of contraction or expanſion that the body has; and they can contract or expand one arm, or any number of arms, independent of the reſt; and they can likewiſe bend their bodies or arms in all poſſible directions. They can alſo dilate or contract their bodies in various places, and ſometimes appear thick ſet with folds, which, when careleſsly viewed, appear like rings. Their progreſſive motion is performed by that power which they have of contracting and dilating their bodies. When about to move, they bend down their head and arms, lay hold by means of them on ſome other ſubſtance to which they deſign to faſten themſelves; then they looſen their tail, and draw it towards the head; then either fix it in that place, or, ſtretching forward their head as before, repeat the ſame operation. They aſcend or deſcend at pleaſure in this manner upon aquatic plants, or upon the ſides of the veſſel in which they are kept; they ſometimes hang by the tail from the ſurface of the water, or ſometimes by one of the arms; and they can walk with eaſe upon the ſurface of the water. On examining the tail with a microſcope, a ſmall part of it will be found to be dry above the ſurface of the water, and as it were in a little concave ſpace, of which the tail forms the bottom; ſo that it ſeems to be ſuſpended on the ſurface of the water on the ſame principle that a ſmall pin or needle is made to ſwim. When a polype, therefore, means to paſs from the ſides of the glaſs to the ſurface of the water, it has only to put that part out of the water by which it is to be ſupported, and to give it time to dry, which it always does upon theſe occaſions; and they attach themſelves ſo firmly by the tail to aquatic plants, ſtones, &c. that they cannot be eaſily diſengaged: they often further ſtrengthen theſe attachments by means of one or two of their arms, which ſerve as a kind of anchors for fixing them to the adjacent ſubſtances.

The ſtomach of the polype is a kind of bag or gut into which the mouth opens, and goes from the head to the tail. This, in a ſtrong light, is viſible to the naked eye, eſpecially if the animal be placed between the eye and a candle; for theſe animals are quite tranſparent, whatever their colour may be. The ſtomach, however, appears to more advantage through a powerful magnifier. Mr. Trembley, by cutting one of theſe animals tranſverſely into three parts, ſatisfied himſelf that they were perforated throughout. Each piece immediately contracted itſelf, and the perforation was very viſible through a microſcope. The ſkin which incloſes the ſtomach is that of the polype itſelf; ſo that the whole animal, properly ſpeaking, conſiſts only of one ſkin, in the form of a tube, and open at both ends. No veſſels of any kind are to be diſtinguiſhed.

The mouth is ſituated at the anterior end in the middle between the ſhooting forth of the arms, and aſſumes different appearances according to circumſtances; being ſometimes lengthened out in the form of a nipple, at others appearing truncated; ſometimes the aperture is quite cloſed, at others there is a hollow; though at all times a ſmall aperture may be diſcovered by a powerful magnifier.

The ſkin of a polype, when examined with a microſcope, appears like ſhagreen, or as if covered with little grains, more or leſs ſeparated from each other, according to the degree of contraction of the body. If the lips of a polype be cut tranſverſely, and placed ſo that the cut part of the ſkin may lie directly before the microſcope, the ſkin throughout its whole thickneſs will be found to conſiſt of an infinite number of grains, and the interior part is found to be more ſhagreened than the exterior one; but they are not ſtrongly united to each other, and may be ſeparated without much trouble. They even ſeparate of themſelves, though in no great numbers, in the moſt healthy animals of this kind; for, where they are obſerved to ſeparate in large quantities, it is a ſymptom of a very dangerous diſorder. In the progreſs of this diſorder, the ſurface of the polype becomes gradually more and more rough and unequal, and no longer well defined or terminated as before. The grains fall off on all ſides; the body and arms contract and dilate, and aſſume a white ſhining colour; and at laſt the whole diſſolves into a heap of grains, which is more particularly obſerved in the green polype. By a careful examination we find, that the ſkin of the polype is entirely compoſed of grains, cemented by means of a kind of gummy ſubſtance; but it is to the grains entirely that the polype owes its colour. The ſtructure of the arms is analogous to that of the body; and they appear ſhagreened when examined by the microſcope, whether they be in a ſtate of contraction or extenſion; but if very much contracted, they appear more ſhagreened than the body, though almoſt quite ſmooth when in their utmoſt ſtate of extenſion. In the green polype the appearance of the arm is continually varying; and theſe variations are more ſenſible towards the extremity of the arm than at its origin, but more ſcattered in the parts further on. The extremity is often terminated by a knob, the hairs of which cannot be obſerved without a very powerful magnifier. They have a remarkable inclination of turning towards the light; ſo that if that part of the glaſs on which they are, be turned from the light, they will quickly remove to the other.

That ſpecies named the *fuſca* has the longeſt arms, and makes uſe of the moſt curious manœuvres to ſeize its prey. They are beſt viewed in a glaſs ſeven or eight inches deep, when their arms commonly hang down to the bottom. When this, or any other kind, is hungry, it ſpreads its arms in a kind of circle to a conſiderable extent; incloſing in this, as in a net, every inſect which has the misfortune to come within the circumference. (See Animalcule.) While the animal is contracted by ſeizing its prey, the arms are obſerved to ſwell like the muſcles of the human body when in action. Though no appearance of eyes can be obſerved in the polype, they certainly have ſome knowledge of the approach of their prey, and ſhow the greateſt attention to it as ſoon as it comes near them. It ſeizes a worm the moment it is touched by one of the arms; and in conveying it to the mouth, it frequently twiſts the arm into a ſpiral like a cork-ſcrew; by which means the inſect is brought to the mouth in a much ſhorter time than otherwiſe it would be; and ſo ſoon are the inſects on which the polypes feed killed by them, that M. Fontana thinks they muſt contain the moſt powerful kind of poiſon; for the lips ſcarce touch the animal when it expires, though their cannot be any wound perceived on it when dead. The worm, when ſwallowed, appears ſometimes ſingle, ſometimes double, according to circumſtances. When full, the polype contracts itſelf, hangs down as in a kind of ſtupor, but extends again in proportion as the food is digeſted and the excrementitious part is diſcharged. The bodies of the inſects, when ſwallowed, are firſt macerated in the ſtomach, then reduced into fragments, and driven backward and forward from one end of the ſtomach to the other, and even into the arms, however fine they may be; whence it appears that the arms, as well as the other parts of this remarkable creature, are a kind of hollow guts or ſtomachs. In order to obſerve this motion, it is beſt to feed the polypes with ſuch food as will give a lively colour; ſuch, for inſtance, as thoſe worms which are furniſhed with a red juice. Some bits of a ſmall black ſnail being given to a polype, the ſubſtance of the ſkin was ſoon diſſolved into a pulp conſiſting of ſmall black fragments; and on examining the polype with a microſcope, it was found that the particles were driven about in the ſtomach, and that they paſſed into the arms, from thence back into the ſtomach, then to the tail; from whence they paſſed again into the arms, and ſo on. The grains of which the body of the polype conſiſt take their colour from the food with which it is nouriſhed, and become red or black as the food happens to afford the one colour or the other. They are likewiſe more or leſs tinged with theſe colours in proportion to the ſtrength of the nutritive juices; and it is obſervable that they loſe their colour if fed with aliments of a colour different from themſelves. They feed on moſt inſects found in freſh water; and will alſo be ſupported with worms, the larvæ of gnats, &c. and even with ſnails, large aquatic inſects, and fiſh or fleſh if cut into ſmall bits. Sometimes two polypes lay hold of the ſame worm, and each begins to ſwallow its own end till their mouths meet and the worm breaks. But ſhould this happen not to be the caſe, the one polype will ſometimes devour the other along with its portion. It appears, however, that the ſtomach of one polype is not fitted for diſſolving the ſubſtance of another; for the one which is ſwallowed always gets clear again after being impriſoned for an hour or two.

The manner in which the polypes generate is moſt perceptible in the griſea and fuſca, as being conſiderably larger than the viridis. If we examine one of them in ſummer, when the animals are moſt active, and prepared for propagation, ſome ſmall tubercles will be found proceeding from its ſides, which conſtantly increaſe in bulk, until at laſt in two or three days they aſſume the figure of ſmall polypes. When they firſt begin to ſhoot, the excreſcence becomes pointed, aſſuming a conical figure, and deeper colour than the reſt of the body. In a ſhort time it becomes truncated, and then cylindrical, after which the arms begin to ſhoot from the anterior end. The tail adheres to the body of the parent-animal, but gradually grows ſmaller, until at laſt it adheres only by a point, and is then ready to be ſeparated. When this is the caſe, both the mother and young ones fix themſelves to the ſides of the glaſs, and are ſeparated from each other by a ſudden jerk. The time requiſite for the formation of the young ones is very different, according to the warmth of the weather and the nature of the food eaten by the mother. Sometimes they are fully formed, and ready to drop off, in 24 hours; in other caſes, when the weather is cold, 15 days have been requiſite for bringing them to perfection.

It is remarkable, that there is a reciprocal communication of food betwixt the young and old before they be ſeparated. The young ones, as ſoon as they are furniſhed with arms, catch prey for themſelves, and communicate the digeſted food to the old ones, who on the other hand do the ſame to the young ones. This was fully verified by the following experiment: One of the large polypes of the *fuſca* kind being placed on a ſlip of paper in a little water, the middle of the body of a young one growing out from it was cut open; when the ſuperior part of that end which remained fixed to the parent was found to be open alſo. By cutting over the parent polype on each ſide of the ſhoot, a ſhort cylinder was obtained, open at both ends; which being viewed through a microſcope, the light was obſerved to come through the young one into the ſtomach of the old one. On cutting open the cylindrical portion lengthwiſe, not only the hole of communication was obſerved, but one might ſee through the end of the young one alſo. On changing the ſituation of the two pieces, the light was ſeen through the hole of communication. This may be ſeen between the parent polype and its young ones after feeding them; for, after the parents have eaten, the bodies of the young ones ſwell as if they themſelves had been eating.

The polypes produce young ones indiſcriminately from all parts of their bodies, and five or ſix young ones have frequently been produced at once; nay, Mr. Trembley has obſerved nine or ten produced at the ſame time.

Nothing like copulation among theſe creatures was ever obſerved by Mr. Trembley, though for two years he had thouſands of them under his inſpection. To be more certain on this ſubject, he took two young ones the moment they came from their parent, and placed them in ſeparate glaſſes. Both of them multiplied, not only themſelves, but alſo their offspring, which were ſeparated and watched in the ſame manner to the ſeventh generation; they have even the ſame power of generation while adhering to their parent. In this ſtate the parent, with its children and grandchildren, exhibits a ſingular appearance, looking like a ſhrub thick ſet with branches. Thus ſeveral generations ſometimes are attached to one another, and all of them to one parent. Mr. Adams gives a figure of one polype with *nineteen* young ones hanging at it; the whole group being about an inch broad, and an inch and a half in length: the old polype ate about twelve monoculi per day, and the young ones about 20 among them.

When a polype is cut tranſverſely or longitudinally into two or three parts, each part in a ſhort time becomes a perfect animal; and ſo great is this prolific power, that a new animal will be produced even from a ſmall portion of the ſkin of the old one. If the young ones be mutilated while they grow upon the parent, the parts ſo cut off will be reproduced, and the ſame property belongs to the parent. A truncated portion will ſend forth young ones before it has acquired a new head and tail of its own, and ſometimes the head of the young one ſupplies the place of that which ſhould have grown out of the old one. If we ſlit a polype longitudinally through the head to the middle of the body, we ſhall have one formed with two heads; and by ſlitting theſe again in the ſame manner, we may form one with as many heads as we pleaſe.

A ſtill more ſurpriſing property of theſe animals is, that they may be grafted together. If the truncated portions of a polype be placed end to end, and gently puſhed together, they will unite into a ſingle one. The two portions are firſt joined together by a ſlender neck, which gradually fills up and diſappears, the food paſſing from the one part into the other; and thus we may form polypes not only from portions of the ſame, but of different animals; we may fix the head of one to the body of another, and the compound animal will grow, eat, and multiply, as if it had never been divided. By puſhing the body of one into the mouth of another, ſo far that their heads may be brought into contact, and kept there for ſome time, they will at laſt unite into one animal, only having double the number of arms which it would otherwiſe have had. The *hydra fuſca* may be turned inſide out like a glove, at the ſame time that it continues to live and act as before. The lining of the ſtomach now forms the outer ſkin, and the former epidermis conſtitutes the lining of the ſtomach. If previous to this operation the polype have young ones attached to it, ſuch as are but newly beginning to vegetate turn themſelves inſide out, while the larger ones continue to increaſe in ſize till they reach beyond the mouth of the parent, and are then ſeparated in the uſual manner from the body. When thus turned, the polype combines itſelf in many different ways. The fore part frequently cloſes, and becomes a ſupernumerary tail. The animal, which was at firſt ſtraight, now bends itſelf, ſo that the two tails reſemble the legs of a pair of compaſſes, which it can open and ſhut. The old mouth is placed as it were at the joint of the compaſſes, but loſes its power of action; to ſupply which a new one is formed in its neighbourhood; and in a little time there is a new ſpecies of hydra formed with ſeveral mouths.

The ſides of a polype, which has been cut through in a longitudinal direction, begin to roll themſelves up, commonly from one of the extremities, with the outſide of the ſkin inwards; but in a little time they unroll themſelves, and the two cut edges join together, ſometimes beginning at one extremity, and ſometimes approaching throughout their whole length. As ſoon as the edges join, they unite ſo cloſely that no ſcar can be perceived. If a polype be partly turned back, the open part cloſes, and new mouths are formed in different places. Every portion of a polype is capable of devouring inſects almoſt as ſoon as it is cut off: and the voracity of the whole genus is aſtoniſhing; for Mr. Adams obſerves, that moſt of the inſects on which they feed bear the ſame proportion to the mouth of a polype that an apple of the ſize of a man's head bears to his mouth.

The *hydra pallens* is very rarely met with, and is deſcribed only by M. Roeſel. It is of a pale yellow colour, growing gradually ſmaller from the bottom; the tail is round or knobbed; the arms are about the length of the body, of a white colour, generally ſeven in number, and are apparently compoſed of a chain of globules. The young are brought forth from all parts of its body.

The *hydratula* is mentioned by many medical writers. Dr. Tyſon, in diſſecting an antelope, found ſeveral hydatides or films, about the ſize of a pigeon's egg, filled with water, and of an oval form, faſtened to the omentum; and ſome in the pelvis between the bladder of urine and rectum. He ſuſpected them to be animals for the following reaſons: 1. Becauſe they were included in a membrane like a matrix, ſo looſely, that by opening it with the finger or a knife, the internal bladder, containing the ſerum or lympha, ſeemed nowhere to have any connection with it, but would very readily drop out, ſtill retaining its liquor without ſpilling any. 2. This internal bladder had a neck or white body, more opaque than the reſt, and protuberant from it, with an orifice at its extremity; by which, as with a mouth, it exhauſted the ſerum from the external membrane, and ſo ſupplied its bladder or ſtomach. 3. On bringing this neck near the candle, it moved and ſhortened itſelf. It is found in the abdomen of ſheep, ſwine, mice, &c. lying between the peritoneum and the inteſtines.

The *ſtentorea*, or funnel-like polype, is of three colours, green, blue, and white; but the laſt is the moſt common. They do not form cluſters, but adhere ſingly by the tail to whatever comes in their way: the anterior end is wider than the poſterior; and, being round, gives the animal ſomewhat of a funnel form, though the circle is interrupted by a kind of ſlit or gap. The edge of this gap is ſurrounded with a great number of little fimbrillæ, which by their motions excite a current of water, that forces into the mouth of the animal the ſmall bodies that come within its reach. Mr. Trembley ſays, that he has often ſeen a great number of animalcules fall into the mouths of theſe creatures; ſome of which were let out again at an opening which he could not deſcribe. They can faſhion their mouths into ſeveral different forms; and they multiply by dividing neither tranſverſely nor longitudinally, but diagonally.

The *ſocialis* is deſcribed by Muller under the title of *vorticella*. They are found in cluſters; and, when viewed by a microſcope, appear like a circle ſurrounded with crowns or ciliated heads, tied by ſmall thin tails to a common centre, from whence they advance towards the circumference, and then turn like a wheel, occaſioning a vortex which brings along with it the food proper for them.

The *anaſtatica*, or cluſtering polypes, form a group reſembling a cluſter, or rather an open flower, ſupported by a ſtem, which is fixed by its lower extremity to ſome of the aquatic plants or extraneous bodies that are found in the water; the upper extremity is formed into eight or nine lateral branches, perfectly ſimilar to each other, which have alſo ſubordinate branches, whoſe collected form much reſembles that of a leaf. Every one of theſe aſſemblages is compoſed of one principal branch or nerve, which makes the main ſtem of the cluſter an angle ſomewhat larger than a right one: the ſmaller lateral branches proceed from both ſides of this nerve, and theſe are ſhorter the nearer their origin is to the principal branch. There is a polype at the extremity, and others on both ſides of the lateral twigs, but at different diſtances from their extremities. They are all exceedingly ſmall, and bell-ſhaped, with a quick motion about the mouth, though it is impoſſible to diſcern the cauſe of it. See ANIMALCULE, PULEX, and VORTICELLA.

The ſeveral ſtrange properties recorded of this animal, though very ſurpriſing, are, however, none of them peculiar to it alone. The Surinam toad is well known to produce its young not in the ordinary way, but in cells upon its back. Mr. Sherwood has very lately diſcovered the ſmall eels in ſour paſte to be without exception full of living young ones. And as to the moſt amazing of all its properties, the reproduction of its parts, we know the crab and lobſter, if a leg be broken off, always produce a new one: and Monſ. Bonet, Monſ. Lyonet, Monſ. de Reaumur, and Mr. Folkes, have all found, by experiment, that ſeveral earth and water worms have the ſame property, ſome of them even when cut into thirty pieces. The urtica marina, or ſea-nettle, has been alſo found to have the ſame; and the ſea ſtar-fiſh, of which the polype is truly a ſpecies, though it had long eſcaped the ſearches of the naturaliſts, was always well known by the fiſhermen to have it alſo.

Marine Polypus, is different in form from the freſh-water polype already deſcribed; but is nouriſhed, increaſes, and may be propagated after the ſame manner: Mr. Ellis having often found in his inquiries, that ſmall pieces cut off from the living parent, in order to view the ſeveral parts more accurately, ſoon gave indications that they contained not only the principles of life, but likewiſe the faculty of increaſing and multiplying into a numerous iſſue. It has been lately diſcovered and ſufficiently proved by Peyſſonel, Ellis, Juſſieu, Reaumur, Donati, &c. that many of thoſe ſubſtances which had formerly been conſidered by naturaliſts as marine vegetables or ſea-plants, are in reality animal-productions; and that they are formed by polypes of different ſhapes and ſizes, for their habitation, defence and propagation. To this claſs may be referred the corals, corallines, keratophyta, eſchara, ſponges, and alcyonium: nor is it improbable, that the more compact bodies, known by the common appellations of *ſtar-ſtones*, *brain-ſtones*, *petrified fungi*, and the like, brought from various parts of the Eaſt and Weſt Indies, are of the ſame origin. To this purpoſe Mr. Ellis obſerves, that the ocean, in all the warmer latitudes near the ſhore, and wherever it is poſſible to obſerve, abounds ſo much with animal life, that no inanimate body can long remain unoccupied by ſome ſpecies. In thoſe regions, ſhips-bottoms are ſoon covered with the habitations of thouſands of animals: rocks, ſtones, and every thing lifeleſs, are covered with them inſtantly; and even the branches of living vegetables that hang into the water are immediately loaded with the ſpawn of different animals, ſhell fiſh of various kinds: and ſhell-fiſh themſelves, when they become impotent and old, are the baſis of new colonies of animals, from whoſe attacks they can no longer defend themſelves. For a further account of this ſyſtem, ſee Coral and Corallines.

Polypus *of the Heart*, properly a fleſhy rooted excreſcence growing from ſome part of its ſubſtance. This name, however, is uſually given to thoſe concretions of coagulable lymph found in the heart on diſſection, and ariſing from a ſpontaneous ſeparation of one of the component parts of the blood.

POLYSARCIA, the ſame as Obesity or Corpulency.

POLYSCHIDES, or sea hunger. See Fucus.

POLYSPERMOUS (from ϖολυ many, and σπερμα *ſeed*), in botany, is applied to ſuch plants as have more than four ſeeds ſucceeding each flower, without any certain order or number.

POLYSYLLABLE, in grammar, a word conſiſting of more than three ſyllables; for, when a word conſiſts of one two, or three ſyllables, it is called a *monoſyllable*, a *diſſyllable*, and *triſyllable*.

POLYSYNDETON. See Oratory.

POLYTHEISM,

THE doctrine of a plurality of gods or inviſible powers ſuperior to man.

" That there exiſt beings, one or many, powerful above the human race, is a propoſition (ſays Lord Kames) univerſally admitted as true in all ages and among all nations. I boldly call it *univerſal*, notwithſtanding what is reported of ſome groſs ſavages; for reports that contradict what is acknowledged to be general among men, require more able vouchers than a few illiterate voyagers. Among many ſavage tribes there are no words but for objects of external ſenſe: is it ſurpriſing that ſuch people are incapable of expreſſing their religious perceptions, or any perception of internal ſenſe? The conviction that men have of ſuperior powers, in every country where there are words to expreſs it, is ſo well vouched, that in fair reaſoning it ought to be taken for granted among the few tribes where language is deficient."

Theſe are judicious obſervations, of which every man will admit the force who has not ſome favourite ſyſtem to build upon the unſtable foundation which his Lordſhip overturns. Taking it for granted, then, that our conviction of ſuperior powers has long been univerſal, the important queſtion is, From what cauſe it proceeds? The ſame ingenious author ſhows, with great ſtrength of reaſoning, that the operations of nature and the government of this world, which to us loudly proclaim the exiſtence of a Deity, are not ſufficient to account for the univerſal belief of ſuperior beings among ſavage tribes. He is therefore of opinion, that this univerſality of conviction can ſpring only from the image of Deity ſtamped upon the mind of every human being, the ignorant equally with the learned. " Nothing leſs (he ſays) is ſufficient: and the original perception which we have of Deity muſt proceed (he thinks) from an internal ſenſe, which may be termed the *ſenſe of Deity*."

We have elſewhere expreſſed our opinion of that philoſophy which accounts for every phenomenon in human nature, by attributing it to a particular inſtinct (ſee Instinct); but to this inſtinct or *ſenſe of Deity*, conſidered as complete evidence, many objections, more than uſually powerful, force themſelves upon us. All nations, except the Jews, were once polytheiſts and idolaters. If therefore his Lordſhip's hypotheſis be admitted, either the doctrine of polytheiſm muſt be true theology, or this inſtinct or ſenſe is of ſuch a nature as to have at different periods of the world miſled all mankind. All ſavage tribes are at preſent polytheiſts and idolaters; but among ſavages every inſtinct appears in greater purity and vigour than among people poliſhed by arts and ſciences; and inſtinct never miſtakes its object. The inſtinct or primary impreſſion of nature, which gives riſe to ſelf-love, affection between the ſexes, love of progeny, &c. has in all nations, and in every period of time, a preciſe and determinate object which it inflexibly purſues. How then comes it to paſs, that this particular inſtinct, which if real is ſurely of as much importance as any other, ſhould have uniformly led thoſe who had no other guide to purſue improper objects, to fall into the groſſeſt errors and the moſt pernicious practices? To no purpoſe are we told, that the ſenſe of Deity, like the moral ſenſe, makes no capital figure among ſavages. There is reaſon to believe that the feeling or perception, which is called the *moral ſenſe*, is not wholly inſtinctive: but whether it be or not, a ſingle inſtance cannot be produced in which it multiplies its objects, or makes even a ſavage expreſs gratitude to a thouſand perſons for benefits which his prince alone had power to confer.

For theſe and other reaſons which might eaſily be aſſigned we cannot help thinking, that the firſt religious principles muſt have been derived from a ſource different as well from internal ſenſe as from the deductions of reaſon; from a ſource which the majority of mankind had early forgotten; and which, when it was baniſhed from their minds, left nothing behind it to prevent the very firſt principle of religion from being perverted by various accidents or cauſes, or, in ſome extraordinary concurrence of circumſtances, from being perhaps entirely obliterated. This ſource of religion every conſiſtent Theiſt muſt believe to be revelation. Reaſon, it is acknowledged, and we ſhall afterwards ſhow (ſee Religion), could not have introduced ſavages to the knowledge of God; and we have juſt ſeen, that a *ſenſe* of Deity is an hypotheſis clogged with inſuperable difficulties. Yet it is undeniable, that all mankind have believed in ſuperior inviſible powers: and if reaſon and inſtinct be ſet aſide, there remains no other origin of this univerſal belief than primeval revelation, corrupted, indeed, as it paſſed by oral tradition from father to ſon, in the courſe of many generations. It is no ſlight ſupport to this doctrine, that if there really be a Deity, it is highly preſumable that he would reveal himſelf to the firſt men—creatures whom he had formed with faculties to adore and to worſhip him. To other animals the knowledge of a Deity is of no importance; to man it is of the firſt importance. Were we totally ignorant of a Deity, this world would appear to us a mere chaos. Under the government of a wiſe and benevolent Deity, chance is excluded, and every event appears to be the reſult of eſtabliſhed laws. Good men ſubmit to whatever happens without repining, knowing that every event is ordered by Divine Providence: they ſubmit with entire reſignation; and ſuch reſignation is a ſovereign balſam for every misfortune or evil in life.

Admitting, then, that the knowledge of Deity was originally derived from revelation, and that the firſt men profeſſed pure theiſm, it ſhall be our buſineſs in the preſent article to trace the riſe and progreſs of *polytheiſm* and *idolatry*; and to aſcertain, if we can, the real opinions of the Pagan world concerning that multitude of gods with which they filled heaven, earth, and hell. In this inquiry, though we ſhall have occaſion to appeal to the writings of Moſes, we ſhall attribute to them no other authority than what is due to records of the earlieſt ages, more ancient and authentic than any others which are now extant.

Whether we believe, with the author of the book of Geneſis, that all men have deſcended from the ſame progenitors; or adopt the hypotheſis of modern theoriſts, that there have been ſucceſſive creations of men, and that the *European* derives his origin from one pair, the *Aſiatic* from another, the woolly-headed *African* from a third, and the copper-coloured *American* from a fourth—polytheiſm and idolatry will be ſeen to have ariſen from the ſame cauſes, and to have advanced nearly in the ſame order from one degree of impiety to another. On either ſuppoſition, it muſt be taken for granted, that the original progenitors were inſtructed by their Creator in the truths of genuine theiſm: and there is no room to doubt, but that thoſe truths, ſimple and ſublime as they are, would be conveyed pure from father to ſon as long as the race lived in one family, and were not ſpread over a large extent of country. If any credit be due to the records of antiquity, the primeval inhabitants of this globe lived to ſo great an age, that they muſt have increaſed to a very large number long before the death of the common parent, who would of courſe be the bond of union to the whole ſociety, and whoſe dictates, eſpecially in what related to the origin of his being and the exiſtence of his Creator, would be liſtened to with the utmoſt reſpect by every individual of his numerous progeny.

Many cauſes, however, would conſpire to diſſolve this family after the death of its anceſtor into ſeparate and independent tribes, of which ſome would be driven by violence, or would voluntarily wander, to a diſtance from the reſt. From this diſperſion great changes would take place in the opinions of ſome of the tribes reſpecting the object of their religious worſhip. A ſingle family, or a ſmall tribe baniſhed into a deſert wilderneſs (ſuch as the whole earth muſt then have been), would find employment for all their time in providing the means of ſubſiſtence, and in defending themſelves from beaſts of prey. In ſuch circumſtances they would have little *leiſure* for meditation, and, being conſtantly converſant with objects of ſenſe, they would gradually loſe the *power* of meditating upon the ſpiritual nature of that Being by whom their anceſtors had taught them that all things were created. The firſt wanderers would no doubt retain in tolerable purity their original notions of Deity; and they would certainly endeavour to impreſs thoſe notions upon their children: but in circumſtances infinitely more favourable to ſpeculation than theirs could have been, the human mind dwells not long upon notions purely intellectual. We are ſo accuſtomed to ſenſible objects, and to the ideas of ſpace, extenſion, and figure, which they are perpetually impreſſing upon the imagination, that we find it extremely difficult to conceive any being without aſſigning to him a form and a place. Hence a learned writer has ſuppoſed, that the earlieſt generations of men (even thoſe to whom he contends that frequent revelations were vouchſafed) may have been no better than *anthropomorphites* in their conceptions of the Divine Being.

Be this as it may, it is not conceivable but that the members of thoſe firſt colonies would quickly loſe many of the arts and much of the ſcience which perhaps prevailed in the parent ſtate; and that, fatigued with the contemplation of intellectual objects, they would relieve their overſtrained faculties by attributing to the Deity a place of abode, if not a human form. To men totally illiterate, the place fitteſt for the habitation of the Deity would undoubtedly appear to be the ſun, the moſt beautiful and glorious object of which they could form any idea; an object too, from which they could not but be ſenſible that they received the benefits of light and heat, and which experience muſt ſoon have taught them to be in a great meaſure the ſource of vegetation. The great ſpirit therefore inhabiting the ſun, which they would conſider as the *power* of light and heat, was in all probability the firſt object of idolatrous adoration.

From looking upon the ſun as the habitation of their God, they would ſoon proceed to conſider it as his body. Of pure mind entirely ſeparated from matter, men in their circumſtances could not long retain the fainteſt notion; but conſcious each of power in himſelf, and experiencing the effects of power in the ſun, they would naturally conceive that luminary to be animated as their bodies were animated. They would feel his influence when above the horizon; they would ſee him moving from eaſt to weſt; they would conſider him when ſet as gone to take his repoſe: and thoſe exertions and intermiſſions of power being analogous to what they experienced in themſelves, they would look upon the ſun as a real animal. Thus would the Divinity appear to their untutored minds to be a compound being like man; partly corporeal and partly ſpiritual; and as ſoon as they imbibed ſuch notions, though perhaps not before, they may be pronounced to have been abſolute idolaters.

When men had once got into this train, their gods would multiply upon them with wonderful rapidity. Darkneſs and cold they could not but perceive to be contrary to light and heat; and not having philoſophy enough to diſtinguiſh between mere privations and poſitive effects, they would conſider darkneſs and cold as entities equally real with light and heat; and attribute theſe different and contrary effects to different and contrary powers. Hence the ſpirit or power of darkneſs was in all probability the ſecond god in the Pagan calendar; and as they conſidered the power of light as a benevolent principle, the ſource of all that is good, they muſt have looked upon the contrary power of darkneſs as a malevolent ſpirit, the ſource of all that is evil. This we know from authentic hiſtory to have been the belief of the Perſian magi, a very ancient ſect, who called their good god *Yazdan*, and alſo *Ormuzd*, and the evil god *Ahraman*. Conſidering light as the ſymbol, or perhaps as the body, of *Oromazd*, they always worſhipped him before the fire, the ſource of light, and eſpecially before the ſun, the ſource of the moſt perfect light; and for the ſame reaſon fires were kept continually burning on his altars. That they ſometimes addreſſed prayers to the evil principle, we are informed by Plutarch in his Life of Themiſtocles; but with what particular rites he was worſhipped, or where he was ſuppoſed to reſide, is not ſo evident. Certain it is, that his worſhippers held him in deteſtation; and when they had occaſion to write his name, they always inverted it *(uvuuvıqɥ)*, to denote the malignity of his nature.

The principles of the magi, though widely diſtant from pure theiſm, were much leſs abſurd than thoſe of other idolaters. It does not appear that they ever worſhipped their gods by the medium of graven images, or had any other emblems of them than light and darkneſs. Indeed we are told by Diogenes Laertius and Clemens Alexandrinus, that they condemned all ſtatues and images, allowing fire and water to be the only proper emblems or repreſentatives of their gods. And we learn from Cicero, that at their inſtigation Xerxes was ſaid to have burnt all the temples of Greece, becauſe the builders of thoſe edifices impiouſly preſumed to incloſe within walls the gods, to whom all things ought to be open and free, and whoſe proper temple is the whole world. To theſe authorities we may add that of all the hiſtorians, who agree, that when magianiſm was the religion of the court, the Perſian monarchs made war upon images, and upon every emblem of idolatry different from their own.

The magi, however, were but one ſect, and not the largeſt ſect, of ancient idolaters. The worſhip of the ſun, as the ſource of light and heat, ſoon introduced into the calendar of divinities the other heavenly bodies, the moon, the planets, and the fixed ſtars. Men could not but experience great benefit from thoſe luminaries in the abſence of their chief God; and when they had proceeded ſo far as to admit two divine principles, a good and an evil, it was natural for minds clouded with ſuch prejudices to conſider the moon and the ſtars as benevolent intelligences, ſent to oppoſe the power of darkneſs whilſt their firſt and greateſt divinity was abſent or aſleep. It was thus, as they imagined, that he maintained (for all held that he did maintain) a conſtant ſuperiority over the evil principle. Though to aſtronomers the moon is known to be an opake body of very ſmall dimenſions when compared with a planet or a fixed ſtar, to the vulgar eye ſhe appears much more magnificent than either. By thoſe early idolaters ſhe was conſidered as the divinity ſecond in rank and in power; and whilſt the ſun was worſhipped as the king, ſhe was adored as the queen, of heaven.

The earth, conſidered as the common mother of all things; the ocean, whoſe waters are never at reſt: the air, the region of ſtorms and tempeſts, and indeed all the elements—were gradually added to the number of divinities; not that mankind in this early age had ſo far degenerated from the principles of their anceſtors as to worſhip brute matter. If ſuch worſhip was ever practiſed, which to us is hardly conceivable, it was at a later period, when it was confined to the very loweſt of the vulgar, in nations otherwiſe highly civilized. The polytheiſts, of whom we now treat, conceived every thing in motion to be animated, and animated by an intelligence powerful in proportion to the magnitude of the body moved.

This ſect of idolaters, which remains in ſome parts of the Eaſt to this day, was known by the name of *Sabians*, which they pretend to have derived from *Sabius* a ſon of Seth; and among the books in which their ſacred doctrines are contained, they have one which they call the book of *Seth*. We need hardly obſerve, that theſe are ſenſeleſs and extravagant fables. The name *Sabian* is undoubtedly derived from the Hebrew word *Tſaba*, which ſignifies "a hoſt or army;" and this claſs of polytheiſts was ſo called, becauſe they worſhipped "the hoſt of heaven;" the *Tſaba heſemim*, againſt which Moſes ſo pathetically cautions the people of Iſrael.

This ſpecies of idolatry is thought to have firſt prevailed in Chaldea, and to have been that from which Abraham ſeparated himſelf, when, at the command of the true God, he "departed from his country, and from his kindred, and from his father's houſe." But as it nowhere appears that the Chaldeans had fallen into the ſavage ſtate before they became polytheiſts and idolaters, and as it is certain that they were not ſavages at the call of Abraham, their early Sabiiſm may be thought inconſiſtent with the account which we have given of the origin of that ſpecies of idolatry. If a great and civilized nation was led to worſhip the hoſt of heaven, why ſhould that worſhip be ſuppoſed to have ariſen among ſavages? Theories, however plauſible, cannot be admitted in oppoſition to facts.

True: but we beg leave to reply, that our account of the origin of polytheiſm is oppoſed by no fact; becauſe we have not ſuppoſed that the worſhip of the hoſt of heaven aroſe among ſavages *only*. That ſavages, between whom it is impoſſible to imagine any intercourſe to have had place, have univerſally worſhipped, as their firſt and ſupreme divinities, the *ſun*, *moon*, and *ſtars*, is a fact evinced by every hiſtorian and by every traveller: and we have ſhown how their rude and uncultivated ſtate naturally leads them to that ſpecies of idolatry. But there may have been circumſtances peculiar to the Chaldeans, which led them likewiſe to the worſhip of the heavenly hoſt, even in a ſtate of high civilization.—We judge of the philoſophy of the ancients by that of ourſelves, and imagine that the ſame refined ſyſtem of metaphyſics was cultivated by them as by the followers of *Deſcartes* and *Locke*. But this is a great miſtake; for ſo groſs were the notions of early antiquity, that it may be doubted whether there was a ſingle man uninſpired, who had any notion of mind as a being diſtinct and entirely ſeparated from matter (ſee METAPHYSICS). From ſeveral paſſages in the books of Moſes, we learn, that when in the firſt ages of the world the Supreme Being condeſcended to manifeſt his preſence to men, he generally exhibited ſome ſenſible emblem of his power and glory, and declared his will from the midſt of a preternatural *fire*. It was thus that he appeared to the Jewiſh lawgiver himſelf, when he ſpoke to him from the midſt of a burning buſh; it was by a pillar of cloud and *fire* that he led the Iſraelites from Egypt to the Land of Promiſe; and it was in the midſt of ſmoke, and *fire*, and thunderings, that the law was delivered from Mount Sinai.—That ſuch manifeſtations of the Divine Preſence would be occaſionally made to the deſcendants of Noah who ſettled in Chaldea ſoon after the deluge, muſt appear extremely probable to every one who admits the authority of the Hebrew Scriptures: and he who queſtions that authority, has no right to make the objection to which we now reply; becauſe it is only from the book of Geneſis that we know the Chaldeans to have been a civilized people when they fell into idolatry. All hiſtories agree in repreſenting the inhabitants of Chaldea as at a very early period corrupted by luxury and ſunk in vice. When this happened, we muſt ſuppoſe that the moral Governor of the univerſe would withdraw from them thoſe occaſional manifeſtations of himſelf, and leave them to their own inventions. In ſuch circumſtances, it was not unnatural for a people addicted to the ſtudy of aſtronomy, who had been taught to believe that the Deity frequently appeared to their anceſtors in a flame of fire, to conſider the ſun as the place of his permanent reſidence, if not as his body. But when either opinion was firmly eſtabliſhed, polytheiſm would be its inevitable conſequence, and the progreſs of Sabiiſm would, in the moſt poliſhed nation, be ſuch as we have traced it among ſavage tribes.

From Chaldea the idolatrous worſhip of the hoſt of heaven ſpread itſelf over all the Eaſt, paſſed into Egypt, and thence into Greece; for Plato affirms, that "the firſt inhabitants of

Greece ſeemed to him to have worſhipped no other gods but the ſun, moon, earth, ſtars, and heavens, as moſt barbarous nations (continues he) ſtill do." That Sabiiſm, or the worſhip of the hoſt of heaven, was the firſt ſpecies of idolatry, beſides the probability of the thing, and the many alluſions to it in ſacred Scripture, we have the poſitive evidence of the moſt ancient pagan hiſtorians of whoſe writings any part has been tranſmitted to us. Herodotus, ſpeaking of the religion of the Perſians, ſays, that " they worſhip the *ſun, moon,* and *earth, fire, water,* and the *winds*; and this adoration they have all along paid from the beginning." He teſtifies the ſame thing of the ſavage Africans, of whom he affirms, that they all worſhipped the *ſun* and *moon,* and no other divinity. Diodorus Siculus, writing of the Egyptians, tells us, that " the firſt men, looking up to the world above them, and terrified and ſtruck with admiration at the nature of the univerſe, ſuppoſed the ſun and moon to be the principal and *eternal gods.*" And Sanchoniathon the Phœnician, a more ancient writer than either of theſe, informs us, in the fragment of his hiſtory preſerved by Euſebius, that " the two firſt mortals were Æon and Protogonus; and their children were Genus and Genea, who inhabited Phœnicia; and when they were ſcorched with the heat, they lifted up their hands to the ſun, whom they believed to be the Lord of Heaven, and called him *Baal-ſamen*, the ſame whom the Greeks call *Ζευς*."

Hitherto thoſe divinities were worſhipped in perſon, or, as Dr. Prideaux expreſſes it, in their *ſacella,* or ſacred tabernacles; for the votaries of each directed their devotions towards the planet which they ſuppoſed to be animated by the particular intelligence whom they meant to adore. But theſe orbs, by their riſing and ſetting, being as much below the horizon as above it, and their groſsly ignorant worſhippers not ſuppoſing it poſſible that any intelligence, however divine, could exert its influence but in union with ſome body, ſtatues or pillars were ſoon thought of as proper emblems of the abſent gods. Sanchoniathon, in the fragment already quoted, informs us, that " *Hyſpouranios* and his brother *Ouſous,* Phœnician patriarchs, erected two pillars, the one to *fire* and the other to *air* or *wind,* and worſhipped thoſe pillars, pouring out to them libations of the blood of the wild beaſts hunted down in the chace." As theſe early monuments of idolatry were called *βαιτυλια,* a word evidently derived from the Hebrew *Bethel,* the probability is, that they were altars of looſe ſtones, ſuch as that which was built by Jacob, and from him received the ſame name. As his was conſecrated to the true God, theirs were conſecrated to the hoſt of heaven; and the form of conſecration ſeems to have been nothing more than the anointing of the ſtone or pillar with oil *, in the name of the divinity whom it was intended to repreſent. When this ceremony was performed, the ignorant idolaters, who fancied that their gods could not hear them but when they were viſible, ſuppoſed that the intelligences by which the ſun and planets were animated, took poſſeſſion, in ſome inexplicable manner, of the conſecrated pillars, and were as well pleaſed with the prayers and praiſes offered up before thoſe pillars, as with the devotions which were addreſſed towards the luminaries themſelves.— Hence Sanchoniathon calls them *animated* or *living ſtones, λιθους εμψυχους,* from the portion of the Divine Spirit which was believed to reſide in them; and as they were dedicated to the hoſt of heaven, they were generally erected on the tops of mountains; or, in countries which, like Egypt, were low and level, they were elevated to a great height by the labour of men.

It has been ſuppoſed, that this practice of raiſing the pillars on *high places* proceeded from a deſire to make the objects of worſhip conſpicuous and magnificent: but we are ſtrongly inclined to believe, that the erectors of *βαιτυλια* had ſomething further in view, and that they thought of nothing leſs than to bring the ſacred ſtone or pillar as near as poſſible to the god whom it repreſented. Whatever be in this, we know that the practice itſelf prevailed univerſally through the eaſt; and that there was nothing which the Jewiſh legiſlator more ſtrictly enjoined his people to deſtroy, than the altars, ſtatues, and pillars, erected for idolatrous worſhip upon mountains and high places. " Ye ſhall utterly deſtroy (ſays he) all the places wherein the nations which ye ſhall poſſeſs ſerved their gods, upon the *high mountains,* and upon the *hills,* and under every green tree. And ye ſhall overthrow their *altars,* and break down their *pillars,* and burn their *groves* with fire."

The mention of *groves* by the Hebrew lawgiver, brings to our recollection another ſpecies of idolatry, which was perhaps the ſecond in order, as men deviating from the principles of pure theiſm were more and more intangled in the labyrinths of error. The Chaldeans, Egyptians, and all the eaſtern nations who believed in a ſuperintending providence, imagined that the government of this world, the care of particular nations, and even the ſuperintendence of groves, rivers, and mountains, in each nation, was committed by the gods to a claſs of ſpirits ſuperior to the ſoul of man, but inferior to thoſe heavenly intelligences which animated the ſun, the moon, and the planets. Theſe ſpirits were by the Greeks called *δαιμονες, dæmons,* and by the Romans *genii.* Timæus the Locrian, who flouriſhed before Plato, ſpeaking of the puniſhment of wicked men, ſays, All theſe things hath Nemeſis decreed to be executed in the ſecond period, by the miniſtry of vindictive terreſtrial dæmons, who are overſeers of human affairs; to which dæmons the Supreme God, the ruler over all, hath committed the government and adminiſtration of this world, which is made up of *gods, men,* and *animals.*

Concerning the origin of theſe intermediate beings, ſcholars and philoſophers have framed various hypotheſes. The belief of their exiſtence may have been derived from five different ſources.

1. It ſeems to have been impoſſible for the limited capacities of thoſe men, who could not form a notion of a God diveſted of a body and a place, to conceive how the influence and agency of ſuch a being could every inſtant extend to every point of the univerſe. Hence, as we have ſeen, they placed the heavenly regions under the government of a multitude of heavenly gods, the *ſun,* the *moon,* and the *ſtars.* But as the neareſt of thoſe divinities was at an immenſe diſtance from the earth, and as the intelligence animating the earth itſelf had ſufficient employment in regulating the general affairs of the whole globe, a notion inſinuated itſelf into the untutored mind, that theſe ſuperior governors of univerſal nature found it neceſſary, or at leaſt expedient, to employ ſubordinate intelligences or *dæmons* as miniſters to execute their beheſts in the various parts of their widely extended dominions.

2. Such an univerſal and uninterrupted courſe of action, as was deemed neceſſary to adminiſter the affairs of the univerſe, would be judged altogether inconſiſtent with that ſtate of *indolence,* which, eſpecially in the eaſt, was held an indiſpenſable ingredient in perfect felicity. It was this notion, abſurd as it is, which made Epicurus deny the *providence* whilſt he admitted the *exiſtence* of gods. And if it had ſuch an effect upon a philoſopher who in the moſt enlightened ages had many followers, we need not ſurely wonder if it made untaught idolaters imagine that the governor or governors of the univerſe had devolved a great part of their trouble on deputies and miniſters.

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* Hence the proverb of a ſuperſtitious man, *παντα λιθον λιπαρον προσκυνει, he kiſſes or adores every anointed ſtone*; which Arnobius calls *lubricatum lapidem, et ex olivi unguine ſordidatum.*—Stillingfleet's *Origines Sacræ.*

3. When men came to reflect on the infinite diſtance between themſelves and the gods, they would naturally form a wiſh, that there might ſomewhere exiſt a claſs of intermediate intelligences, whom they might employ as mediators and interceſſors with their far diſtant divinities. But what men earneſtly wiſh, they very readily believe. Hence the ſuppoſed diſtance of their gods would, among untutored barbarians, prove a fruitful ſource of intermediate intelligences, more pure and more elevated than human ſouls.

4. Theſe three opinions may be denominated popular; but that which we are now to ſtate, wherever it may have prevailed, was the offspring of philoſophy.—On this earth we perceive a ſcale of beings riſing gradually above each other in perfection, from mere brute matter through the various ſpecies of foſſils, vegetables, inſects, fiſhes, birds, and beaſts, up to man. But the diſtance between man and God is infinite, and capable of admitting numberleſs orders of intelligences, all ſuperior to the human ſoul, and each riſing gradually above the other till they reach that point, wherever it may be, at which creation ſtops. Part of this immenſe chaſm the philoſophers perceived to be actually filled by the heavenly bodies; for in *philoſophical* polytheiſm there was one inviſible God ſupreme over all theſe: but ſtill there was left an immenſe vacuity between the human ſpecies and the moon, which was known to be the loweſt of the heavenly hoſt; and this they imagined muſt certainly be occupied by inviſible inhabitants of different orders and diſpoſitions, which they called good and evil *dæmons*.

5. There is yet another ſource from which the univerſal belief of good and evil dæmons may be derived, with perhaps greater probability than from any or all of theſe. If the Moſaic account of the creation of the world, the peopling of the earth, and the diſperſion of mankind, be admitted as true (and a more conſiſtent account has not as yet been given or deviſed), ſome knowledge of good and evil *angels* muſt neceſſarily have been tranſmitted from father to ſon by the channel of oral tradition. This tradition would be corrupted at the ſame time, and in the ſame manner, with others of greater importance. When the true God was ſo far miſtaken as to be conſidered, not as the ſole governor of the univerſe, but only as the ſelf-extant power of light and good, the Devil would be elevated from the rank of a rebellious created ſpirit to that of the independent power of darkneſs and evil; the angels of light would be transformed into good dæmons, and thoſe of darkneſs into dæmons that are evil. This account of the origin of dæmonology receives no ſmall ſupport from Plato, who derives one branch of it wholly from tradition. "With reſpect to thoſe dæmons (ſays he) who inhabit the ſpace between the earth and the moon, to underſtand and declare their generation is a taſk too arduous for my ſlender abilities. In this caſe we muſt credit the report of men of other times, who, according to their own account, were the deſcendants of the gods, and had, by ſome means or other, gained exact intelligence of that myſtery from their anceſtors. We muſt not queſtion the veracity of the children of the gods, even though they ſhould tranſgreſs the bounds of probability, and produce no evidence to ſupport their aſſertions. We muſt, I ſay, notwithſtanding, give them credit, becauſe they profeſs to give a detail of facts with which they are intimately acquainted, and the laws of our country oblige us to believe them."

Though theſe dæmons were generally inviſible, they were not ſuppoſed to be pure diſembodied ſpirits. Proclus, in his Commentary upon Plato's Timæus, tells us, that "every dæmon ſuperior to human ſouls conſiſted of an intellectual mind and an ethereal vehicle." Indeed it is very little probable, that thoſe who gave a body and place to the Supreme God, ſhould have thought that the inferior orders of his miniſters were ſpirits entirely ſeparated from matter. Plato himſelf divides the claſs of dæmons into three orders; and whilſt he holds their ſouls to be particles or emanations from the divine eſſence, he affirms that the bodies of each order of dæmons are compoſed of that particular element in which they for the moſt part reſide. "Thoſe of the firſt and higheſt order are compoſed of pure ether; thoſe of the ſecond order conſiſt of groſſer air; and dæmons of the third or loweſt rank have vehicles extracted from the element of water. Dæmons of the firſt and ſecond orders are inviſible to mankind. The aquatic dæmons, being inveſted with vehicles of groſſer materials, are ſometimes viſible and ſometimes inviſible. When they do appear, though faintly obſervable by the human eye, they ſtrike the beholder with terror and aſtoniſhment." Dæmons of this laſt order were ſuppoſed to have paſſions and affections ſimilar to thoſe of men; and though all nature was full of them, they were believed to have local attachments to mountains, *rivers*, and *groves*, where their appearances were moſt frequent. The reaſon of theſe attachments ſeems to be obvious. Polytheiſm took its riſe in countries ſcorched by a burning ſun; and dæmons by their compoſition being neceſſarily ſubject in ſome degree to the influence of heat and cold, it was natural to ſuppoſe that they, like men, would delight in the ſhady grove and the purling ſtream. Hence the earlieſt altars of paganiſm were generally built in the midſt of *groves*, or on the banks of *rivers*; becauſe it was believed that in ſuch places were aſſembled multitudes of thoſe intelligences, whoſe office it was to regulate the affairs of men, and to carry the prayers and oblations of the devout to the far-diſtant reſidence of the celeſtial gods. Hence too are to be derived the mountain and river gods, with the dryads and hamadryads, the ſatyrs, nymphs, and fauns, which held a place in the creed of ancient paganiſm, and make ſo conſpicuous a figure in the Greek and Roman poets.

Theſe different orders of intelligences, which, though worſhipped as gods or demigods, were yet believed to partake of human paſſions and appetites, led the way to the deification of departed heroes and other eminent benefactors of the human race. By the philoſophers all ſouls were believed to be emanations from the divinity; but "gratitude and admiration, the warmeſt and moſt active affections of our nature, concurred to enlarge the object of religious worſhip, and to make man regard the inventors of arts and the founders of ſociety as having in them more than a common ray of the divinity. So that, god-like benefits beſpeaking as it were a god-like mind, the deceaſed parent of a people was eaſily advanced into the rank of a dæmon. When the religious bias was in ſo good a train, natural affection would have its ſhare in promoting this new mode of adoration. Piety to parents would naturally take the lead, as it was ſupported by gratitude and admiration, the *primum mobile* of the whole ſyſtem: and in thoſe early ages, the *natural father* of the tribe often happened to be the *political father* of the people, and the founder of the ſtate. Fondneſs for the offspring would next have its turn; and a diſconſolate father, at the head of a people, would contrive to ſooth his grief for the untimely death of a favourite child, and to gratify his pride under the want of *ſucceſſion*, by paying divine honours to its memory." (Warburton.)—"For a father afflicted with untimely mourning, when he had made an image of his child ſoon taken away, now honoured him as a god, who was then a dead man, and delivered to thoſe that were under him ceremonies and ſacrifices." That this was the origin and progreſs of the worſhip of departed ſouls, we have the authority of the famous fragment of Sanchoniathon already quoted, where the various motives for this ſpecies of idolatry are recounted in expreſs words. "After many generations (ſays he) came *Chryſor*; and he invented many things uſeful to civil life, for which, after his deceaſe, he was worſhipped as a *god*. Then flouriſhed *Ouranos* and his ſiſter *Ge*, who deified and offered ſacrifices to their father *Hypſiſtos*, when he had been torn in pieces by wild beaſts. Afterwards *Cronos* conſecrated *Muth* his ſon, and was himſelf conſecrated by his ſubjects."

In the reign of Cronos flouriſhed a perſonage of great reputation for wiſdom, who by the Egyptians was called *Thoth*, by the Phœnicians *Taautos*, and by the Greeks *Hermes*. According to Plutarch, he was a profound politician, and chief counſellor to Oſiris, then the king, and afterwards the principal divinity, of Egypt: and we are told by *Philo Byblius*, the tranſlator of Sanchoniathon, "that it was their *Thoth* or *Hermes* who firſt took the matters of religious worſhip out of the hands of unſkilful men, and brought them into due method and order." His object was to make religion ſerviceable to the intereſts of the ſtate. With this view he appointed *Oſiris* and other departed princes to be joined with the ſtars and worſhipped as gods; and being by Cronos made king of Egypt, he was, after his death, worſhipped himſelf as a god by the Egyptians. To this honour, if what is recorded of him be true, he had indeed a better title than moſt princes; for he is ſaid to have been the inventor of letters, arithmetic, geometry, aſtronomy, and hieroglyphics, and was therefore one of the greateſt benefactors of the human race which any age or country has ever produced.

That the gods of Greece and Rome were derived from Egypt and Phœnicia, is ſo univerſally known, that it is needleſs to multiply quotations in order to prove that the progreſs of polytheiſm among the Greeks and Romans was the ſame with that which we have traced in more ancient nations. The deification of departed heroes and ſtateſmen was that which in all probability introduced the univerſal belief of *national* and *tutelar* gods, as well as the practice of worſhipping thoſe gods through the medium of *ſtatues* cut into a *human figure*. When the founder of a ſtate or any other public benefactor was elevated to the rank of a god, as he was believed ſtill to retain human paſſions and affections, it was extremely natural to ſuppoſe that he would regard with a favourable eye that nation for which he had done ſo much upon earth; that he would oppoſe its enemies, and protect the laws and inſtitutions which he himſelf had given it. By indulging the ſame train of ſentiment, each city, and even every family of conſequence, found *Lares* and *Penates* among their departed anceſtors, to whom they paid the warmeſt adoration, and under whoſe protection they believed their private affairs to be placed. As thoſe national and houſehold gods were believed to be in their deified ſtate clothed with airy bodies, ſo thoſe bodies were ſuppoſed to retain the form which their groſſer bodies had upon earth. The image of a departed friend might perhaps be formed by the hand of ſorrowful affection, before the ſtatue or the ſhrine of a deity was thought of; but when that friend or benefactor became the object of religious adoration, it was natural for his votaries to enliven their devotion by the view of his ſimilitude. Maximus Tyrius tells us, that "there is no race of men, whether barbarian or Grecian, living on the ſea-coaſt or on the continent, wandering in deſerts or living in cities, which hath not conſecrated ſome kind of ſymbol or other in honour of the gods." This is certainly true; but there is no good evidence that the firſt ſymbols of the gods were ſtatues of men and women. Whilſt the ſun and other heavenly bodies continued to be the ſole objects of religious worſhip, the ſymbols conſecrated to them were pillars of a *conical* or *pyramidal* figure; and if ſuch pillars are ever called *graven* images by Moſes and other ancient writers, it was probably on account of the *allegoric figures* and *characters*, or hieroglyphic writing, with which they were inſcribed.

Hitherto we have conſidered the ſouls of departed heroes as holding the rank only of dæmons or demigods; but they gradually roſe in the ſcale of divinities, till they dethroned the heavenly bodies, and became themſelves the *dii majorum gentium*. This revolution was effected by the combined operation of the prince and the prieſt; and the firſt ſtep taken towards it ſeems to have been the complimenting of their heroes and public benefactors with the name of that being which was moſt eſteemed and worſhipped. "Thus, a king for his beneficence was called the *ſun*, and a queen for her beauty the *moon*. Diodorus relates, that Sol firſt reigned in Egypt, called ſo from the luminary of that name in the heavens. This will help us to underſtand an odd paſſage in the fragment of Sanchoniathon, where it is ſaid that *Cronus had ſeven ſons by Rhea, the youngeſt of whom was a* GOD *as ſoon as* BORN. The meaning probably is, that this youngeſt ſon was called after ſome luminary in the heavens to which they paid divine honours; and theſe honours came in proceſs of time to be transferred to the terreſtrial nameſake. The ſame hiſtorian had before told us, that the ſons of Genos, mortals like their father, were called by the names of the elements—*light*, *fire*, and *flame*, of which they had diſcovered the uſe."

"As this adulation advanced into an eſtabliſhed worſhip, they turned the compliment the other way, and called the planet or luminary after the hero, the better to accuſtom the people, even in the act of *planet-worſhip*, to this *new* adoration. Diodorus, in the paſſage already quoted, having told us, that by the firſt inhabitants of Egypt the ſun and moon were ſuppoſed to be the principal and eternal gods, adds, that the former was called Osiris, and the latter Isis. This was indeed the general practice; for we learn from Macrobius, that the Ammonites called the ſun *Moloch*; the Syrians *Adad*; the Arabs *Dionyſus*; the Aſſyrians *Belus*; the Phœnicians *Saturn*; the Carthaginians *Hercules*; and the Palmyrians *Elegabalus*. Again, by the Phrygians the moon was called *Cybele*, or the mother of the gods; by the Athenians *Minerva*; by the Cyprians *Venus*; by the Cretans *Diana*; by the Sicilians *Proſerpine*; by others *Hecate*, *Bellona*, *Veſta*, *Urania*, *Lucina*, &c. Philo Byblius explains this practice: "It is remarkable (ſays he) that the ancient idolaters impoſed on the *elements*, and on thoſe parts of nature which they eſteemed gods, *the names of their kings*: for the natural gods which they acknowledged were only the ſun, moon, planets, elements, and the like; they being now in the humour of having gods of both claſſes, the *mortal* and the *immortal*."

"As a further proof that *hero*-worſhip was thus ſuperinduced upon the *planetary*, it is worthy of obſervation, that the firſt ſtatues conſecrated to the *greater* hero-gods—thoſe who were ſuppoſed to be *ſupreme*—were not of a human form, but *conical* or *pyramidal*, like thoſe which in the earlieſt ages of idolatry were dedicated to the ſun and planets. Thus the ſcholiaſt on the Veſpæ of Ariſtophanes tells us, that the ſtatues of Apollo and Bacchus were *conic* pillars or obeliſks; and Pauſanias, that the ſtatue of Jupiter Meilichius repreſented a *pyramid*; that of the Argive Juno did the ſame, as appears from a verſe of Phoronis quoted by Clemens Alexandrinus; and indeed the practice was univerſal as well amongſt the early barbarians as amongſt the Greeks. But it is well known that the ancients repreſented the *rays of light* by pillars of a conical or pyramidal form; and therefore it follows, that when they erected ſuch pillars as repreſentatives of their hero-gods, theſe latter had ſucceeded to the titles, rights, and honours of the *natural* and *celeſtial divinities*." Warburton.

But though it ſeems to be certain that *hero*-worſhip was thus engrafted on the *planetary*, and that ſome of thoſe heroes in proceſs of time ſupplanted the planets themſelves, this was ſuch a revolution in theology as could not have been ſuddenly effected by the united influence of the prince and the prieſt. We doubt not the fact that Sol was believed to have reigned in Egypt, and was afterwards worſhipped under the name of *Oſiris*; but it was ſurely impoſſible to perſuade any nation, however ſtupid or prone to idolatry, that a man whom they *remembered* diſcharging the duties of their ſovereign and legiſlator, was the identical ſun whom they beheld in the heavens. Oſiris, if there was in Egypt a king of that name, may have been deified immediately after his death, and honoured with that worſhip which was paid to good *dæmons;* but he muſt have been dead for ages before any attempt was made to perſuade the nation that he was the *ſupreme God.* Even then great addreſs would be requiſite to make ſuch an attempt ſucceſsful. The prince or prieſt who entered upon it would probably begin with declaring from the oracle, that the divine intelligence which animates and governs the ſun had deſcended to earth, and animated the perſon of their renowned legiſlator; and that, after their laws were framed, and the other purpoſes ſerved for which the deſcent was made, the ſame intelligence had returned to its original reſidence and employment among the celeſtials. The poſſibility of this double tranſmigration from heaven to earth and from earth to heaven, would without difficulty be admitted in an age when the pre-exiſtence of ſouls was the univerſal belief. Having proceeded thus far in the apotheoſis of dead men, the next ſtep taken in order to render it in ſome degree probable that the early founders of ſtates, and inventors of arts, were divine intelligences clothed with human bodies, was to attribute to one ſuch benefactor of mankind the actions of many of the ſame name. Voſſius, who employed vaſt erudition and much time on the ſubject, has proved, that before the æra of the Trojan wars, moſt kings who were very powerful, or highly renowned for their ſkill in legiſlation, &c. were called *Jove;* and when the actions of all theſe were attributed to one *Jove* of *Crete,* it would be eaſy for the crafty prieſt, ſupported by all the power and influence of the ſtate, to perſuade an ignorant and barbarous people, that he whoſe wiſdom and heroic exploits ſo far ſurpaſſed thoſe of ordinary men muſt have been the ſupreme God in human form.

This ſhort ſketch of the progreſs of polytheiſm and idolatry will enable the reader to account for many circumſtances recorded of the pagan gods of antiquity, which at firſt view ſeem very ſurpriſing, and which at laſt brought the whole ſyſtem into contempt among the philoſophers of Athens and Rome. The circumſtances to which we allude are the immoral characters of thoſe divinities, and the abominable rites with which they were worſhipped. Jupiter, Apollo, Mars, and the whole rabble of them, are deſcribed by the poets as raviſhers of women and notorious adulterers. Hermes or Mercury was a thief, and the god of thieves. Venus was a proſtitute, and Bacchus a drunkard. The malice and revenge of Juno were implacable; and ſo little regard was any of them ſuppoſed to pay to the laws of honour and rectitude, that it was a common practice of the Romans, when beſieging a town, to evocate the tutelar deity, and to tempt him by a reward to betray his friends and votaries. In a word, they were, in the language of the poet,

> "Gods partial, changeful, paſſionate, unjuſt,
> "Whoſe attributes were rage, revenge, and luſt."

This was the natural conſequence of their origin. Having once animated human bodies, and being ſuppoſed ſtill to retain human paſſions and appetites, they were believed, in their ſtate of deification, to feel the ſame ſenſual deſires which they had felt upon earth, and to purſue the ſame means for their gratification. As the men could not well attempt to ſurpaſs the gods in purity and virtue, they were eaſily perſuaded by artful and profligate prieſts, that the moſt acceptable worſhip which could be rendered to any particular deity was to imitate the example of that deity, and to indulge in the practices over which he preſided. Hence the worſhip of Bacchus was performed during the night by men and women mixing in the dark after intemperate eating and drinking. Hence too it was the practice in Cyprus and ſome other countries to ſacrifice to Venus the virginity of young women ſome days before their marriage, in order, as it was pretended, to ſecure their chaſtity ever afterwards; and, if Herodotus may be credited, every woman among the Babylonians was obliged once in her life to proſtitute herſelf in the temple of the goddeſs *Mylitte* (Venus), that ſhe might thenceforward be proof againſt all temptation.

The progreſs of polytheiſm, as far as we have traced it, has been regular; and after the enormous error of forſaking the worſhip of the true God was admitted, every ſubſequent ſtep appears to be natural. It would be no difficult taſk to prove that it has likewiſe been univerſal. Sir William Jones, the learned preſident of the Aſiatic Society, has diſcovered ſuch a ſtriking reſemblance between the gods of ancient Greece and thoſe of the pagans of Hindoſtan, as puts it beyond a doubt that thoſe divinities had the ſame origin. The GANESA of the Hindoos he has clearly proved to be the JANUS of the Greeks and Romans. As the latter was repreſented with two and ſometimes with four faces, as emblems of prudence and circumſpection, the former is painted with an elephant's head, the well-known ſymbol among the Indians of ſagacious diſcernment. The SATURN of Greece and Rome appears to have been the ſame perſonage with the MENU or SATYAVRATA of Hindoſtan, whoſe patronymic name is VAIVASWATA, or *child of the ſun;* which ſufficiently marks his origin. Among the Romans there were many Jupiters, of whom one appears from Ennius to have been nothing more than the firmament perſonified.

> "*Aſpice hoc ſublime candens, quem invocant omnes Jovem.*"

But this Jupiter had the ſame attributes with the Indian god of the viſible heavens called INDRA or the *king,* and DIVESPETIR or the *lord of the ſky,* whoſe conſort is *Sachi,* and whoſe weapon is *vajra* or the thunderbolt. INDRA is the regent of winds and ſhowers; and though the eaſt is peculiarly under his care, yet his Olympus is the north pole, allegorically repreſented as a mountain of gold and gems. With all his power he is conſidered as a ſubordinate deity, and far inferior to the Indian triad BRAHMA, VISHNOU, and MAHADEVA or SIVA, (ſee pl. 16.) who are three forms of one and the ſame godhead. The preſident having traced the reſemblance between the idolatry of Rome and India through many other gods, obſerves, that "we muſt not be ſurpriſed at finding, on a cloſe examination, that the characters of all the pagan deities melt into each other, and at laſt into one or two; for it ſeems a well-founded opinion, that the whole crowd of gods and goddeſſes in ancient Rome, and likewiſe in Hindoſtan, mean only the powers of nature, and principally thoſe of the ſun, expreſſed in a variety of ways, and by a multitude of fanciful names."

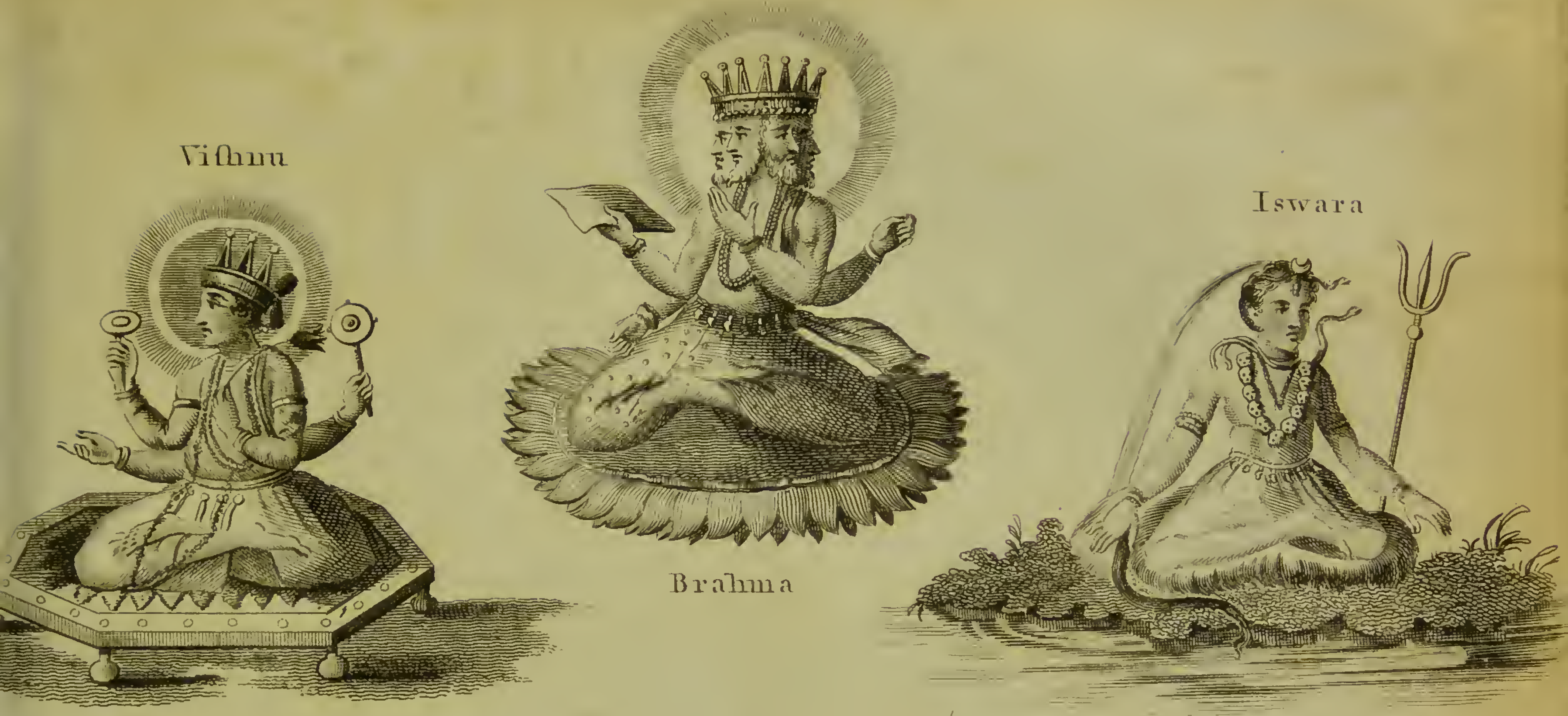
Nor is it only in Greece, Rome, Egypt, and India, that the progreſs of idolatry has been from planetary to hero-worſhip. From every account which modern travellers have given us of the religion of ſavage nations, it appears that thoſe nations adore, as their firſt and greateſt gods, the ſun, moon, and ſtars; and that ſuch of them as have any other divinities have proceeded in the ſame road with the celebrated nations of antiquity, from the worſhip of the heavenly bodies to that of celeſtial dæmons, and from celeſtial dæmons to the deification of dead men. It appears likewiſe that they univerſally believe their hero-gods and demi-gods to retain the paſſions, appetites, and propenſities of men.

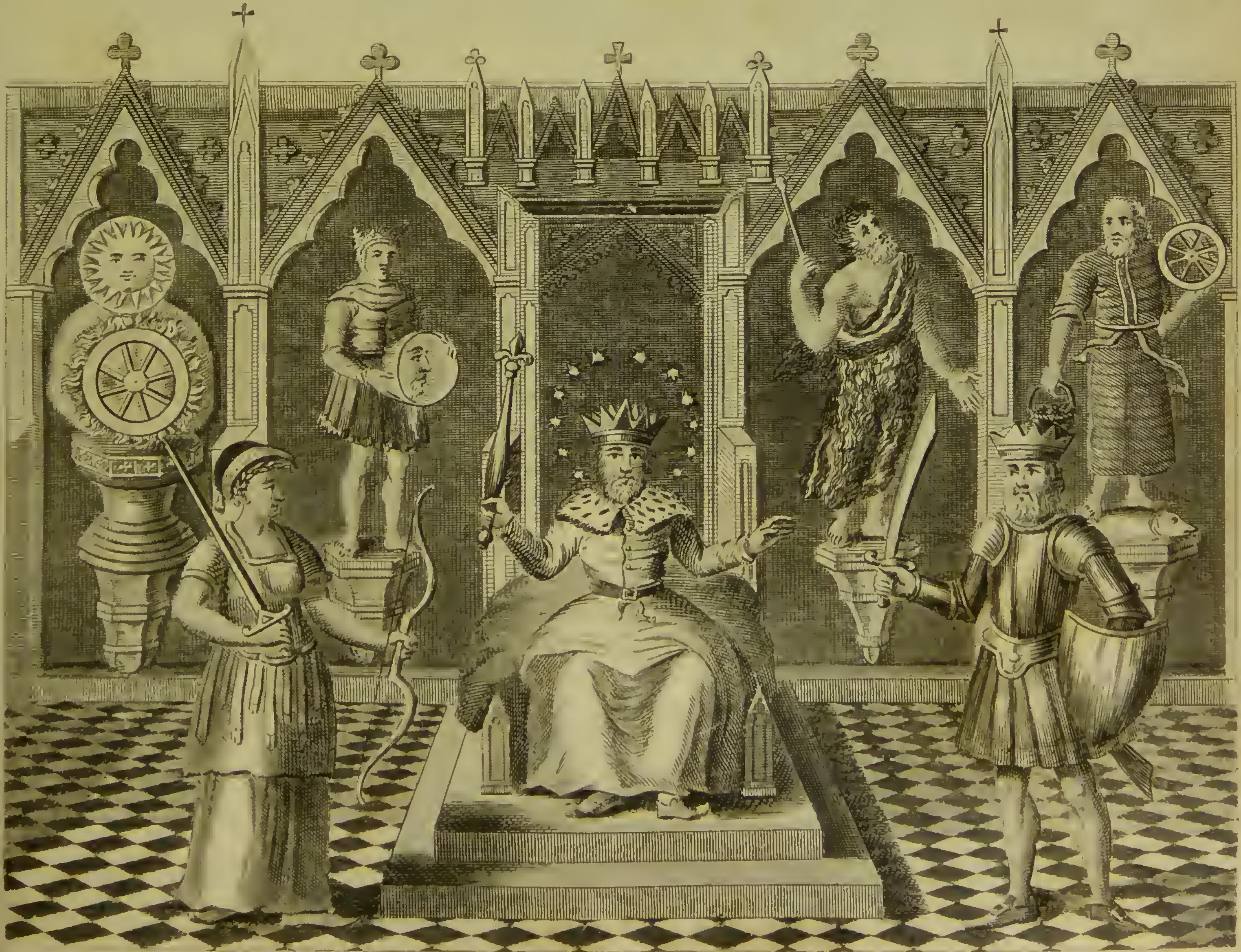
That the Scandinavians and our Saxon anceſtors had the ſame notions of the gods with the other pagans whoſe opinions we have ſtated, is evident from their calling the days of the week by the names of their divinities, and from the forms of the ſtatues by which thoſe divinities were repreſented. (See the plate.)

1. The *Idol of the Sun,* from which *Sunday* is derived, among the Latins *dies Solis,* was placed in a temple, and adored and ſacrificed to; for they believed that the ſun did co-operate

POLYTHEISM.

INDIAN GODS.





The Principal Idols of the Saxons worſhipped in Britain.

with this idol. He was repreſented like a man half naked, with his face like the ſun, holding a burning wheel with both hands on his breaſt, ſignifying his courſe round the world; and by its fiery gleams, the light and heat with which he warms and nouriſheth all things.

2. The *Idol of the Moon*, from which cometh our *Monday*, *dies Lunæ*, anciently *Moonday*, appears ſtrangely ſingular, being habited in a ſhort coat like a man. Her holding a moon expreſſes what ſhe is; but the reaſon of her ſhort coat and long-eared cap is loſt in oblivion.

3. *Tuiſco*, the moſt ancient and peculiar god of the Germans, repreſented in his garment of a ſkin according to their ancient manner of clothing, was, next to the ſun and moon, the idol of higheſt rank in the calendar of northern paganiſm. To him the third day in the week was dedicated; and hence is derived the name *Tueſday*, anciently *Tuiſday*, called in Latin *dies Martis*, though it muſt be confeſſed that Mars does not ſo much reſemble this divinity as he does Odin or Woden.

4. *Woden* was a valiant prince among the Saxons. His image was prayed to for victory over their enemies; which if they obtained, they uſually ſacrificed the priſoners taken in battle to him. Our *Wedneſday* is derived from him, anciently *Wodenſday*. The northern hiſtories make him the father of *Thor*, and *Friga* to be his wife.

5. *Thor* was placed in a large hall, ſitting on a bed canopied over, with a crown of gold on his head, and 12 ſtars over it, holding a ſceptre in the right hand. To him was attributed the power over both heaven and earth; and that as he was pleaſed or diſpleaſed he could ſend thunder, tempeſts, plagues, &c. or fair, ſeaſonable weather, and cauſe fertility. From him our *Thurſday* derives its name, anciently *Thorſday*; among the Romans *dies Jovis*, as this idol may be ſubſtituted for Jupiter.

6. *Friga* repreſented both ſexes, holding a drawn ſword in the right hand and a bow in the left; denoting that women as well as men ſhould fight in time of need. She was generally taken for a goddeſs; and was reputed the giver of peace and plenty, and cauſer of love and amity. Her day of worſhip was called by the Saxons *Frigedeag*, now *Friday*, *dies Veneris*; but the habit and weapons of this figure have a reſemblance of Diana rather than Venus.

7. *Seater*, or *Crodo*, ſtood on the prickly back of a perch. He was thin-viſaged and long-haired, with a long beard, bare-headed and bare footed, carrying a pail of water in his right hand wherein are fruit and flowers, and holding up a wheel in his left, and his coat tied with a long girdle. His ſtanding on the ſharp fins of a fiſh ſignified to the Saxons, that by worſhipping him they ſhould paſs through all dangers unhurt; by his girdle flying both ways was ſhown the Saxons freedom; and by the pail with fruit and flowers was denoted that he would nouriſh the earth. From him, or from the Roman deity Saturn, comes *Saturday*.

Such were the principal gods of the northern nations: but theſe people had at the ſame time inferior deities, who were ſuppoſed to have been tranſlated into heaven for their heroic deeds, and whoſe greateſt happineſs conſiſted in drinking *ale* out of the ſkulls of their enemies in the *hall of Woden*. But the limits preſcribed to the preſent article do not permit us to purſue this ſubject; nor is it neceſſary that we ſhould purſue it. The attentive reader of the article MYTHOLOGY, of the hiſtories given in this work of the various divinities of paganiſm, and of the different nations by whom thoſe divinities were worſhipped, will perceive that the progreſs of polytheiſm and idolatry has been uniform over the whole earth.

There is, however, one ſpecies of idolatry more wonderful than any thing that has yet been mentioned, of which our readers will certainly expect ſome account. It is the worſhip of *brutes*, *reptiles*, and *vegetables*, among the Egyptians. To the Greeks and Romans, as well as to us, that ſuperſtition appeared ſo monſtrous, that to enumerate every hypotheſis, ancient and modern, by which philoſophers have endeavoured to account for it, would ſwell this article beyond all proportion. Brute-worſhip prevailed at ſo early a period in Egypt, that the philoſophers of antiquity, whoſe writings have deſcended to us, had little or no advantage over the moderns in purſuing their reſearches into its origin; and among the modern hypotheſes, thoſe of *Moſheim* and *Warburton* appear to us by much the moſt probable of any that we have ſeen*. The former of theſe learned writers attributes it wholly to the policy of the prince and the craft of the prieſt. The latter contends, with much earneſtneſs and ingenuity, that it reſulted from the uſe of hieroglyphic writing. We are ſtrongly inclined to believe that both theſe cauſes contributed to the production of ſo portentous an effect: and that the uſe of hieroglyphics as ſacred ſymbols, after they were laid aſide in civil life, completed that wonderful ſuperſtition which the craft of the prieſt and the policy of the prince had undoubtedly begun.

We learn from Herodotus, that in his time the number of uſeful animals in Egypt was ſo ſmall as hardly to be ſufficient for tillage and the other purpoſes of civil life; whilſt ſerpents, and other noxious animals, ſuch as the crocodile, wolf, bear, and hippopotamus, abounded in that country. From this fact Moſheim very naturally concludes, that the founders of ſociety and government in Egypt would by every art endeavour to increaſe the number of uſeful animals as the number of inhabitants increaſed; and that with this view they would make it criminal to kill or even to hurt ſheep, cows, oxen, or goats, &c. whilſt they would wage perpetual war upon the noxious animals and beaſts of prey. Such animals as were aſſiſting to them in the carrying on of this warfare would be juſtly conſidered as in a high degree uſeful to ſociety. Hence the moſt grievous puniſhments were decreed againſt the killing, or ſo much as the wounding, of the *ichneumon* and *ibis*; becauſe the former was looked upon as the inſtinctive enemy of the crocodile, and the latter of every ſpecies of ſerpents. The learned writer, however, obſerves, that in Egypt as in other countries, people would be tempted to ſacrifice the good of the public to the gratification of their own appetites, and ſometimes even to the indulgence of a momentary caprice. Hence he thinks it was found neceſſary to ſtrengthen the authority of the laws enacted for the preſervation of uſeful animals by the ſanctions of religion: and he ſays, that with this view the prieſts declared that certain animals were under the immediate protection of certain gods; that ſome of thoſe animals had a divine virtue reſiding in them; and that they could not be killed without the moſt ſacrilegious wickedneſs, incurring the higheſt indignation of the gods. When once the idolatrous Egyptians were perſuaded that certain animals were ſacred to the immortal gods, and had a divine virtue reſiding in them, they could not avoid viewing thoſe animals with ſome degree of veneration; and the prieſts, taking advantage of the ſuperſtition of the people, appointed for each ſpecies of ſacred animals appropriated rites and ceremonies, which were quickly followed with building ſhrines and temples to them, and approaching them with oblations, and ſacrifices, and other rites of divine adoration.

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* There is, however, another hypotheſis worthy of ſome attention, if it were only for the learning and ingenuity of its author. The celebrated Cudworth infers, from the writings of Philo and other Platoniſts of the Alexandrian ſchool, that the ancient Egyptians held the Platonic doctrine of ideas exiſting from eternity, and conſtituting, in one of the perſons of the godhead, the intelligible and archetypal world. (See PLATONISM.) Philo, he obſerves, did not himſelf conſider thoſe ideas as ſo many diſtinct *ſubſtances* and *animals*, much leſs as *gods*; but he mentions others who deified the whole of this intelligible ſyſtem as well as its ſeveral parts. Hence, when they paid their devotions to the *ſenſible ſun*, they pretended to worſhip only the divine *idea* or *archetype* of that luminary: and hence, thinks our learned author, the ancient Egyptians, by falling down to bulls, and cows, and crocodiles, meant at firſt to worſhip only the divine and eternal *ideas* of thoſe animals. He allows, indeed, that as few could entertain any thoughts at all of thoſe eternal ideas, there were ſcarcely any who could perſuade themſelves that the *intelligible ſyſtem* had ſo much reality in it as the *ſenſible things of nature*; and hence he thinks the devotion which was originally paid to the divine ideas had afterwards no higher object than the brutes and vegetables of which thoſe ideas were the eternal patterns.

This hypotheſis is ingenious, but not ſatisfactory. There is no evidence that the myſterious doctrine of Plato concerning *ideas* had anywhere been thought of for ages after brute-worſhip was eſtabliſhed in Egypt. Of the ſtate of Egyptian theology at that early period, Philo, and the other philoſophers of the Alexandrian ſchool, had no better means of forming a judgment than we have; and they laboured under many Grecian prejudices, which muſt have prevented them from judging with our impartiality.

To corroborate this hypotheſis, he obſerves, that, beſides the animals ſacred over all Egypt, each province and each city had its particular animal to which the inhabitants paid their devotions. This aroſe from the univerſal practice among idolaters of conſecrating to themſelves *Lares* and *Penates*; and as the animals which were worſhipped over the whole kingdom were conſidered as ſacred to the *Dii majorum gentium*, ſo the animals whoſe worſhip was confined to particular cities or provinces were ſacred to the *Lares* of thoſe cities and provinces. Hence there was in Upper Egypt a city called *Lycopolis*, becauſe its inhabitants worſhipped the wolf, whilſt the inhabitants of *Thebes* or *Heliopolis* paid their devotions to the eagle, which was probably looked upon as ſacred to the ſun. Our author, however, holds it as a fact which will admit of no diſpute, that there was not one noxious animal or beaſt of prey worſhipped by the Egyptians till after the conqueſt of their country by the Perſians. That the earlieſt gods of Egypt were all benevolent beings, he appeals to the teſtimony of Diodorus Siculus; but he quotes Herodotus and Plutarch, as agreeing that the latter Egyptians worſhipped an evil principle under the name of *Typhon*. This *Typhon* was the inveterate enemy of *Oſiris*, juſt as *Ahraman* was of *Ormuzd*; and therefore he thinks it in the higheſt degree probable that the Egyptians derived their belief of two ſelf-exiſtent principles, a good and an evil, from their Perſian conquerors, among whom that opinion prevailed from the earlieſt ages.

From whatever ſource their belief was derived, Typhon was certainly worſhipped in Egypt, not with a view of obtaining from him any good, for there was nothing good in his nature, but in hopes of keeping him quiet, and averting much evil. As certain animals had long been ſacred to all the benevolent deities, it was natural for a people ſo beſotted with ſuperſtition as the Egyptians to conſecrate emblems of the ſame kind to their god Typhon. Hence aroſe the worſhip of *ſerpents, crocodiles, bears*, and other noxious animals and beaſts of prey. It may indeed ſeem at firſt ſight very inconſiſtent to deify ſuch animals, after they had been in the practice for ages of worſhipping others for being their deſtroyers; but it is to be remembered, that long before the deification of crocodiles, &c. the real origin of brute worſhip was totally forgotten by the people, if they were ever acquainted with it. The crafty prieſt who wiſhes to introduce a gainful ſuperſtition, muſt at firſt employ ſome plauſible reaſon to delude the multitude; but after the ſuperſtition has been long and firmly eſtabliſhed, it is obviouſly his buſineſs to keep its origin out of ſight.

Such is Moſheim's account of the origin and progreſs of that ſpecies of idolatry which was peculiar to Egypt; and with reſpect to the *riſe* of *brute* worſhip, it appears perfectly ſatisfactory. But the Egyptians worſhipped ſeveral ſpecies of vegetables; and it ſurely could be no part of the policy of wiſe legiſlators to preſerve *them* from deſtruction, as vegetables are uſeful only as they contribute to animal ſubſiſtence. We are therefore obliged to call in the aid of Warburton's hypotheſis to account for this branch of Egyptian ſuperſtition.

That learned and ingenious author having proved, with great clearneſs and ſtrength of argument, that hieroglyphic writing was prior to the invention of alphabetic characters; and having traced that kind of writing from ſuch rude pictures as thoſe which were in uſe among the Mexicans, through all the different ſpecies of what he calls *curiologic*, *tropical*, and *ſymbolic* hieroglyphics (ſee HIEROGLYPHICS)—ſhows, by many quotations from ancient authors, that the Egyptian prieſts wrapt up their theology in the ſymbolic hieroglyphics, after alphabetic characters had baniſhed from the tranſactions of civil life a mode of communicating information neceſſarily ſo obſcure. Theſe ſymbols were the figures of animals and vegetables, denoting, from ſome imaginary analogy, certain attributes of their divinities; and when the vulgar, forgetting this analogy, ceaſed to underſtand them as a ſpecies of writing, and were yet taught to conſider them as ſacred, they could not well view them in any other light than as emblems of the divinities whom they adored. But if rude ſculptures upon ſtone could be emblematical of the divinities, it was ſurely not unnatural to infer, that the living animals and vegetables which thoſe ſculptures repreſented muſt be emblems of the ſame divinities more ſtriking and more ſacred. Hence the learned author thinks aroſe that wonderful ſuperſtition peculiar to the Egyptians, which made them worſhip not only animals and vegetables, but alſo a thouſand chimeras of their own creation; ſuch as figures with human bodies and the heads or feet of brutes, or with brutal bodies and the heads and feet of men.

Theſe two hypotheſes combined together appear to us to account ſufficiently for the idolatry of Egypt, monſtrous as it was. We are perſuaded, that with reſpect to the *origin* of brute-worſhip, Moſheim is in the right[*]; and it was a very eaſy ſtep for people in ſo good training to proceed upon the crutches of hieroglyphics to the worſhip of plants and thoſe chimeras, which, as they never had a real exiſtence in nature, could not have been thought of as emblems of the divinity, had they not been uſed in that ſymbolic writing which Warburton ſo ably and ingeniouſly explains.

To this account of the origin of brute-worſhip we are fully aware that objections will occur. From a learned friend, who peruſed the article in manuſcript, we have been favoured with one which, as it is exceedingly plauſible, we ſhall endeavour to obviate. "Brute-worſhip was not peculiar to Egypt. The Hindoos, it is well known, have a religious veneration for the cow and the alligator; but there is no evidence that in India the number of uſeful animals was ever ſo ſmall as to make the interference of the prince and the prieſt neceſſary for their preſervation; neither does it appear that the Hindoos adopted from any other people the worſhip of a ſelf-exiſtent principle of evil." Such is the objection. To which we reply,

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[*] To prove that it was merely to preſerve and increaſe the breed of uſeful animals in Egypt, that the prince and the prieſt *firſt* taught the people to conſider ſuch animals as ſacred, he argues thus: "Hæc ita eſſe, non ex eo tantum liquet, quod paulo ante obſervavi, nullas beſtias univerſo Ægyptiorum populo ſacras fuiſſe, præter eas, quæ manifeſtam regioni utilitatem comparant; ſed inde quoque apparet, quod longe major ratio habita fuit femellarum inter animalia, quam marium. Boves diis immolare licebat, vaccas nullo modo. Canes fœminæ contumulabantur, non item mares." *Lege* HERODOT. *Hiſtor.* lib. ii. cap. 41. & cap. 67.

That there is every reaſon to believe that brute-worſhip was introduced into India by a colony of Egyptians at a very remote period. That between theſe two nations there was an early intercourſe, is univerſally allowed: and though the learned preſident of the Aſiatic Society has laboured to prove, that the Egyptians derived all that wiſdom for which they were famed, as well as the rudiments of their religious ſyſtem, from the natives of Hindoſtan, he does not appear to us to have laboured with ſucceſs. To examine his arguments at length would ſwell this article beyond its due proportion; and we have noticed ſome of them elſewhere (ſee PHILOLOGY). At preſent we ſhall only obſerve, that Seſoſtris undoubtedly made an inroad into India, and conquered part of the country, whilſt we nowhere read of the Hindoos having at any time conquered the kingdom of Egypt. Now, though the victors have ſometimes adopted the religion of the vanquiſhed, the contrary has happened ſo much more frequently, and is in itſelf a proceſs ſo much more natural, that this ſingle circumſtance affords a ſtrong preſumption that the Egyptian monarch would rather impoſe his gods upon the Hindoos than adopt theirs and carry them with him to Egypt. Brute-worſhip might likewiſe be introduced into Hindoſtan by thoſe vaſt colonies of Egyptians who took refuge in that country from the tyranny and oppreſſion of the ſhepherd kings. That ſuch colonies did ſettle on ſome occaſion or other in India ſeems undeniable, from monuments ſtill remaining in that country of forms which could hardly have occurred to a native of Aſia, though they are very natural as the workmanſhip of Africans. But we need not reaſon in this manner. We have ſeen a manuſcript letter from Mr. Burt, a learned ſurgeon in Bengal, and a member of the Aſiatic Society, which puts it beyond a doubt that great numbers of Egyptians had at a very early period not only ſettled in Hindoſtan, but alſo brought with them writings relating to the hiſtory of their country. As the ſhepherd-kings were enemies to the arts and to literature, it is probable that this ſettlement took place on their conqueſt of Egypt. Mr. Burt's words are: "Mr. Wilford, lieutenant of engineers, has extracted moſt wonderful diſcoveries from the Shanſcrit records; ſuch as the origin and hiſtory of the Egyptian pyramids, and even the account of the expence in their building." Upon our hypotheſis there is nothing incredible in this account; upon the hypotheſis of Sir William Jones, it is not eaſy to be conceived how the hiſtory of *Egyptian* pyramids could have found a place in the *Shanſcrit* records.

We may admit that the Hindoos have never adopted from the Perſians or Egyptians the worſhip of an independent principle of evil, and yet diſpoſe of the other part of the objection with very little difficulty. It will be ſeen by and by, that the bramins believe a kind of triad of hypoſtaſes in the divine nature, of which one is viewed as the *deſtroyer*, and known by ſeveral names, ſuch as *Siva* and *Iſwara*. When brute-worſhip was introduced into Hindoſtan, it was not unnatural to conſider the alligator as emblematical of *Iſwara*; and hence in all probability it is that the Hindoos believe that a man cannot depart more happily from this world than by falling into the Ganges, and being devoured by one of thoſe ſacred animals. Upon the whole, the brute-worſhip of the Hindoos, inſtead of militating againſt our account of that monſtrous ſuperſtition as it prevailed in Egypt, ſeems to lend no ſmall ſupport to that account, as there was unqueſtionably an early intercourſe between the two nations, and as colonies of Egyptians ſettled in India. To him who is not ſatisfied with our reaſoning on this ſubject, we beg leave to recommend an attentive peruſal of Maurice's *Indian Antiquities*, where he will find many facts brought together which tend to prove that Egypt has a juſt claim to a higher antiquity than India.

Having thus traced the riſe and progreſs of polytheiſm and idolatry as they prevailed in the moſt celebrated nations of antiquity, we now proceed to inquire into the real opinions of thoſe nations concerning the nature of the gods whom they adored. And here it is evident from the writings of Homer, Heſiod, and the other poets, who were the principal theologians among the Greeks and Romans, that though heaven, earth, hell, and all the elements, were filled with divinities, there was yet one who, whether called *Jove*, *Oſiris*, *Ormuzd*, or by any other title, was conſidered as ſupreme over all the reſt. "Whence each of the gods was generated (ſays Herodotus), or whether they have all exiſted from eternity, and what are their *forms*, is a thing that was not known till very lately; for Heſiod and Homer were, as I ſuppoſe, not above four hundred years my ſeniors; and theſe were they who introduced the theogony among the Greeks, and gave the gods their ſeveral names." Now Heſiod, towards the beginning of his theogony, expreſsly invokes his muſe to celebrate in ſuitable numbers the generation of the immortal gods who had ſprung from the earth, the dark night, the ſtarry heavens, and the ſalt ſea. He calls upon her likewiſe to ſay, "in what manner the gods, the earth, the rivers, ocean, ſtars, and firmament, were generated, and what divine intelligences had ſprung from them of benevolent diſpoſitions towards mankind." From this invocation, it is evident that the poet did not conſider the gods of Greece as ſelf-exiſtent beings: neither could he look upon them as *creatures*; for of creation the ancient Greeks had no conception (ſee METAPHYSICS): but he conſidered them as emanations coeval with the earth and heavens, from ſome ſuperior principles; and by the divine intelligences ſprung from them, there cannot be a doubt but that he underſtood benevolent dæmons. The firſt principles of all things, according to the ſame Heſiod, were *Chaos*, and *Tartarus*, and *Love*; of which only the laſt being active, muſt undoubtedly have been conceived by this father of Grecian polytheiſm to be the greateſt and only ſelf-exiſting god. This we ſay muſt undoubtedly have been Heſiod's belief, unleſs by *Tartarus* we here underſtand a ſelf-exiſtent principle of evil; and in that caſe his creed will be the ſame with that of the ancient Perſians, who, as we have ſeen, believed in the ſelf-exiſtence as well of *Ahraman* as of *Ormuzd*.

Heſiod is ſuppoſed to have taken his theology from Orpheus; and it is evident that his doctrine concerning the generation of the gods is the ſame with that taught in certain verſes uſually attributed to Orpheus, in which Love and Chaos are thus brought together. "We will firſt ſing (ſays the poet) a pleaſant and delightful ſong concerning the ancient Chaos, how the heavens, earth, and ſeas, were formed out of it; as alſo concerning that all-wiſe *Love*, the oldeſt and ſelf-perfect principle, which actively produced all theſe things, ſeparating one from another." In the original paſſage, Love is ſaid not only to be πολυμητις, of *much wiſdom* or *ſagacity*, and therefore a real intelligent ſubſtance; but alſo to be πρεσβυτατος and αυτοτελης, the *oldeſt* and *ſelf-perfect*, and therefore a being of ſuperior order to the other divinities who were generated together with the elements over which they were conceived to preſide.

With the theology of Homer our readers of all deſcriptions are ſo well acquainted, that we need not ſwell the article with quotations, to prove that the father of epic poetry held *Jove* to be the father of gods and men. But the doctrine of the poets was the creed of the vulgar Greeks and Romans; and therefore we may conclude, that thoſe nations, though they worſhipped gods and lords innumerable, admitted but one, or at the moſt two*, ſelf-exiſtent principles; the one good and the other evil. It does not indeed appear, that in the ſyſtem of vulgar paganiſm the ſubordinate gods were accountable to their chief for any part of their conduct, except when they tranſgreſſed the limits of the provinces aſſigned them. Venus might conduct the amours of heaven and earth in whatever manner ſhe pleaſed; Minerva might communicate or with-hold wiſdom from any individual with or without reaſon; and we find, that in Homer's battles the gods were permitted to ſeparate into parties, and to ſupport the Greeks or Trojans according as they favoured the one or the other nation. Jove indeed ſometimes called them to order; but his interference was thought partial, and an inſtance of tyrannical force rather than of juſt authority. The vulgar Greeks, therefore, although they admitted but one, or at moſt two, ſelf-exiſtent principles, did not conſider the inferior divinities as mediators between them and the ſupreme, but as gods to whom their worſhip was on certain occaſions to be ultimately directed.

The creed of the philoſophers ſeems to have been different. Such of them as were theiſts, and believed in the adminiſtration of Providence, admitted but of one God, to whom worſhip was ultimately due; and they adored the ſubordinate divinities as his children and miniſters, by whom the courſe of Providence was carried on. With reſpect to the origin of thoſe divinities, Plato is very explicit; where he tells us, that "when all the gods, both thoſe who move viſibly round the heavens, and thoſe who appear to us as often as they pleaſe, were generated, that God, who made the whole univerſe, ſpoke to them after this manner: Ye gods of gods, of whom I myſelf am father, attend." Cicero teaches the very ſame doctrine with Plato concerning the gods; and Maximus Tyrius, who ſeems to have underſtood the genius of polytheiſm as thoroughly as any man, gives us the following clear account of that ſyſtem as received by the philoſophers:

"I will now more plainly declare my ſenſe by this ſimilitude: Imagine a great and powerful kingdom or principality, in which all agree freely and with one conſent to direct their actions according to the will and command of one ſupreme king, the oldeſt and the beſt; and then ſuppoſe the bounds and limits of this empire not to be the river Halys, nor the Helleſpont, nor the Mæotian lake, nor the ſhores of the ocean; but heaven above, and the earth beneath. Here then let that great king ſit immoveable, preſcribing to all his ſubjects laws, in the obſervance of which conſiſt their ſafety and happineſs: the partakers of his empire being many, both viſible and inviſible gods; ſome of which that are neareſt and immediately attending on him, are in the higheſt regal dignity, feaſting as it were at the ſame table; others again are their miniſters and attendants; and a third ſort are inferior to them both: and thus you ſee how the order and chain of this government deſcends down by ſteps and degrees from the ſupreme God to the earth and men." In this paſſage we have a plain acknowledgment of one ſupreme God, the ſovereign of the univerſe, and of three inferior orders of gods, who were his miniſters in the government of the world; and it is worthy of obſervation, that the ſame writer calls theſe intelligences *ϑεους, ϑεου παιδας και φιλους*, *gods, the ſons and friends of God.* He likewiſe affirms, that all ranks of men, and all nations on earth, whether barbarous or civilized, held the ſame opinions reſpecting one ſupreme Numen and the generation of the other gods.

"If there were a meeting (ſays he) called of all theſe ſeveral profeſſions, a painter, a ſtatuary, a poet, and a philoſopher, and all of them were required to declare their ſenſe concerning *the God*; do you think that the painter would ſay one thing, the ſtatuary another, the poet a third, and the philoſopher a fourth? No; nor the Scythian neither, nor the Greek, nor the Hyperborean. In other things we find men ſpeaking very diſcordantly, all men as it were differing from all. But amidſt this war, contention and diſcord, you may find everywhere, throughout the whole world, one uniform law and opinion, that there is ONE GOD, THE KING AND FATHER OF ALL, and many gods, the SONS OF GOD, who reign with GOD. Theſe things both the Greek and barbarian affirm, both the inhabitants of the continent and of the ſea-coaſt, both the wiſe and the unwiſe."

This account of philoſophical polytheiſm receives no ſmall ſupport from the Aſiatic Reſearches of Sir William Jones. "It muſt always be remembered (ſays that accompliſhed ſcholar), that the learned Indians, as they are inſtructed by their own books, acknowledge only one ſupreme Being, whom they call BRAHME, or THE GREAT ONE, in the neuter gender (See the plate). They believe his eſſence to be infinitely removed from the comprehenſion of any mind but his own; and they ſuppoſe him to manifeſt his power by the operation of his divine ſpirit, whom they name VISHNOU the *pervader*, and NE'RA'YAN or *moving on the waters*, both in the maſculine gender; whence he is often denominated the *firſt male*. When they conſider the divine power as exerted in *creating* or giving exiſtence to that which exiſted not before, they call the deity Brahma; when they view him in the light of *deſtroyer*, or rather *changer of forms*, they give him a thouſand names, of which Siva, Iswara, and Mahadeva, are the moſt common; and when they conſider him as the preſerver of created things, they give him the name of Vishnou. As the ſoul of the world, or the pervading *mind*, ſo finely deſcribed by Virgil, we ſee Jove repreſented by ſeveral Roman poets; and with great ſublimity by Lucan in the well known ſpeech of Cato concerning the Ammonian oracle. 'Jupiter is wherever we look, wherever we move.' This is preciſely the Indian idea of Vishnou: for, ſince the power of preſerving created things by a ſuperintending providence belongs eminently to the godhead, they hold that power to exiſt tranſcendently in the *preſerving* member of the triad, whom they ſuppoſe to be EVERYWHERE ALWAYS, not in ſubſtance, but in ſpirit and energy." This ſupreme god, Brahme, in his triple form, is the only ſelf-exiſtent divinity acknowledged by the philoſophical Hindoos. The other divinities, Genesa, Indra, Cuvera, &c. are all looked upon either as his creatures or his children; and of courſe are worſhipped only with inferior adoration.

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* Plutarch is commonly ſuppoſed, and we think juſtly ſuppoſed, to have been a believer in two ſelf-exiſtent principles, a good and an evil. His own opinion, whatever it was, he declares (*de Iſide et Oſiride*) to have been moſt ancient and univerſal, and derived from theologers and lawgivers by poets and philoſophers. "Though the firſt author of it be unknown, yet (ſays he) it hath been ſo firmly believed *everywhere*, that traces of it are to be found in the ſacrifices and myſteries both of the *barbarians* and the Greeks. There is a confuſed mixture of good and evil in every thing, and nothing is produced by nature *pure*. Wherefore it is not one only diſpenſer of things, who, as it were, out of ſeveral veſſels diſtributeth theſe ſeveral liquors of good and evil, mingling them together, and daſhing them as he pleaſes; but there are two diſtinct and contrary powers or principles in the world, one of them always leading, as it were, to the right hand, but the other tugging the contrary way. For, if nothing can be made without a cauſe, and that which is good cannot be the cauſe of evil, there muſt needs be a diſtinct principle in nature for the production of evil as well as good."

That this is palpable manicheiſm (ſee MANICHEISM), appears to us ſo very evident, as to admit of no debate. It appeared in the ſame light to the learned Cudworth; but that author labours to prove that Plutarch miſtook the ſenſe of Pythagoras, Empedocles, Heraclitus, Anaxagoras, and Plato, when he attributed to them the ſame opinions which were held by himſelf. Moſheim, on the other hand, has put it beyond a doubt, that whatever was Plutarch's belief reſpecting the origin of evil and the exiſtence of two independent principles, it was taken implicitly from the writings of Plato. But the pious chancellor of *Gottingen*, actuated by the ſame motives with Cudworth, wiſhes to perſuade his readers, that by Plato and Plutarch nothing *active* was underſtood by their evil principle, but only *that tendency to confuſion*, which was then deemed inſeparable from matter. But that ſomething more was meant ſeems undeniable; for, immediately after the words which we have quoted, Plutarch proceeds to affirm that the wiſeſt men declare θεους ειναι δυο καθαπερ αντιτεχνους, *that there are two gods, as it were of contrary trades or crafts*, of which one is the author of all good and the other of all evil. See *Moſheim. ed. Cudworth. Syſtem. Intellect.* lib. i. cap. 4. § 13.

It was upon this principle of the generation of the gods, and of their acting as miniſters to the ſupreme *Numen*, that all the philoſophers of Greece, who were not atheiſts, worſhipped many divinities, though they either openly condemned or ſecretly deſpiſed the traditions of the poets reſpecting the amours and villanies of Jupiter, Venus, Mercury, and the reſt of the tribe. It was the ſame principle ſincerely admitted, and not an ill timed jeſt, as has been abſurdly ſuppoſed, that made Socrates, after he had ſwallowed the poiſon, requeſt his friend to offer a votive cock for him to Eſculapius.

But a theogony was not peculiar to the Greeks, Romans, and the Hindoos; it made part of every ſyſtem of polytheiſm. Even the Egyptians themſelves, the groſſeſt of all idolaters, believed in one ſelf exiſting God, from whom all their other divinities deſcended by generation. This appears probable from the writings of Horus Apollo, Jamblichus, Porphyry, and many other ancient authors; but if the inſcription on the gates of the temple of *Neith* in *Sais*, as we have it from Plutarch and Proclus, be genuine, it will admit of no doubt. This famous inſcription, according to the laſt of theſe writers, was to this purpoſe: "I am whatever is, whatever ſhall be, and whatever hath been. My veil no man hath removed. The offspring which I brought forth was the ſun *."

The Perſian magi, as we have ſeen, believed in two ſelf-exiſtent principles, a good and an evil: but if Diogenes Laertius deſerves to be credited, they held that fire, earth, and water, which they called gods, were generated of theſe two. It was obſerved in the beginning of this article, that the firſt object of idolatrous worſhip was probably the ſun, and that this ſpecies of idolatry took its riſe in Chaldea or Perſia. But when it became the practice of eaſtern monarchs to conceal themſelves wholly from their people, the cuſtom, as implying dignity, was ſuppoſed to prevail as well in heaven as on earth; and Zoroaſter, the reformer of the Perſian theology, taught, that "Ormuzd was as far removed from the ſun as the ſun is removed from the earth." According to this modification of magianiſm, the ſun was one of the generated gods, and held the office of prime miniſter or vicegerent to the inviſible fountain of light and good. Still, however, a ſelf-exiſtent principle of evil was admitted; but though he could not be deſtroyed or annihilated by any power, it was believed that he would at laſt be completely vanquiſhed by Ormuzd and his miniſters, and rendered thenceforward incapable of producing any miſchief.

From this ſhort view of polytheiſm, as we find it delineated by the beſt writers of antiquity, we think ourſelves warranted to conclude, that the whole pagan world believed in but *one*, or at moſt *two*, SELF-EXISTENT GODS, from whom they conceived all the other divinities to have deſcended in a manner analogous to human generation. It appears, however, that the vulgar pagans conſidered each divinity as ſupreme and unaccountable within his own province, and therefore entitled to worſhip, which reſted ultimately in himſelf. The philoſophers, on the other hand, ſeem to have viewed the inferior gods as accountable for every part of their conduct to him who was their ſire and ſovereign, and to have paid to them only that inferior kind of devotion which the church of Rome pays to departed ſaints. The vulgar pagans were ſunk in the groſſeſt ignorance, from which ſtateſmen, prieſts, and poets, exerted their utmoſt influence to keep them from emerging; for it was a maxim which, however abſurd, was univerſally received, that "there were many things true in religion, which it was not convenient for the vulgar to know: and ſome things which, though falſe, it was yet expedient that they ſhould believe." The polytheiſm and idolatry of the vulgar, therefore, was their misfortune rather than their fault. But the philoſophers were wholly "without excuſe; becauſe that, when they knew God, they glorified him not as God, neither were thankful, but became vain in their imaginations, and their fooliſh heart was darkened. Profeſſing themſelves wiſe, they became fools, and worſhipped and ſerved the creature more than the Creator, who is God bleſſed for ever." *Romans*, i. 20, 21, &c.

POLYTRICHUM, in botany: A genus of the order of muſci, belonging to the cryptogamia claſs of plants. The anthera is operculated, and placed upon a very ſmall apophyſis or articulation; the calyptra villous; the ſtar of the female is on a diſtinct individual. There are three ſpecies; the moſt remarkable of which is the *commune*, or great golden maiden-hair, frequently to be met with in the bogs and wet places of this country. It grows in patches, the ſtalks erect, generally ſingle and unbranched, from three inches to a foot, or even a yard high. The leaves are numerous, ſtiff, lanceolate, acute, growing round the ſtalk without order, and, if viewed with a microſcope, appear to have their edges finely ſerrated. They are of a bright green when young and freſh, but reddiſh when dried or in decay: the filaments, or peduncles, are of a ſhining red, or orange colour, from two to four inches long, ariſing ſingly from the top of the ſtalks, and ſurrounded at their baſe with a cylindrical tubular vagina, or perichætium. The anthera, or capſule, is quadrangular, green at firſt, afterwards yellow, and red when ripe, having an annular pedeſtal, or apophyſis, at its baſe. The operculum is flat, with a projecting point in the centre; and underneath is a whitiſh circular membrane, placed in the middle of the capſule's orifice, and ſuſtained there by numerous arched threads, or cilia, connected by one end to the circumference of this membrane, and by the other faſtened to the ring of the anthera. The pollen, or, as others term it, the ſeed, is freed from the anthera or capſule through the ſpace between the cilia. The calyptra is twofold, an internal and external one; both which at firſt entirely cover and hang over the anthera. The internal one is conical, membranaceous, and ſmooth; the external one is compoſed only of tawny hairs, connected into a ſort of mat, lacerated at the baſe, and ſerving like a roof of thatch to defend the other. Beſides the ſtalks before deſcribed, there are commonly ſome others near at hand, which are deſtitute both of filaments and capſules, but are terminated with a kind of roſaceous cup, either of a bright red or yellowiſh colour, compoſed of leaves of different ſizes, the outermoſt broad, the innermoſt lanceolate, growing gradually more and more fine and ſlender to the centre. This cup is looked upon by Linnæus as the female flower of this moſs; but Haller is of opinion, that it is only the gem or origin of a new ſtalk, which frequently riſes from its centre, and this again becomes ſometimes proliferous. There are two varieties of this moſs: the firſt has much ſhorter ſtalks than the preceding, and often branched; the leaves ſtiffer, erect, and more crowded; in other reſpects the ſame. The other has a ſtalk ſcarcely more than half an inch high, terminated with a cluſter of linear, erect, rigid leaves, for the moſt part entire on the edges, and tipped each with a white hair. The filament is about an inch high, and the capſule quadrangular. The female flower, or gem, is of a bright red colour.

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* Τα οντα, και τα εσομενα, και τα γεγονοτα, εγω ειμι. Τον εμον χιτωνα ουδεις απεκαλυψεν. Ὁν εγω καρπον ετεκον, ἡλιος εγενετο. The antiquity of this inſcription is admitted by Cudworth, denied by Moſheim, and doubted by Jablonſki. The reader who wiſhes to know their arguments may conſult Moſheim's edition of the *Intellectual Syſtem*, and Jablonſki's *Pantheon Ægyptiorum*.

The firſt kind, when it grows long enough for the purpoſe, is ſometimes uſed in England and Holland to make brooms or bruſhes. Of the female ſort the Laplanders, when obliged to ſleep in deſert places, frequently make a ſpeedy and convenient bed. Their manner of doing it is curious: Where this moſs grows thick together, they mark out, with a knife, a piece of ground, about two yards ſquare, or of the ſize of a common blanket; then beginning at one corner, they gently ſever the turf from the ground; and as the roots of the moſs are cloſely interwoven and matted together, they by degrees ſtrip off the whole circumſcribed turf in one entire piece: afterwards they mark and draw up another piece, exactly correſponding with the firſt; then, ſhaking them both with their hands, they lay one upon the ground, with the moſs uppermoſt, inſtead of a mattreſs, and the other over it, with the moſs downwards, inſtead of a rug; and between them both take a comfortable nap, free from fleas and bugs, and without fear of contagious diſtempers. It is probable they might take the hint of making ſuch a bed from the bear, a cohabitant of their country, which prepares his winter quarters with a large collection of this ſame moſs. See Musci, and the plate annexed to that article.

POLYXÆNUS, or Polyænus. See Polyænus.

POLYXO, a prieſteſs of Apollo's temple in Lemnos. She was likewiſe nurſe to queen Hypſipyle. It was by her advice that the Lemnian women murdered all their huſbands.—— There was another Polyxo, a native of Argos, who married Tlepolemus ſon of Hercules. She followed him to Rhodes after the murder of his uncle Licymnius; and when he departed for the Trojan war with the reſt of the Greek princes, ſhe became the ſole miſtreſs of the kingdom. After the Trojan war, Helen fled from Peloponneſus to Rhodes, where Polyxo reigned. Polyxo detained her; and to puniſh her as being the cauſe of a war in which Tlepolemus had periſhed, ſhe ordered her to be hanged on a tree by her female ſervants, diſguiſed in the habit of Furies.

POMACEÆ, (*pomum* "an apple,") the name of the 36th order in Linnæus's Fragments of a natural method, the genera of which have a pulpy eſculent fruit of the apple, berry, and cherry kind. See Botany.

POMATUM, an unguent generally uſed in dreſſing the hair. It is compoſed of one part of freſh ſuet and five of lard, briſkly ſtirred or beaten in a mortar, with any kind of agreeable eſſence or perfume.

POMEGRANATE. See Punica.

POMERANIA, a province of Germany, in the circle of Upper Saxony, with the title of a duchy. It is bounded on the north by the Baltic Sea, on the eaſt by Pruſſia and Poland, on the ſouth by the marquiſate of Brandenburg, and on the weſt by the duchy of Mecklenburgh; and is about 250 miles in length, and in ſome places 75 miles and in others 50 in breadth. It is watered by ſeveral rivers, the moſt conſiderable of which are the Oder, the Pene, the Rega, the Perſant, the Wipper, the Stolp, the Lupo, and the Lobo. The air is cold; but the ſoil abounds in paſtures, and produces corn, of which a great deal is exported. It is a flat country; containing many lakes, woods, and foreſts, and has ſeveral good harbours. It is divided into the Hither and Farther Pomerania, and the territories of the kings of Sweden and Pruſſia in this duchy are divided by the river Pene.

POMET (Peter), an able druggiſt at Paris, was born in 1658. He collected at a great expenſe from all countries drugs of every kind, and rendered himſelf celebrated by his book entitled *Hiſtoire Generale des Drogues*, which is the moſt complete book on the ſubject that has yet been printed. He gave demonſtrations with reſpect to his drugs in the king's garden, and a catalogue of all the drugs contained in his work. with a liſt of all the rarities of his cabinet, which he propoſed to publiſh by ſubſcription; but was prevented by his death, which happened in 1679, upon the very day when the patent for a penſion granted him by Louis XIV. was made out.

POMFRET (John), an Engliſh poet, ſon of the rector of Luton in Bedfordſhire, was born in 1667, and educated at Cambridge; after which he took orders, and was preſented to the living of Malden in Bedfordſhire. About 1703 he went to London for inſtitution to a larger and very conſiderable living; but was ſtopped ſome time by Compton, then biſhop of London, on account of theſe four lines of his poem, entitled The Choice:

> "And as I near approach'd the verge of life,
> Some kind relation (for I'd have no wife)
> Should take upon him all my worldly care,
> While I did for a better ſtate prepare."

The parentheſis in theſe lines was ſo maliciouſly repreſented, that the good biſhop was made to believe that Pomfret preferred a miſtreſs to a wife. But he was ſoon convinced that this repreſentation was the mere effect of malice, as Pomfret at that time was actually married. The oppoſition, however, which his ſlanderers had made to him had its effect; for, being by this obliged to ſtay in London longer than he intended, he catched the ſmallpox, and died of it, aged 35.

He publiſhed a volume of his poems in 1699, with a very modeſt and ſenſible preface. Two pieces of his were publiſhed after his death by his friend Philalethes; one entitled Reaſon, and written in 1700, when the diſputes about the Trinity ran high; the other *Dies Noviſſima*, or the "Laſt Epiphany," a Pindaric ode. His verſification is not unmuſical; but there is not the force in his writings which is neceſſary to conſtitute a poet. A diſſenting teacher of his name, and who publiſhed ſome rhimes upon ſpiritual ſubjects, occaſioned fanaticiſm to be imputed to him; but his friend Philalethes has juſtly cleared him from the imputation. Pomfret had a very ſtrong mixture of devotion in him, but no fanaticiſm. "The Choice (ſays Dr. Johnſon) exhibits a ſyſtem of life adapted to common notions, and equal to common expectations; ſuch a ſtate as affords plenty and tranquillity, without excluſion of intellectual pleaſures. Perhaps no compoſition in our language has been oftener peruſed than Pomfret's Choice. In his other poems there is an eaſy volubility; the pleaſure of ſmooth metre is afforded to the ear, and the mind is not oppreſſed with ponderous, or intangled with intricate, ſentiment. He pleaſes many; and he who pleaſes many muſt have merit."

POMME', or POMMETTE', in heraldry, is a croſs with one or more balls or knobs at each of the ends.

POMMEL, or PUMMEL, in the manege, a piece of braſs or other matter at the top and in the middle of the ſaddle bow.

POMMERCULLIA, in botany: A genus of the monogynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 4th order, *Gramina*. The calyx is bivalved, and ſhaped like a top; the valvula quadrifid, and bearded on the back. The corolla has two unequal valves; the filaments three, with long pointed antheræ; the ſtyle ſimple. The whole flower forms itſelf into a ſharp point, and the corolla ſerves as a covering to the ſeed, which is long, clear, and ſmooth. There is only one ſpecies, viz. the *Dianthoides*.

POMŒRIUM, in Roman antiquity, was, according to Livy, that ſpace of ground, both within and without the walls, which the augurs, at the firſt building of cities, ſolemnly conſecrated, and on which no edifices were allowed to be raiſed. Plutarch gives this account of the ceremony of drawing the pomœrium: "They dug a trench, and threw into it the firſt-fruits of all things, either good by cuſtom or neceſſary by nature; and every man taking a ſmall turf of earth of the country from whence he came, they caſt them in promiſcuouſly. Then making this trench their centre, they deſcribed the city in a circle round it. After this, the founder, yoking a bull and a cow together, ploughed a deep furrow, with a brazen ploughſhare, round the bounds. The attendants took care that all the clods fell inwards, *i. e.* toward the city. This furrow they called *pomœrium*, and built the wall upon it."—Plutarch, in this account, is to be underſtood as ſpeaking of Rome.

POMŒRIUM *Proferre*, ſignifies to extend or enlarge a city, which could not be done by any but thoſe who had taken away ſome part of an enemy's country in war. But this qualification was ſometimes diſpenſed with. *Pomœrium* is *quaſi pone mœnia*, "behind the walls."

POMONA, in fabulous hiſtory, the tutelar deity of orchards and fruit-trees. See VERTUMNUS.

POMPEII (anc. geog.), a town of Campania near Herculaneum, and deſtroyed along with it by the great eruption of Veſuvius in the time of Titus. See HERCULANEUM. It is about 15 miles from Naples, and ſix or ſeven from Portici.—So much has been ſaid and written on the diſcovery of this place, as makes it unneceſſary for us to ſay much: we ſhall therefore only give a ſhort extract on the ſubject from an anonymous work lately publiſhed, apparently of conſiderable merit. "On entering the city (ſays our author), the firſt object is a pretty ſquare, with arcades, after the preſent manner of Italy. This was, as it is imagined, the quarter of the ſoldiers; numbers of military weapons being found here.

"A narrow, but long ſtreet, with ſeveral ſhops on each ſide, is now perfectly cleanſed from its rubbiſh, and in good preſervation. Each houſe has a court. In ſome of them are paintings al freſco, principally in chiaroſcuro; and their colours not in the leaſt injured by time. The few colours which the ancients knew were extracted only from minerals; and this may be a ſufficient reaſon for their freſhneſs. The ſtreet is paved with irregular ſtones of a foot and half or two feet long, like the Appian way.

"In diſcovering this city, it was at firſt doubted whether it were actually Pompeii: but the name inſcribed over the gateway put it beyond all doubt. The ſkeletons found were innumerable. It is ſaid that many had ſpades in their hands, endeavouring, probably, at firſt, to clear away the torrent of aſhes with which they were deluged. Indeed, the ſatisfaction which is felt at the view of ancient habitations, is much allayed by inevitable reflections on this frightful ſcene of deſolation, though at the diſtance of ſo many centuries.

"An ancient villa is alſo ſeen entire at a little diſtance from Pompeii. The houſe is really elegant and ſpacious, but only two ſtories high. The pavement of the chambers is compoſed of teſſelated marble, and, when poliſhed, diſplays the deſign perfectly well.—There is ſome at the muſeum of Portici brought from this place, which the eye would really miſtake for painting. Under the houſe is a fine triangular cellar, of which each part is 100 feet long, well filled with amphoræ. The ſkeletons of 29 perſons were found here, ſuppoſed to have fled to it for ſafety. Each houſe is filled with aſhes: they have almoſt penetrated through every crevice; and it is incredible how ſuch a volume of them could have been thrown out by Veſuvius with ſufficient force to have reached ſo far." See Swinburne's *Travels in the Two Sicilies*, vol. 2. p. 98, &c.; Lady Miller's *Letters*, or *De la Lande*; Captain Sutherland's *Tour up the Straits, from Gibraltar to Conſtantinople*, p. 75, &c.; Dr. Smith's *Sketch of a Tour on the Continent*, in 1786 and 1787, vol. 2. p. 118, &c.; and Watkins's *Tour through Swiſſerland, Italy*, &c.

POMPEY the GREAT, (CNEIUS POMPEIUS MAGNUS), the renowned rival of Julius Cæſar. Being defeated by him at the battle of Pharſalia, owing to the defection of his cavalry, he fled to Egypt by ſea, where he was baſely aſſaſſinated by order of Theodotus, prime miniſter to Ptolemy the younger, then a minor, 48 B. C.

POMPEYS (CNEIUS and SEXTUS), his ſons, commanded a powerful army when they loſt their illuſtrious father. Julius Cæſar purſued them into Spain, and defeated them at the battle of Munda, in which Cneius was ſlain, 45 B. C. Sextus made himſelf maſter of Sicily; but being defeated in the celebrated naval engagement at Actium by Auguſtus and Lepidus, he fled to Aſia with only 7 ſhips, the remains of his fleet, which conſiſted of more than 350; and from thence, unable to continue the war, he was obliged to retire to Leſbos; where renewing the war by raiſing an army, and ſeizing on ſome conſiderable cities, Marcus Titius, in the intereſt of Marc Antony, gave him battle, defeated him, took him priſoner, and baſely put him to death, 35 B. C.

POMPILUS, in ichthyology, a ſpecies of CORYPHŒNA.

POMPONATIUS (PETER), an eminent Italian philoſopher, was born at Mantua in 1462. He was of ſo ſmall a ſtature, that he was little better than a dwarf; yet he poſſeſſed an exalted genius, and was conſidered as one of the greateſt philoſophers of the age in which he lived. He taught philoſophy, firſt at Padua and afterwards at Bologna, with the higheſt reputation. He had frequent diſputations with the celebrated Achillini, whoſe puzzling objections would have confounded him, had it not been for his ſkill in parrying them by ſome joke. His book *De Immortalitate Animæ*, publiſhed in 1516, made a great noiſe. He maintained, that the immortality of the ſoul could not be proved by philoſophical reaſons; but ſolemnly declared his belief of it as an article of faith. This precaution did not, however, ſave him; many adverſaries roſe up againſt him, who did not ſcruple to treat him as an atheiſt; and the monks procured his book, although he wrote ſeveral apologies for it, to be burnt at Venice. His book upon Incantations was alſo thought very dangerous. He ſhows in it, that he believed nothing of magic and ſorcery; and he lays a prodigious ſtreſs on occult virtues in certain men, by which they produced miraculous effects. He gives a great many examples of this; but his adverſaries do not admit them to be true, or free from magic.—

Paul Jovius ſays, that he died in 1525, in his grand-climacteric. He was three times married; and had but one daughter, to whom he left a large ſum of money. He uſed to apply himſelf to the ſolution of difficulties ſo very intenſely, that he frequently forgot to eat, drink, ſleep, and perform the ordinary functions of nature: nay, it made him almoſt diſtracted, and a laughing-ſtock to every one, as he himſelf tells us.

POMPONIUS MELA. See MELA.

POMUM, an APPLE; a ſpecies of ſeed-veſſel, compoſed of a ſucculent fleſhy pulp; in the middle of which is generally found a membranous capſule, with a number of cells, or cavities, for containing the ſeeds. Seed-veſſels of this kind have no external opening or valve. At the end oppoſite to the footſtalk is frequently a ſmall cavity, called by the gardeners the *eye of the fruit*, and by botaniſts *umbilicus*, the "navel," from its fancied reſemblance to the navel in animals. Gourd, cucumber, melon, pomegranate, pear, and apple, furniſh inſtances of the fruit or ſeed-veſſel in queſtion.

POND, or FISH-*Pond*. See FISH-*Ponds*.

POND, is a ſmall pool or lake of water from whence no ſtream iſſues. In the *Tranſactions of the Society inſtituted at London for the Encouragement of Arts, Manufactures, and Commerce*, vol. viii. and printed in the year 1790, there is a ſhort account of a machine for draining ponds without diſturbing the mud. It was communicated to the ſociety, together with a drawing and model of the machine, by Lieutenant-colonel Danſey. The model was made from the deſcription of a machine uſed by a gentleman near Taunton for many years before, for ſupplying a caſcade in his pleaſure-grounds.—The colonel's regiment was then lying at Windſor; and thinking that the invention might be uſeful to ſupply the grand caſcade at Virginia-water, he made the model, and preſented it to the king, who was graciouſly pleaſed to approve of it. In conſequence of which, by his majeſty's deſire, a penſtock on that principle was conſtructed from the model at one of the ponds in the neighbourhood.—The colonel thinks the machine may be uſeful in the hands of men of ſcience, and applicable to ſilk, cotton, and other mills, where a ſteady and uniform velocity of water is wanted; which might be regulated at pleaſure, occaſioning no current to diſturb the mud or fiſh, as the ſtream conſtantly runs from the ſurface. He ſays he has often made the experiment by the model in a tub of water.

Of this machine we have given an engraving, (See pl. 18.) taken from the above mentioned Tranſactions; and we ſhall now add the deſcription which accompanies the plate in that work. In figure 1. A is the pipe, loaded with a rim of lead, of ſuch weight as ſerves to ſink it below the ſurface of the water. B is the diſcharging pipe, laid through the bank HI. C is the joint on which the pipe A turns its form, which is ſhown fig. 2. D is the ball or float, which, ſwimming on the ſurface of the pond, prevents the pipe A from deſcending deeper than the length of the chain by which they are connected. E is a chain winding on the windlaſs F, and ſerving to raiſe the tube A above the ſurface of the water, when the machinery is not in uſe. G is a ſtage. HI is the bank, repreſented as if cut through at I, to ſhow the tube B lying within it. K is a poſt to receive the tube A when lowered, and to prevent its ſinking in the mud. In figure 2. A is a caſt cylinder, with a plate or check, B, which is faſtened to the timber of the tube on one ſide, but not on the other, as the part of the cylinder C turns in the hollow of the wooden tube when it is immerged. A piece of ſtrong ſole leather is put inſide the braſs plate B, to prevent leaking.

POND-*Weed*, in botany. See POTAMOGETON.

PONDICHERRY, is a large town of Aſia, in the peninſula on this ſide the Ganges, and on the coaſt of Coromandel. Its ſituation is low, and the ſhips anchor about a mile and a half from it; nor can the boats or canoes come nearer it than a muſket-ſhot, on account of the breakers, ſo that the blacks come in flat bottomed boats to carry the men and merchandiſes to the fleet. The fort is 200 paces from the ſea, and very irregular; built with bricks, and covered with fine plaſter, reſembling white marble. The huts of the blacks lie here and there, and the walls are of bamboos mixed with the branches of trees. The French are greatly addicted to women, from whom they catch diſeaſes that render them pale, livid, and meagre, with a frightful aſpect. However, ſeveral of the French are married to a ſort of Portugueſe women, who are of a mixed breed, being a kind of Mulattoes. The country about it is barren, and conſequently moſt of their proviſions are brought from other places. Their trade conſiſts of cotton-cloth, ſilks, pepper, ſaltpetre, and other merchandiſes that are brought from Bengal. With regard to the religion of the natives, the moſt numerous are the Gentoos; but there are Mahometans or Moors, who hold a great many ridiculous opinions. The Gentoos are of different ſects, and that of the Brahmins are prieſts. The cuſtom of women burning themſelves with the bodies of their dead huſbands was very common, but of late much diſcountenanced. The ſlaves or ſervants are very numerous, and their chief food is rice. This place was taken, and the fortifications demoliſhed, by Colonel Coote; it was reſtored to the French by the peace of 1763; and was retaken in the beginning of the preſent war with the French republic. It is 60 miles ſouth of Fort St. George. E. lon. 79. 58. N. lat. 11. 42.

PONDICO, an iſland of the Archipelago, lying on the gulph of Ziton, near the coaſt of Negropont. It is ſmall and uninhabited, as well as two others that lie near it.

PONG-HOU *Iſles*, in the province of Fo-kien in China, form an archipelago between the port of Emouy and the iſland of Formoſa. A Chineſe garriſon is kept here, with one of thoſe mandarines who are called *literati*, whoſe principal employment is to watch the trading veſſels which paſs from China to Formoſa, or from Formoſa to China. As theſe iſlands are only ſand-banks or rocks, the inhabitants are obliged to import every neceſſary of life; neither ſhrubs nor buſhes are ſeen upon them; all their ornament conſiſts of one ſolitary tree. The harbour is good, and ſheltered from every wind; it has from 20 to 25 feet depth of water. Although it is an uncultivated and uninhabited iſland, it is abſolutely neceſſary for the preſervation of Formoſa, which has no port capable of receiving veſſels that draw above eight feet of water.

PONIARD, a little pointed dagger, very ſharp-edged; borne in the hand, or at the girdle, or hid in the pocket. The word is formed from the French *poignard*, and that from *poignée* "handful."—The poniard was anciently in very great uſe; but it is now in a good meaſure ſet aſide, except among aſſaſſins.—Sword and poniard were the ancient arms of duelliſts; and are ſaid to continue ſtill ſo among the Spaniards. The practice of ſword and poniard ſtill makes a part of the exerciſe taught by the maſters of defence.

PONS, a town of France, in the department of Lower Charente, and late province of Saintonge, famous in the time of the Huguenots. It has a mineral ſpring, and is ſeated on a hill, near the river Sevigne, 10 miles ſouth of Saintes. W. lon. 0. 30. N. lat. 45. 36.

PONT DU-GARD, is a bridge of France, in Lower Languedoc, built over the river Gardon, which ſerved for an aqueduct. It is a very remarkable and a moſt magnificent work, and was raiſed by the ancient Romans. It conſiſts of three bridges, one above another; the uppermoſt of which was the aqueduct, to convey water to the city of Niſmes, which is eight miles to the ſouth. They are altogether 192 feet high, and the uppermoſt 580 feet long. They are conſtructed between two rocks. E. lon. 4. 26. N. lat. 43. 58.

PONTEDERIA, in botany: A genus of the monogynia order, belonging to the hexandria claſs of plants; and in the natural method ranking under the ſixth order, *Enſatæ.* The corolla is monopetalous, ſexfid, bilabiate; there are three ſtamina inſerted into the top, and three into the tube of the corolla; the capſule is bilocular.

PONTEFRACT, or Pomfret, a town of the weſt riding of Yorkſhire, ſituated on the river Arc. It is ſaid to take its name from a broken bridge, which is ſuppoſed to have been laid anciently over that marſhy ſpot called the *Waſh.* Here are the ruins of a noble old caſtle, where Richard II. was barbarouſly murdered, and two of Edward V.'s uncles. The collegiate chapel of St. Clement, which had a dean, three prebendaries, &c. is ſtill diſtinguiſhable in it. This town has a good market, and fairs for horſes, ſheep, and other cattle. It is a corporation, governed by a mayor, recorder, aldermen, and burgeſſes, and gives title of earl to the family of Fermor. In the reign of queen Elizabeth, 200l. was left by George Talbot, earl of Shrewſbury, to be lent for ever, at 5l. a time, on proper ſecurity, for three years, to the poor artificers of the town; and Thomas Wentworth, eſq. anceſtor to the marquis of Rockingham, left 200l. to the charity-ſchool. A branch of the great Roman military way called *Ermin-ſtreet,* which paſſed from Lincoln to York, may be traced betwixt this town and Doncaſter. The adjacent country yields plenty of limeſtone, together with liquorice and ſkirrets. W. lon. 1. 5. N. lat. 53. 42.

PONTIFEX, Pontiff, or *High-Prieſt,* a perſon who has the ſuperintendence and direction of divine worſhip, as the offering of ſacrifices and other religious ſolemnities. The Romans had a college of pontiffs; and over theſe a ſovereign pontiff, or pontifex maximus, inſtituted by Numa, whoſe function it was to preſcribe the ceremonies each god was to be worſhipped withal, compoſe the rituals, direct the veſtals, and for a good while to perform the buſineſs of augury, till, on ſome ſuperſtitious occaſion, he was prohibited intermeddling therewith. The office of the college of pontiffs was to aſſiſt the high-prieſt in giving judgement in all cauſes relating to religion, inquiring into the lives and manners of the inferior prieſts, and puniſhing them if they ſaw occaſion, &c. The Jews too had their pontiffs; and among the Romaniſts, the pope is ſtill ſtyled the *ſovereign pontiff.*

PONTIFICATE, is uſed for the ſtate or dignity of a pontiff or high-prieſt; but more particularly in modern writers for the reign of a pope.

PONTIUS (Pilate). See Pilate.

PONTON, or Pontoon, in war, a kind of flat-bottomed boat, whoſe carcaſe of wood is lined within and without with tin: they ſerve to lay bridges over rivers for the artillery and army to march over. The French pontoons, and thoſe of moſt other powers, are made of copper on the outſide: though theſe coſt more at firſt, yet they laſt much longer than thoſe of tin; and, when worn out, the copper ſells nearly for as much as it coſt at firſt; but when ours are rendered uſeleſs, they ſell for nothing. Our pontoons are 21 feet long, five feet broad, and depth within two feet 1.5 inches.

Pontoon-*Carriage,* is made with two wheels only, and two long ſide-pieces, whoſe fore-ends are ſupported by a limber; and ſerves to carry the pontoon, boards, croſs-timbers, anchors, and every other thing neceſſary for making a bridge.

Pontoon-*Bridge,* is made of pontoons ſlipped into the water, and placed about five or ſix feet aſunder; each faſtened with an anchor, when the river has a ſtrong current; or to a ſtrong rope that goes acroſs the river, running through the rings of the pontoons. Each boat has an anchor, cable, baulks, and cheſts. The baulks are about five or ſix inches ſquare, and 21 feet long. The cheſts are boards joined together by wooden bars, about three feet broad and 12 feet long. The baulks are laid acroſs the pontoons at ſome diſtance from one another, and the cheſts upon them joined cloſe; which makes a bridge in a very ſhort time, capable of ſupporting any weight.

PONT St. Esprit, a town of France, in the department of Gard and late province of Languedoc. It is ſeated on the river Rhone, over which is one of the fineſt bridges in Europe, conſiſting of 19 great and four ſmall arches. To facilitate the paſſage of the water in time of floods, apertures are made through each pier, ſix feet above the common level of the river; and to ſtem the extreme rapidity of the Rhone, the bridge is not built in a right line, but in the form of a curve. This paſſage is defended by a citadel, within which is the church of the Holy Spirit, projecting into the river. As the bridge is ſo ſlight, the goods are conveyed over in ſledges, by way of precaution. Pont St. Eſprit is 17 miles ſouth of Viviers, and 55 north-eaſt of Montpellier. E. lon. 4. 46. N. lat. 44. 13.

PONTUS, the name of an ancient kingdom of Aſia, originally a part of Cappadocia; bounded on the eaſt by Colchis, on the weſt by the river Halys, on the north by the Euxine Sea, and on the ſouth by Armenia Minor. Some derive the name of Pontus from the neighbouring ſea, commonly called by the Latins *Pontus Euxinus;* others from an ancient king named *Pontus,* who imparted his name both to the country and the ſea; but Bochart deduces it from the Phœnician word *botno,* ſignifying a filberd, as if that nut abounded remarkably in this place. But this derivation ſeems to be very far fetched; and the common opinion that the country derived its name from the ſea, ſeems by far the moſt probable. The kingdom was divided into three parts; the firſt, named *Pontus Galaticus,* extending from the river Halys to the Thermodon; the ſecond, named *Pontus Polemonaicus,* extended from the Thermodon to the borders of *Pontus Cappadocicus;* and this laſt extended from Pontus Polemonaicus to Colchis, having Armenia Minor and the upper ſtream of the Euphrates for its ſouthern boundary.

It is commonly believed, that the firſt inhabitants of Pontus were deſcended from Tubal; but in proceſs of time mixed with Cappadocians, Paphlagonians, and other foreign nations, beſides many Greek colonies which ſettled in thoſe parts, and maintained their liberty till the time of Mithridates the Great and Pharnaces. The firſt king of this country whom we find mentioned in hiſtory is Artabazes, who had the crown beſtowed on him by Darius Hyſtaſpes. The next was Rhodobates, who reigned in the time of Darius Nothus. After him came Mithridates, who, refuſing to pay the uſual tribute to the Perſians, was defeated by Artaxerxes Mnemon; but a peace was ſoon after concluded by the mediation of Tiſſaphernes. Beſides this, we hear nothing of him further than that he was treacherouſly taken priſoner by Clearchus afterwards tyrant of Heraclea, and obliged to pay a large ſum for his ranſom. The hiſtory of their ſucceſſion is given fully in the Univerſal Hiſtory.

PONTYPOOL, a town of Monmouthſhire, ſeated between two hills. It is but a ſmall place, though noted for its iron-mills, great manufacture of japanned mugs, &c. W. lon. 3. 6. N. lat. 51. 42.

PONZA, or Pontia, is a ſmall iſland of the Tuſcan Sea, well known to be the place to which many illuſtrious Romans were formerly baniſhed. It is ſituated on the coaſt of Italy near Terracina, and in the neighbourhood of other ſmall iſlands or rocks mamed *Palmarole, Zannone,* &c. between the iſland of Ventotienne and Monte Circello. All theſe iſlands were viſited by Sir William Hamilton in the year 1785; and an account of his journey is given in a letter to Sir J. Banks, which appeared in the Phil. Tranſ. vol. lxxvi. p. 365. Sir William arrived at Ponza on the 20th Auguſt; and, according to his account, it lies about 30 miles from Ventotienne. On the 21ſt he went round it in a boat. Its length is about five miles;

but its breadth is nowhere above half a mile, and in ſome places not more than 500 feet. It is ſurrounded by a multitude of detached rocks, ſome of them very high, and moſt of them compoſed of a compact lava. There are many irregularly formed baſaltes, but none in large columns. In ſome places they have a reddiſh tinge from iron ochre, are very ſmall, and irregularly laid over one another. Some ſtand perpendicularly, others obliquely, and ſome lie horizontally. The rocks themſelves in which theſe maſſes are found are lava of the ſame nature with the baſaltes. At firſt ſight they appear like the ruins of ancient Roman brick or tile buildings. One rock is compoſed of large ſpherical baſaltes, and in other places our author found the lava inclined to take the like ſpherical form, though on a much ſmaller ſcale, ſome of the former baſaltes being near two feet in diameter. All theſe rocks, in our author's opinion, have been detached by the ſea from this iſland, which is entirely compoſed of volcanic matter, lavas, and tufas of various qualities and colours, as green, yellow, black, and white. Some of theſe matters are more compact in their texture than others; and in ſome parts great tracts ſeem to have undergone ſimilar operations, which ſtill ſubſiſt at a ſpot called the *Piſciarelli*, on the outſide of the Solfatara, near Puzzole, and where a hot ſulphureous vitriolic acid vapour converts all which it penetrates, whether lavas, tufas, volcanic aſhes, or pumice-ſtones, into a pure clay, moſtly white, or with a tint of red, blue, green, or yellow.

In one part of this iſland there is a ſort of tufa remarkably good for the purpoſe of building. It is as hard as Bath-ſtone, and nearly of the ſame colour, without any mixture of lava or pumice-ſtone, which uſually abound in the tufas of Naples, Baia, and Puzzoli.

The iſland of Palmarole, which is about four miles from Ponza, is not much more than a mile in circumference. It is compoſed of the ſame volcanic matter, and probably was once a part of Ponza; and in our author's opinion it looks as if the iſland of Zannone, which lies about the ſame diſtance from Ponza, was once likewiſe a part of the ſame; for many rocks of lava riſe above water in a line betwixt the two laſt-mentioned iſlands, and the water there is much more ſhallow than in the gulf of Terracina.

Zannone is much larger and higher than Palmarole; and that half of it next the continent is compoſed of a lime-ſtone ſimilar to that of the Apennines near it; the other half is compoſed of lavas and tufas, reſembling in every other reſpect the ſoil of the iſlands juſt deſcribed. Neither Palmarole nor Zannone is inhabited; but the latter furniſhes abundance of bruſhwood for the uſe of the inhabitants of Ponza, whoſe number, including the garriſon, amounts to near 1700. The uninhabited iſland of St. Stefano in like manner furniſhes wood for the people of Ventotienne. It is probable that all theſe iſlands and rocks may in time be levelled by the action of the ſea. Ponza, in its preſent ſtate, is the mere ſkeleton of a volcanic iſland; little more than its hard or vitrified parts remaining, and they ſeem to be ſlowly and gradually mouldering away. The governor of the caſtle of Ponza, who had reſided there 53 years, told our author that the iſland was ſtill ſubject to earthquakes; that there had been one violent ſhock there about four years before; but that the moſt violent one he ever felt was on the very day and at the hour that Liſbon was deſtroyed. Two houſes out of three which were then on the iſland were thrown down. "This (ſays our author) ſeems to prove that the volcanic matter which gave birth to theſe iſlands is not exhauſted."

In Plate 17. fig. 1. is a plan of the iſland of Ponza, as given in the Philoſophical Tranſactions. Fig. 2. is a view of the inſide of the harbour of the iſland. A in the ſame figure is a rock of lava. In many parts it is formed into regular baſaltes of a reddiſh colour, tinged in all probability with ſome ochre. Moſt of the detached rocks of the iſland reſemble this. B B repreſents a tract of volcanic country, converted by a hot ſulphureous vitriolic acid vapour into a pure clay, the ground colour of which is moſtly white.—Fig. 3. is a view from the outſide of the harbour, near the light-houſe. C is a rock of volcanic matter converted to pure clay; D is a rock of the ſame kind, with ſtrata of pumice-ſtone; E is a rock of lava, inclining to take baſaltic forms; and F is a rock compoſed of ſpherical baſaltes.

POOD is a Ruſſian weight, equal to 40 Ruſſian or 36 Engliſh pounds.

POOL is properly a reſervoir of water ſupplied with ſprings, and diſcharging the overplus by ſluices, defenders, weirs, and other cauſeways.

Pool, a ſea-port town of Dorſetſhire. It is ſurrounded on all ſides by the ſea, except on the north, where there is an entrance through a gate. It was formerly nothing but a place where a few fiſhermen lived: but in the reign of Henry VI. it was greatly enlarged, and the inhabitants had the privilege to wall it round. It was alſo made a county of itſelf, and ſent two members to parliament. It is governed by a mayor, a ſenior bailiff, four other juſtices, and an indeterminate number of burgeſſes. The town conſiſts of a church and about 600 houſes, with broad paved ſtreets; and has a manufactory of knit hoſe. It is 47 miles weſt-ſouth-weſt of Wincheſter, and 110 weſt-by-ſouth of London. W. lon. 2.0. N. lat. 50. 42.

POOLE (Matthew), a very learned writer in the 17th century, was born at York in 1624. He was educated at Emanuel college, Cambridge, and afterwards incorporated in the univerſity of Oxford. He ſucceeded Dr. Anthony Tuckney in the rectory of St. Michael le Quern, in London, about 1648. In 1658 he ſet on foot a project for maintaining youths of great parts at the univerſities, and had the approbation of the heads of houſes in both of them. He ſolicited the affair with ſo much vigour, that in a ſhort time 900 l. *per annum* was procured for that purpoſe; but this deſign was laid aſide at the Reſtoration. In 1662 he was ejected from his living for nonconformity. He was ten years employed in compoſing his *Synopſis Criticorum*, &c. Beſides this great work he publiſhed ſeveral other pieces. When Dr. Oates's depoſitions concerning the popiſh plot were printed, our author found his name in the liſt of thoſe who were to be cut off, on the account (as was ſuppoſed) of what he had written againſt the papiſts in his *Nullity of the Romiſh Faith*. So that he was obliged to retire into Holland, where he died in 1679, and left behind him the character of a very able critic and caſuiſt.

POOP, the ſtern of a ſhip; or the higheſt, uppermoſt, and hinder part of a ſhip's hull. See Stern.

POOR, in law, an appellation given to thoſe who are in ſuch low and mean condition, that they either are or may become a burden to the pariſh. They who rank pity amongſt the original impulſes of our nature rightly contend, that when it prompts us to the relief of human miſery, it indicates ſufficiently the Divine intention, and our duty. Indeed, the ſame concluſion is deducible from the exiſtence of the paſſion, whatever account be given of its origin. Whether it be inſtinct, or a habit founded in aſſociation (ſee Passion), it is in fact a property of our nature which God appointed: and the final cauſe for which it was appointed is to afford to the miſerable, in the compaſſion of their fellow-creatures, a remedy for thoſe inequalities and diſtreſſes to which many are neceſſarily expoſed under every poſſible rule for the diſtribution of property. That the poor have a claim upon the rich, founded in the law of nature, can be queſtioned by no man who admits the benevolence of the Deity, and conſiders his purpoſe in creating the world (ſee Theology); and upon this claim the Chriſtian Scriptures are more explicit than almoſt upon any other.

Island of PONZA.

Fig. 1.

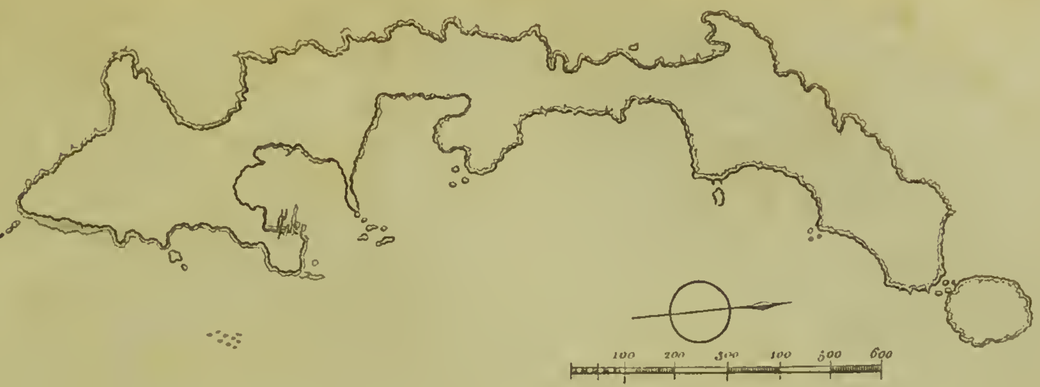


Fig. 2.

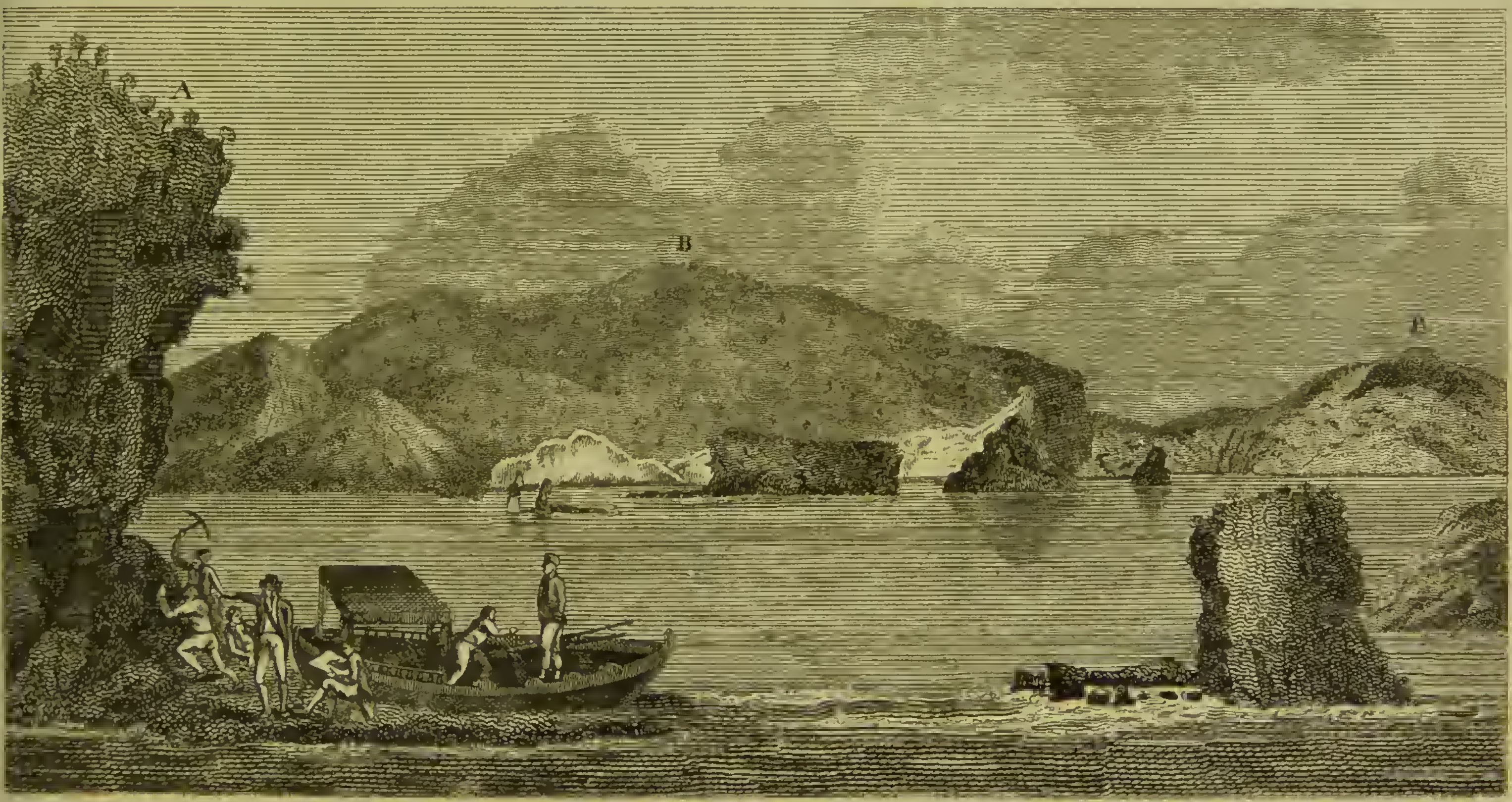
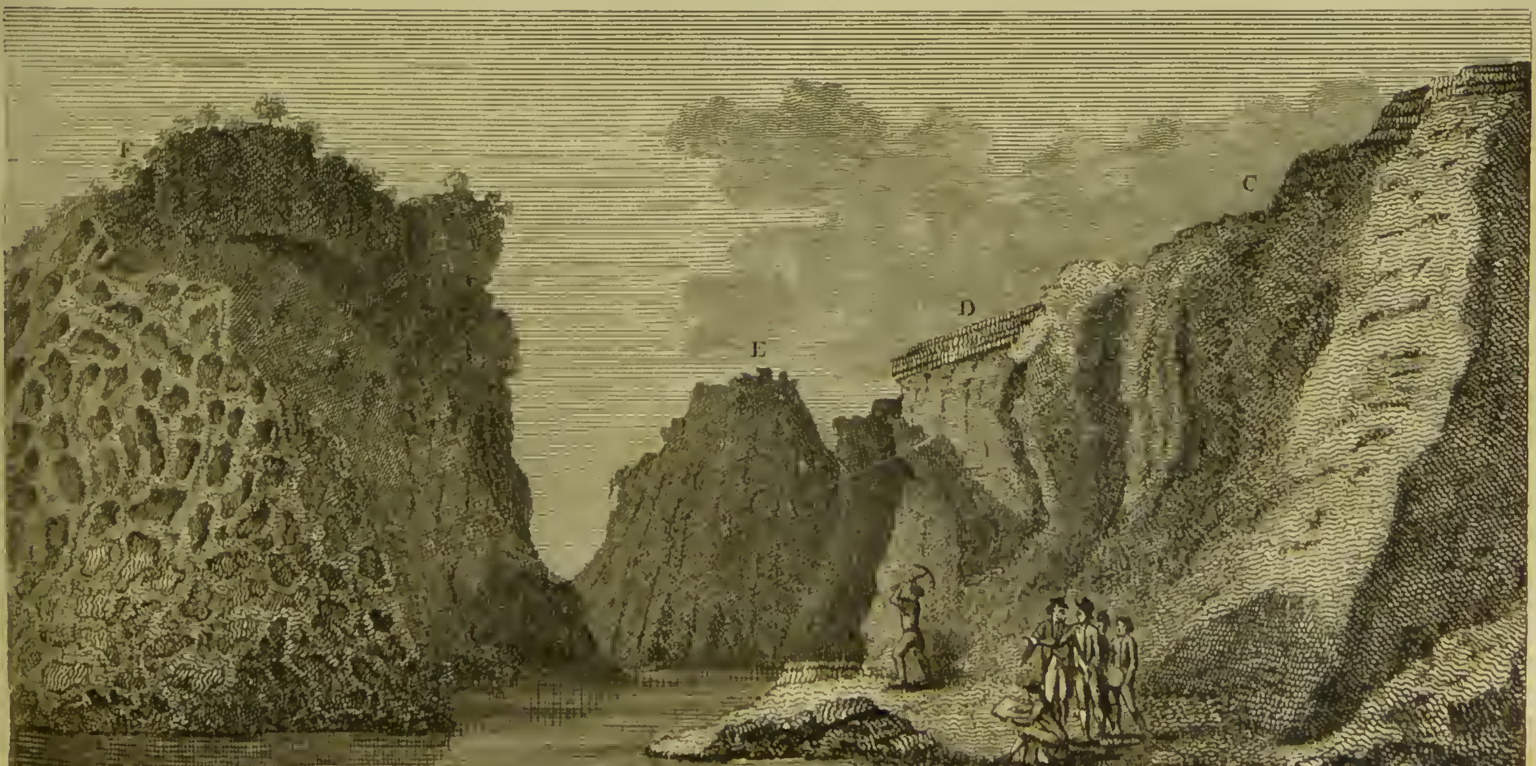


Fig. 3.



The rights of the poor, however, to be relieved by the rich, as they originate in nature, and are ſanctioned by Chriſtianity, are evidently of that kind which is called *imperfect* (See Moral *Philoſophy*). It is ſurely needleſs to warn our readers in this place, that imperfect rights are in themſelves as ſacred, and the duties reſulting from them as obligatory in *foro conſcientiæ*, as the moſt rigid claims of juſtice. Every one knows, that they are called *imperfect*, only becauſe the extent of them in particular inſtances cannot be aſcertained by poſitive laws, nor the breach of them be puniſhed by the civil magiſtrate. Hence the apoſtle, though he enjoins a weekly contribution to be made for the poor in the church of Corinth, yet leaves the ſum to be contributed by each individual wholly undetermined. "Now, concerning the collection for the ſaints, as I have given order to the churches of Galatia, even ſo do ye. Upon the firſt day of the week let every one of you lay by him in ſtore as God hath *proſpered him*." By which St. Paul certainly recommends to every man to contribute, not a fixed ſum, but as much as, from a deliberate compariſon of his fortune, with the reaſonable expenſes and expectations of his family, he finds he can ſpare for charitable purpoſes.

It is well known that thoſe weekly contributions were laid at the feet of the apoſtles, who transferred the management of the fund thence ariſing to deacons elected by the people, and ordained by them to ſee that the money was properly diſtributed. Hence, under Chriſtianity, the maintenance of the poor became chiefly an eccleſiaſtical concern; and when that holy and benevolent religion was eſtabliſhed in the Roman empire, a fourth part of the tithes was in ſome countries of Europe, and particularly in England, ſet apart for that purpoſe. Afterwards, when the tithes of many pariſhes were appropriated to the monaſteries, theſe ſocieties were the principal reſource of the poor, who were further relieved by voluntary contributions. Judge Blackſtone obſerves, that till the ſtatute 26 Hen. VIII. cap. 26. he finds no compulſory method for providing for the poor; but, upon the total diſſolution of the monaſteries, abundance of ſtatutes were made in the reign of king Henry VIII. Edward VI. and Eliſabeth, which at laſt eſtabliſhed the

Poor's *Rate*, or legal aſſeſſment for the ſupport of the poor. The ſums that had been appropriated for charitable uſes before the Reformation were immenſe, and the wealth that had been accumulated through a ſucceſſion of ages by mendicant orders of religious perſons was inconceivably great; nor was it in the power of any laws to confine men who were in the poſſeſſion of ſuch wealth from gratifying thoſe deſires which money can ſo eaſily find means of ſupplying. Yet, among the various abuſes to which this opulence had given riſe, theſe religious orders had never ſo far loſt ſight of their original inſtitution as ever to neglect the poor. Theſe were indeed provided for by them with an indiſcriminate profuſion of largeſſe, better proportioned to their own opulence than to the wants of the claimants, who were too often, without examination, all equally ſerved, whether deſerving or undeſerving of that bounty which they claimed.

When the *religious houſes*, as they were called, were entirely ſuppreſſed at the Reformation, and the wealth that belonged to them was diverted into other channels, the poor, who had been in uſe to receive their ſupport from thence, were of courſe left entirely deſtitute; and this ſoon became a grievance ſo intolerable, not only to the poor themſelves, but to the whole nation, as to excite a univerſal deſire to have it remedied. Accordingly, by the 14 Eliz. cap. 5. power was given to the juſtices to lay a general aſſeſſment; and this hath continued ever ſince. For, by 43 Eliz. cap. 2. the churchwardens and overſeers of the poor of every pariſh, or the greater part of them (with the conſent of two juſtices, one of whom is of the quorum, dwelling in or near the pariſh), are empowered to raiſe weekly, or otherwiſe, by taxation of every inhabitant, parſon, vicar, and other, and of every occupier of lands, houſes, &c. materials for employing the poor, and competent ſums for their relief. Notice ſhall be given in church of every ſuch rate the next Sunday after it is allowed, which may be inſpected by every inhabitant, paying 1s. and copies of it granted on demand, 6d. being paid for every 24 names; and a churchwarden or overſeer refuſing, ſhall forfeit 20l. to the party aggrieved. The rate is to be levied by diſtreſs on thoſe who refuſe to pay it; and, by 17 Geo. II. cap. 2. ſec. 38. appeals againſt it are allowed.

If the juſtices find that the inhabitants of any pariſh are not able to levy among themſelves ſufficient ſums for the purpoſes ſpecified in the act, they may aſſeſs any other pariſh within the hundred; and if the hundred be unable to grant neceſſary relief, they may rate and aſſeſs any pariſh within the county. 43 Eliz. cap. 2.

In order to compel huſbands and parents to maintain their own families, the law hath provided, that all perſons running away out of their pariſhes, and leaving their families upon the pariſh, ſhall be deemed and ſuffer as incorrigible rogues (7 Jac. cap. 4.) And if a perſon merely threatens to run away and leave his wife and children upon the pariſh, he ſhall, upon conviction, before one juſtice by confeſſion, or oath of one witneſs, be committed to the houſe of correction for any time not exceeding one month (17 Geo. II. cap. 5.) For the further maintenance of the poor, there are many fines and forfeitures payable to their uſe; as for ſwearing, drunkenneſs, deſtroying the game, &c. And alſo parts of waſtes, woods, and paſtures, may be incloſed for the growth and preſervation of timber and underwood for their relief. See Work-*Houſe*.

The famous ſtatute of the 43d of Elizabeth, which is the baſis of all the poor-laws in England, was conſtructed with a cautious forethought that can perhaps be equalled by few laws that ever were enacted; and if proſpective reaſoning alone were to be relied on in matters of legiſlation, it ſeemed impoſſible to amend it: yet experience has now proved, with a moſt demonſtrative certainty, that it is not ſo ſalutary as was undoubtedly expected.

The perſons who compoſed that law had before their eyes ſuch a recent proof of the abuſe that had been made of the charitable beneficence of individuals, that they ſeem to have been chiefly ſolicitous to obviate ſimilar abuſes in future; and to guard againſt that partial kind of ſeduction, they rather choſe to eſtabliſh a deſpotic power, which ſhould be authoriſed to wreſt from every individual in the nation whatever ſums it might think proper to call for, truſting to a few feeble devices which they contrived, for curbing that power which was virtually armed with force ſufficient to ſet all theſe aſide whenever it pleaſed. The conſequence has been, that the ſums levied for the relief of the poor, which were at firſt but ſmall, are now enormous, and that the demands are increaſing in ſuch a rapid manner as to give riſe to the moſt ſerious and well grounded apprehenſions. In the year 1774, parliament inſtituted an inquiry into the amount of the poor's-rate in England and Wales, and again in 1783. On comparing theſe together, the riſe during that ſhort period was found to be in England upwards of 850,000l. *per annum*, being nearly in the proportion of one-third of the rate at the firſt period. In Wales, during the ſame period of time, the rates were more than doubled. Nor was this a temporary ſtart, but a part only of a gradual progreſſion. Mr. Wenderdon, in his View of England, obſerves, that "in the year 1680 the poor's-rates produced no more than 665.390l. in 1764 they ſtood at 1,200,000l. and in 1773 they were eſtimated at 3,000,000l." It is a known fact (ſays Mr. Beaufoy, in the debate on Mr. Gilbert's poor bill, April 17th 1788), that within the laſt nine years the poor's-rates have increaſed one-third; and ſhould they continue increaſing in the ſame proportion for 50 or 53 years, they would amount to the enormous ſum of 11,230,000l. a burden which the country could not poſſibly bear. It was therefore, he added, highly neceſſary that ſomething ſhould be attempted to prevent this alarming addition, if not to annihilate the preſent glaring miſconduct in the management of the poor." Such has been the fate of England with regard to the poor laws.

In Scotland, the reformation having been carried forward with a ſtill more violent precipitancy than in England, and the funds of the regular clergy being more entirely alienated, the caſe of the poor there became ſtill more ſeemingly deſperate, and the clamours were alſo there conſiderable at that time. Then alſo it was that the Scottiſh court, imitating as uſual at that time the practice of England, made ſeveral feeble attempts to introduce a ſyſtem of compulſory poor's rates into that country, but never digeſted the ſyſtem ſo thoroughly as to form a law that could in any caſe be carried into effect. Many crude laws on this head were indeed enacted; but all of them ſo evidently inadequate for the purpoſe, that they never were, even in one inſtance that we have heard of, attempted at the time to be carried into effect. Indeed it ſeems to have been impoſſible to carry them into effect; for they are all ſo abſurd and contradictory to each other, that hardly a ſingle clauſe of any one of them can be obeyed without tranſgreſſing others of equal importance.

But how, it will be aſked by our inquiſitive reader, are the poor in Scotland really maintained? We anſwer, By the private alms of individuals, and by certain funds under the management of the *kirk-ſeſſions* (ſee PRESBYTERIANS). It is the univerſal practice, each Lord's day, in every pariſh, for ſuch of the audience as are in eaſy circumſtances, to give to the poor ſuch an offering of alms as they ſhall deem proper. This offering is generally dropped into a baſon placed at the church-door, and under the immediate care of an elder. When the ſervice is begun, the elder removes with the baſon, which he keeps under his charge till the congregation be diſmiſſed. The ſeſſion then meets, and the money is told over, its amount marked down in the ſeſſion account book, and depoſited in a box kept for that purpoſe. This box has uſually a ſmall ſlit in the top, through which the pieces of money can be dropped without opening it; and it is cloſed with two locks, the key of one of which is uſually kept by the miniſter, and the other by the kirk-treaſurer, ſo that it can never be opened but in the preſence of theſe two at leaſt.

A kirk-ſeſſion, when regularly conſtituted, muſt always conſiſt of the miniſter, elders, ſeſſion-clerk, and kirk-treaſurer. None of theſe ever receive any ſalary except the ſeſſion-clerk, who is uſually the ſchoolmaſter of the pariſh, and has a ſmall ſalary allowed for minuting the tranſactions. The kirk-treaſurer is for the moſt part one of the elders; and he is an important member of this court. Without his intervention no diſtribution of the poor's funds is deemed legal; nor can any payments be made, receipts granted, or money transferred, but by him; the miniſter and ſeſſion being perſonally liable to make good all money that may otherwiſe be given away, ſhould it ever afterwards be challenged by any heritor in the pariſh.

The precautions taken for the diſtribution of the poor's funds are likewiſe ſimple and excellent, and are as follow:

No money can be legally iſſued from the poor's funds even by the treaſurer and ſeſſion, unleſs legal proof can be brought that public intimation has been given from the pulpit immediately after divine ſervice, and before the congregation has diſperſed, that a diſtribution of poor's money is to be made by the ſeſſion, at ſuch a time and place, ſpecifying the ſame, and inviting all who have intereſt in the caſe to attend if they ſhall incline. This intimation muſt be made a full fortnight before the time of diſtribution; and as every heritor (owner of landed property) in the pariſh has a right to vote in the diſtribution of the poor's funds, they may all, if they ſo incline, then attend and exerciſe that right: but if none of them ſhould attend, which is often the caſe, the ſeſſion has then a right to proceed; and whatever they ſhall thus do is deemed ſtrictly legal, and is liable to no challenge. But ſhould they proceed without having given this previous intimation, they may, if the heritors ſhould afterwards challenge it, be made to repay out of their own pockets every ſhilling they ſhall have ſo iſſued. It ſometimes happens, that young miniſters, through heedleſsneſs in this reſpect, expoſe themſelves and families to conſiderable trouble and loſs, which by attention might be eaſily avoided. In the ſame way, ſhould a miniſter and ſeſſion, without the intervention of a treaſurer regularly conſtituted, lend upon bond or otherwiſe any of the poor's funds, and ſhould the perſon ſo borrowing afterwards fail, theſe lenders are perſonally liable to make good the whole, and any heritor in the pariſh who chooſes it can compel him to do ſo.

The members of the ſeſſion are alſo liable to pay all loſſes, and to account for all ſums that it can be inſtructed they received, if they neglect to keep regular books, in which every tranſaction ſhall be entered: Or, if theſe books have not been reviſed and approved of by the preſbytery[*]; but if they ſhall have been ſo reviſed, they cannot be challenged for omiſſion of forms, and can only be made to account for errors, or frauds, or evident dilapidations.

Under this wiſe and economical ſyſtem of management, it has been found by the experience of more than 200 years, that in the low parts of the country, where the pariſhes are in general of ſuch moderate extent as to admit of the people of every part of the pariſh generally to attend divine ſervice every Lord's day, the ordinary funds have been amply ſufficient to ſupply all the real demands of the poor, and in moſt pariſhes a fund has been accumulated from the ſavings of ordinary years to help the deficiencies that may ariſe in years of uncommon ſcarcity.

Beſides the weekly collections, the extra offerings at the adminiſtration of the Lord's ſupper, the pious donations of charitable individuals, which are all voluntary, together with ſome ſmall fees paid for the uſe of a *mort-cloth* (a black velvet pall) at funerals, which is generally purchaſed with the poor's money, go to make up this parochial fund. Nor muſt any one believe that the money which comes through the hands of the adminiſtrators of the poor's funds is all that is beſtowed upon the poor in Scotland; far from it: there are a thouſand other channels through which the indigent derive conſolation and ſupport, all of them tending to produce the happieſt effects upon ſociety: A ſon feels himſelf aſhamed to think that his parents ſhould require the aſſiſtance of another to ſupport them; he therefore ſtrains every nerve when in the vigour of life to ſpare a little of his earning to render their old age more eaſy than it might have been; and ſweet to a parent is the bread that is given by the pious attention of a child. If there are ſeveral children, they become emulous who ſhall diſcover moſt kindneſs. It is a pious contention, which ſerves to unite them the cloſer to each other, by commanding their mutual eſteem.

Directly contrary to this is the effect of the poor laws of England, where, in London at leaſt, it is not uncommon to ſee men in good buſineſs neglecting their aged and diſeaſed parents for no better reaſon than that the pariſh is bound to find them bread. Theſe laws have other pernicious conſequences; for they are obviouſly ſubverſive of induſtry as well as morality among the lower orders of the people. "This is a heavy charge, but no leſs true than heavy. Fear of want is the only effectual motive to induſtry with the labouring poor: remove that fear, and they ceaſe to be induſtrious. The ruling paſſion of thoſe who live by bodily labour, is to ſave a pittance for their children, and for ſupporting themſelves in old age. Stimulated by deſire of accompliſhing thoſe ends, they are frugal and induſtrious: and the proſpect of ſucceſs is a continual feaſt to them. Now, what worſe can malice invent againſt ſuch a man, under colour of friendſhip, than to ſecure bread to him and his children whenever he takes a diſlike to work? which effectually deadens his ſole ambition, and with it his honeſt induſtry. Relying on the certainty of a proviſion againſt want, he relaxes gradually till he ſinks into idleneſs; idleneſs leads to profligacy; profligacy begets diſeaſes; and the wretch becomes an object of public charity before he has run half his courſe. Wiſely therefore is it ordered by Providence, that charity ſhould in every inſtance be voluntary, to prevent the idle and profligate from depending on it for ſupport. During the reign of Elizabeth, when the monaſteries were recently ſuppreſſed, and all their revenues ſquandered, ſome compulſion might be neceſſary to prevent the poor from ſtarving. A temporary proviſion for this purpoſe, ſo contrived as not to ſuperſede voluntary charity, but rather to promote it, would have been a meaſure extremely proper. Unlucky it is for England that ſuch a meaſure was overlooked; but the queen and her parliaments had not the talent of foreſeeing conſequences without the aid of experience. A perpetual tax for the poor was impoſed, the moſt pernicious tax, ſays lord Kames[*], that ever was impoſed in any country."

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[*] The preſbytery is by law appointed auditor of the poor's accounts of the ſeveral pariſhes within its bounds; and if they find any difficult caſe occur in the diſcharge of this duty, they may lay it before the ſynod for advice.

POPA-MADRE, is a town of South America, in Terra Firma. In this place is a convent and chapel dedicated to the Virgin Mary, to whoſe image the Spaniards in thoſe parts go in pilgrimage, particularly thoſe who have been at ſea. It is ſeated on a very high mountain, 50 miles eaſt of Carthagena. W. lon. 74. 32. N. lat. 10. 15.

POPAYAN, a province of South America, in the kingdom of New Granada, between the audience of Panama, that of Quito, and the South Sea; 400 miles in length, and 300 in breadth. A chain of barren mountains runs through the country from north to ſouth; and near the ſea the ſoil is ſo ſoaked with almoſt continual rains, that few care to reſide there, except for the ſake of the gold that is met with in great plenty in the ſands of the rivulets. This bewitching metal brings many in ſearch of it, though it is a great doubt whether they ever return back alive or not. For this reaſon the ſavage Americans are ſtill maſters of a great part of it, and continually annoy the Spaniards.

Popayan, the capital town of a province of that name in South America, with a biſhop's ſee, a Spaniſh governor, and where the courts of juſtice are held. The inhabitants are almoſt all Creoles. It is ſituated 220 miles north-eaſt of Quito. W. lon. 75. 55. N. lat. 2. 35.

POPE, a name which comes from the Greek word Παπα, and ſignifies *Father*. In the Eaſt this appellation is given to all Chriſtian prieſts; and in the Weſt, biſhops were called by it in ancient times: but now for many centuries it has been appropriated to the biſhop of Rome, whom the Roman Catholics look upon as the common father of all Chriſtians.

Much has been ſaid, much written, and many warm diſputes have been carried on concerning the pope, and the power belonging to him, within theſe two or three laſt centuries. We ſhall here, without entering into controverſy, lay down diſtinctly, from the beſt authority, what the Roman Catholics really believe concerning the *pope*, after having deſcribed the manner of his election; and we ſhall give ſome other particulars relating to this ſubject that ſeem to deſerve notice, and are in this country not generally known.

All in communion with the ſee of Rome unanimouſly hold, that our Saviour Jeſus Chriſt conſtituted St. Peter the apoſtle chief paſtor under himſelf, to watch over his whole flock here on earth, and to preſerve the unity of it; giving him the power requiſite for theſe ends. They alſo believe, that our Saviour ordained that St. Peter ſhould have ſucceſſors with the like charge and power, to the end of time. Now, as St. Peter reſided at Rome for many years, and ſuffered martyrdom there, they conſider the biſhops of Rome as his ſucceſſors in the dignity and office of the univerſal paſtor of the whole Catholic church. There have been ſome varieties in the manner of chooſing the biſhop of Rome in different ages, as alterations may be made in diſcipline; but ſtill the clergy of Rome have juſtly had the chief part in that election: and that clergy is now repreſented by, or in ſome manner conſiſts of, *the cardinals*, who have for ſeveral centuries been the ſole electors of the pope.

Theſe *cardinals* or *principal perſons* of the church of Rome are 70 in number, when the *ſacred college*, as it is called, is complete. Of theſe, ſix are cardinal biſhops; the biſhops of Oſtia, of Porto, Albano, Sabino, Tuſculum or Freſcati, and Præneſte or Paleſtrina; which are the ſix ſuburbicarian churches; fifty are cardinal prieſts, who have all titles from pariſh churches in Rome; and fourteen are cardinal deacons, who have their titles from churches in Rome of leſs note, called *diaconias* or *deaconries*. Theſe cardinals are created by the pope when there happen to be vacancies; and ſometimes he names one or two only at a time; but commonly he defers the promotion until there be ten or twelve vacancies or more; and then at every ſecond ſuch promotion the emperor, the kings of Spain and France, and of Britain, when Catholic, are allowed to preſent one each, to be made cardinal, whom the pope always admits, if there be not ſome very great and evident objection. Theſe cardinals are commonly promoted from among ſuch clergymen as have borne offices in the Roman court; ſome are aſſumed from religious orders; eminent eccleſiaſtics of other countries are likewiſe often honoured with this dignity, as the archbiſhops of Toledo and Vienna are at preſent cardinal prieſts of Rome. Sons of ſovereign princes have frequently been members of the ſacred college; and there ends the direct line of the royal family of Stuart. Their diſtinctive dreſs is ſcarlet, to ſignify that they ought to be ready to ſhed their blood for the faith and church, when the defence and honour of either require it. They wear a ſcarlet cap and hat: the cap is given to them by the pope if they are at Rome, and is ſent to them if they are abſent; but the hat is never given but by the pope's own hand. Theſe cardinals form the pope's ſtanding council or *conſiſtory* for the management of the public affairs of church and ſtate. They are divided into different *congregations*, for the more eaſy diſpatch of buſineſs; and ſome of them have the principal offices in the pontifical court, as that of cardinal-vicar—penitentiary—chancellor—camerlingo or chamberlain—prefect of the ſignature of juſtice—prefect of memorials—and ſecretary of ſtate. They have the title given them of *eminence*, and *moſt-eminent*. But here we conſider them principally as the perſons entruſted with the choice of the pope. See Cardinal.

On the demiſe of a pope his pontifical ſeal is immediately broken by the chamberlain, and all public buſineſs is interrupted that can be delayed: meſſengers are diſpatched to all the Catholic ſovereigns to acquaint them of the event, that they may take what meaſures they think proper; and that the cardinals in their dominions, if any there be, may haſten to the future election if they chooſe to attend; whilſt the whole attention of the ſacred college is turned to the preſervation of tranquillity in the city and ſtate, and to the neceſſary preparations for the future election. The cardinal chamberlain has, during the vacancy of the holy ſee, great authority; he coins money with his own arms on it, lodges in the pope's apartments, and is attended by body-guards. He, and the firſt cardinal biſhop, the firſt cardinal prieſt, and the firſt cardinal deacon, have, during that time, the government almoſt entirely in their hands. The body of the deceaſed pope is carried to St. Peter's, where funeral ſervice is performed for him with great pomp for nine days, and the cardinals attend there every morning. In the mean time, all neceſſary preparations for the election are made; and the place where they aſſemble for that purpoſe, which is called the *conclave*, is fitted up in that part of the Vatican palace which is neareſt to St. Peter's church, as this has long been thought the moſt convenient ſituation. Here are formed by partitions of wood a number of cells or chambers equal to the number of cardinals, with a ſmall diſtance between every two, and a broad gallery before them. A number is put on every cell, and ſmall papers with correſponding numbers are put into a box: every cardinal, or ſome one for him, draws out one of theſe papers, which determines in what cell he is to lodge. The cells are lined with cloth; and there is a part of each one ſeparated for the conclaviſts or attendants, of whom two are allowed to each cardinal, and three to cardinal princes. They are perſons of ſome rank, and generally of great confidence; but they muſt carry in their maſter's meals, ſerve him at table, and perform all the offices of a menial ſervant. Two phyſicians, two ſurgeons, an apothecary, and ſome other neceſſary officers, are choſen for the conclave by the cardinals.

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[*] See *Sketches of Man*, book ii. ſketch 10. where many other arguments equally forcible are urged againſt all involuntary *poor-rates*, and where many ingenious expedients are propoſed for gradually aboliſhing them where they are eſtabliſhed.

On the 10th day after the pope's death, the cardinals who are then at Rome, and in a competent ſtate of health, meet in the chapel of St. Peter's, which is called the *Gregorian chapel*, where a ſermon on the choice of a pope is preached to them, and maſs is ſaid for invoking the grace of the Holy Ghoſt. Then the cardinals proceed to the conclave in proceſſion two by two, and take up their abode. When all is properly ſettled, the conclave is ſhut up, having boxed *wheels* or places of communication in convenient quarters: there are alſo ſtrong guards placed all around. When any foreign cardinal arrives after the incloſure, the conclave is opened for his admiſſion. In the beginning every cardinal ſigns a paper, containing an obligation, that if he ſhall be raiſed to the papal chair he will not alienate any part of the pontifical dominion; that he will not be prodigal to his relations; and any other ſuch ſtipulations as may have been ſettled in former times or framed for that occaſion.

We come now to the election itſelf; and that this may be effectual, two thirds of the cardinals preſent muſt vote for the ſame perſon. As this is often not eaſily obtained, they ſometimes remain whole months in the conclave. They meet in the chapel twice every day for giving their votes; and the election may be effectuated by *ſcrutiny*, *acceſſion*, or *acclamation*. Scrutiny is the ordinary method; and conſiſts in this: every cardinal writes his own name on the inner part of a piece of paper, and this is folded up and ſealed; on a ſecond fold of the ſame paper a conclaviſt writes the name of the perſon for whom his maſter votes. This, according to agreements obſerved for ſome centuries, muſt be one of the ſacred college. On the outer ſide of the paper is written a ſentence at random, which the voter muſt well remember. Every cardinal, on entering into the chapel, goes to the altar and puts his paper into a large chalice.

When all are convened, two cardinals number the votes; and if there are more or leſs than the number of cardinals preſent, the voting muſt be repeated. When that is not the caſe, the cardinal appointed for the purpoſe reads the outer ſentence, and the name of the cardinal under it; ſo that each voter, hearing his own ſentence and the name joined with it, knows that there is no miſtake. The names of all the cardinals that are voted for are taken down in writing, with the number of votes for each; and when it appears that any one has two thirds of the number preſent in his favour the election is over: but when this does not happen, the voting papers are all immediately burnt without opening up the inner part. When ſeveral trials of coming to a concluſion by this method of *ſcrutiny* have been made in vain, recourſe is ſometimes had to what is called *acceſſion*. By it, when a cardinal perceives that one or very few votes are wanting to any one for whom he had not voted at that time, he may ſay that he *accedes* to the one who has near the number of votes requiſite; and if his one vote ſuffices to make up the two thirds, or if he is followed by a ſufficient number of *acceders* or new voters for the ſaid cardinal, the election is accompliſhed. Laſtly, a pope is ſometimes elected by *acclamation*; and that is, when a cardinal, being pretty ſure that he will be joined by a number ſufficient, cries out in the open chapel, that ſuch a one ſhall be pope. If he is ſupported properly, the election becomes unanimous; thoſe who would perhaps oppoſe it foreſeeing that their oppoſition would be fruitleſs, and rather hurtful to themſelves. It is to be obſerved, that the emperor of Germany and the kings of France and Spain claim a right of excluding one cardinal from being pope at every election. Hence, when the ambaſſador at Rome of any of theſe ſovereigns perceives that any cardinal diſagreeable to his maſter, according to the inſtructions he has received, is like to be made pope, he demands an audience of the conclave, is admitted, and there declares his maſter's will; which is always attended to for the common good. But each of thoſe ſovereigns is allowed thus to exclude only one at one time; and they unwillingly and but very ſeldom put this right in execution.

When a pope is choſen in any of the three above-mentioned ways, the election is immediately announced from the balcony in the front of St. Peter's, homage is paid to the new pontiff, and couriers are ſent off with the news to all parts of Chriſtendom. The pope appoints a day for his coronation at St. Peter's, and for his taking poſſeſſion of the patriarchal church of St. John Lateran; all which is performed with great ſolemnity. He is addreſſed by the expreſſion of *Holineſs*, and *Moſt holy Father*.

Let us now proceed to ſee what authority Roman Catholics attribute to the pope thus choſen. They believe, then, that the biſhop of Rome is, under Chriſt, ſupreme paſtor of the whole church; and as ſuch is not only the firſt biſhop in order and dignity, but has alſo a power and juriſdiction over all Chriſtians, in order to preſerve unity and purity of faith and moral doctrine, and to maintain order and regularity in all churches. Wherefore they hold, that when the pope underſtands that any error has been broached againſt faith or manners, or that any conſiderable difference on ſuch ſubjects has ariſen in any part of Chriſtendom, it belongs to him, after due deliberation and conſultation, to iſſue out his paſtoral decree, condemning the error, clearing up the doubt, and declaring what has been delivered down, and what is to be believed. Some Catholic divines are of opinion that the pope cannot err, when he thus addreſſes himſelf *to all the faithful* on matters of doctrine. They well know, that as a private doctor he may fall into miſtakes as well as any other man; but they think, that when he teaches the whole church Providence muſt preſerve him from error; and they apprehend, that this may be deduced from the promiſes of Chriſt to St. Peter, and from the writings of the ancient fathers. However, this infallibility of the pope, even when he pronounces in the moſt ſolemn manner, is only an opinion, and not an article of the Roman Catholic faith. Wherefore, when he ſends forth the doctrinal decrees, the other biſhops, who are alſo guardians of the faith in an inferior degree, may, with due reſpect, examine theſe decrees; and if they ſee them agree with what has been always taught, they either formally ſignify their acceptance, or they tacitly acquieſce; which, conſidering their duty, is equivalent to a formal approbation. When the acceptation of the generality of the biſhops has been obtained, either immediately or after ſome mutual correſpondence and explanation, the decrees of the pope thus accepted come to be the ſentence of the whole church, and are believed to be beyond the poſſibility of error!

Sometimes it may happen that the diſputes and difference may be ſo great and intricate, that to the end it may be ſeen more clearly what has really been delivered down, and to give all poſſible ſatisfaction, it may appear proper to convene all the biſhops who can conveniently attend to one place, to learn from them more diſtinctly what has been taught and held in their reſpective churches. Roman Catholics believe that it belongs to the pope to call ſuch general councils, and to preſide in them in perſon, or by his legates. They likewiſe hold, that when the pope has approved the decrees of ſuch councils concerning faith or manners, ſuch decrees are then final, and muſt be received as ſuch by all Catholics. In all this they believe, that the particular aſſiſtance of the Holy Ghoſt is with the paſtors of the church, that ſo *the gates of hell may never prevail againſt her*.

The ſee of Rome, according to Roman Catholics, is the centre of Catholic unity. All their biſhops communicate with the pope, and by his means with one another, and ſo form one body. However diſtant their particular churches may be, they all meet at Rome either in perſon or by their delegates, or at leaſt by their letters. And, according to the diſcipline of the latter ages, though they are preſented to the pope for their office from their reſpective countries, yet from him they muſt receive their bulls of conſecration before they can take poſſeſſion of their ſees.

In matters of church diſcipline, the pope, as chief paſtor, not only ought to take care that the canons actually in force be obſerved in all churches, but he may alſo make new canons and regulations when he ſees it neceſſary or expedient for the ſpiritual benefit of the faithful, according to times and circumſtances. But in doing this he muſt not infringe the eſtabliſhed rights or cuſtoms with injury to any perſon; which if, through miſtake or wrong information, he ſhould ever do, the perſons who think themſelves aggrieved may remonſtrate with reſpect, and ſue for redreſs. He may eſtabliſh new epiſcopal ſees, where there have been none before; and he may alter the limits of former dioceſes; but in ſuch alterations he always of courſe conſults the temporal ſovereign, if in communion with him. He ſends paſtors to preach the goſpel to all countries where the Catholic religion is not by law eſtabliſhed; and to him appeals may be made from all parts of Chriſtendom in eccleſiaſtical cauſes of great importance.

The pope may diſpenſe with the obſervation of eccleſiaſtical canons when there are juſt reaſons for it, as may frequently happen; he may alſo diſpenſe with vows when they are made with that expreſs or tacit condition* that he really may diſpenſe with them; he may alſo on ſome occaſions declare that obligations have really ceaſed when that is truly the caſe, from a great alteration of circumſtances: But he can never grant any diſpenſation, to the injury of any third perſon, and can never allow any one to do what is unjuſt, or to ſay what he knows to be falſe, whatever advantage might be expected from it.

The pope is alſo a temporal prince, and poſſeſſes conſiderable dominions in the middle part of Italy, beſides Avignon, which the French have lately taken from him, and the duchy of Benevento incloſed within the kingdom of Naples. It is alſo ſuppoſed that the kingdoms of Naples and Sicily, and the duchies of Parma and Placentia, are ſtill held of him in fief as they were before. His predeceſſors have acquired theſe poſſeſſions at different times and on different occaſions, by various donations, conceſſions, treaties, and agreements, in like manner as has happened with regard to the eſtabliſhment of other ſovereignties; and his title to them is like to that of other potentates to their reſpective poſſeſſions. The revenue ariſing from this eſtate, and what he receives for various reaſons from Catholic countries, which is now much reduced, is employed for the ſupport of government, in ſalaries to the officers of his court, for the education of clergymen, and for the maintaining of miſſionaries in infidel countries. Great ſums are particularly expended for the propagation of the Chriſtian faith in different parts of Aſia, eſpecially in Armenia, Syria, and China. Nor is it much to be wondered at, if the families of which the ſovereign pontiffs happen to have been born, acquire greater riches and ſplendour from that connection. The princely families of Barberini, Borgheſe, Chigi, Corſini, Albani, are examples of this kind: but regulations have been made in later times to prevent exceſſive nepotiſm. Beyond the limits of his own temporal dominions the pope has no temporal power or juriſdiction, excepting what any nation may be pleaſed to allow him: when any thing of that kind has been granted or brought in by cuſtom, it is evident that it ought not to be taken away raſhly, nor without juſt reaſon. But, as chief paſtor of the church, he has no right to any temporal juriſdiction over his flock. As ſuch, his power is entirely ſpiritual, and has no means of coercion originally or neceſſarily connected with it, but only eccleſiaſtical cenſures. It muſt be owned, that the popes, in ſome ages, ſometimes imagining that they could do much good, ſometimes by the conſent, or even at the deſire, of the ſovereigns, and ſometimes no doubt out of ambitious views, have interfered a great deal in the temporal affairs of the different kingdoms of Europe; which has frequently given ſcandal and done harm to religion. But it is known to thoſe moſt verſant in hiſtory, that their faults of this kind have been exaggerated, and their conduct often miſunderſtood or miſrepreſented. However, in this a Roman Catholic is not obliged to approve what they have done: nay, without acting contrary to his religion, he may judge of them freely, and blame them if he think they deſerve it; only he will do it with reſpect and regret. Thus, a Roman Catholic may either apologiſe, if he think he can do it, for the conduct of Innocent III. in depoſing king John of England; or, without being guilty of any offence againſt his religion, he may blame the pontiff for what he did on that occaſion; becauſe the power of the pope to depoſe princes, or to abſolve ſubjects from their allegiance, was never propoſed as an article of faith, or made a term of communion with the church of Rome. Some Catholic divines, indeed, eſpecially among the Jeſuits, are univerſally known to have held this extravagant and dangerous opinion; but by far the greater part of them condemn and abhor it as abſurd and impious: and ſurely it is but fair and juſt to allow them to know beſt what they themſelves believe. And here, to conclude, we ſhall add, that it is very deſirable that Chriſtians of all denominations endeavour to underſtand one another better than they have often done; and inſtead of ſuppoſing imaginary differences, ſtrive to remove real ones, for the general good of mankind, for the glory of God, and honour of religion; and that all vie with one another to excel in juſt and charitable ſentiments, language, and behaviour.

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* Any other man may unqueſtionably do the ſame when they are made with that expreſs condition.

The reader, who wiſhes to know what can be urged for and againſt the ſupremacy of the pope, and who is fitted by his knowledge of eccleſiaſtical hiſtory to underſtand the nature of the queſtion at iſſue, may conſult, on the one hand, the works of Bellarmine, together with a ſmall tract lately publiſhed in Engliſh, under the title of *The Divine Economy of Chriſt in his Kingdom or Church*; and on the other, Barrow's treatiſe *on the Pope's Supremacy*, together with Chillingworth's *Religion of Proteſtants*, &c.

Pope (Alexander), a celebrated Engliſh poet, was deſcended from good families, and born the 8th of June 1688, at London, where his father was then a conſiderable merchant. He was taught to read very early by an aunt; and learned to write without any aſſiſtance, by copying printed books. The family being of the Romiſh religion, he was put, at eight years of age, under one Taverner, a prieſt, who taught him the rudiments of the Latin and Greek tongues together; and ſoon after was ſent to a Popiſh ſeminary at Wincheſter, from whence he was removed to a ſchool at Hyde-Park Corner. He diſcovered early an inclination to verſifying; and the tranſlations of Ogilby and Sandys from Virgil and Ovid firſt falling in his way, they were his favourite authors. At twelve he retired with his parents to Binfield, in Windſor Foreſt; and there became acquainted with the writings of Spenſer, Waller, and Dryden. Dryden ſtruck him moſt, probably becauſe the caſt of that poet was moſt congenial with his own; and therefore he not only ſtudied his works intenſely, but ever after mentioned him with a kind of rapturous veneration. He once obtained a ſight of him at a coffee-houſe, but never was known to him: a misfortune which he laments in theſe ſhort but expreſſive words, *Virgilium tantum vidi.* Though Pope had been under more tutors than one, yet it ſeems they were ſo inſufficient for the purpoſe of teaching, that he had learned very little from them: ſo that, being obliged afterwards to begin all over again, he may juſtly be conſidered as one of the αυτοδιδακτοι or *ſelf-taught*. At fifteen he had acquired a readineſs in the two learned languages; to which he ſoon after added the French and Italian. He had already ſcribbled a great deal of poetry in various ways; and this year ſet about an epic poem called *Alcander*. He long after communicated it to Atterbury, with a declared intention to burn it; and that friend concurred with him: "Though (adds he) I would have interceded for the firſt page, and put it, with your leave, among my curioſities." What the poet himſelf obſerves upon theſe early pieces is agreeable enough; and ſhows, that though at firſt a little intoxicated with the waters of Helicon, he afterwards arrived to great ſobriety of thinking. "I confeſs (ſays he) there was a time when I was in love with myſelf; and my firſt productions were the children of Self-love upon Innocence. I had made an epic poem, and panegyrics on all the princes; and I thought myſelf the greateſt genius that ever was. I cannot but regret theſe delightful viſions of my childhood, which, like the fine colours we ſee when our eyes are ſhut, are vaniſhed for ever." His Paſtorals, begun in 1704, firſt introduced him to the wits of the time; amongſt whom were Wycherly and Walſh. This laſt gentleman proved a ſincere friend to him; and ſoon diſcerning that his talent lay, not ſo much in ſtriking out new thoughts of his own, as in improving thoſe of other men, and in an eaſy verſification, told him, among other things, that there was one way left open for him to excel his predeceſſors in, which was correctneſs: obſerving, that though we had ſeveral great poets, yet none of them were correct. Pope took the hint, and turned it to good account; for no doubt the diſtinguiſhing harmony of his numbers was in a great meaſure owing to it. The ſame year, 1704, he wrote the firſt part of his Windſor Foreſt, though the whole was not publiſhed till 1710. In 1708, he wrote the Eſſay on Criticiſm; which production was juſtly eſteemed a maſterpiece in its kind, and ſhowed not only the peculiar turn of his talents, but that thoſe talents, young as he was, were ripened into perfection. He was not yet twenty years old; and yet the maturity of judgment, the knowledge of the world, and the penetration into human nature, diſplayed in that piece, were ſuch as would have done honour to the greateſt abilities and experience. But whatever may be the merit of the Eſſay on Criticiſm, it was ſtill ſurpaſſed, in a poetical view, by the Rape of the Lock, firſt completely publiſhed in 1712. The former excelled in the didactic way, for which he was peculiarly formed; a clear head, ſtrong ſenſe, and a ſound judgment, being his characteriſtical qualities; but it is the creative power of the imagination that conſtitutes what is properly called a *poet*; and therefore it is in the Rape of the Lock that Pope principally appears one, there being more *vis imaginandi* diſplayed in this poem than perhaps in all his other works put together. In 1713, he gave out propoſals for publiſhing a tranſlation of Homer's Iliad, by ſubſcription; in which all parties concurred ſo heartily, that he acquired a conſiderable fortune by it. The ſubſcription amounted to 6000l. beſides 1200l. which Lintot the bookſeller gave him for the copy. Pope's finances being now in good condition, he purchaſed a houſe at Twickenham, whither he removed with his father and mother in 1715: where the former died about two years after. As he was a Papiſt, he could not purchaſe, nor put his money to intereſt on real ſecurity; and as he adhered to the cauſe of king James, he made it a point of conſcience not to lend it to the new government; ſo that, though he was worth near 20,000l. when he laid aſide buſineſs, yet, living afterwards upon the quick ſtock, he left but a ſlender ſubſtance to his family. Our poet, however, did not fail to improve it to the utmoſt: he had already acquired much by his publications, and he was all attention to acquire more. In 1717, he publiſhed a collection of all he had printed ſeparately; and proceeded to give a new edition of Shakeſpeare; which, being publiſhed in 1721, diſcovered that he had conſulted his fortune more than his fame in that undertaking. The Iliad being finiſhed, he engaged upon the like footing to undertake the Odyſſey. Mr. Broome and Mr. Fenton did part of it, and received 500l. of Mr. Pope for their labours. It was publiſhed in the ſame manner, and on the ſame conditions to Lintot; excepting that, inſtead of 1200l. he had but 600l. for the copy. This work being finiſhed in 1725, he was afterwards employed with Swift and Arbuthnot in printing ſome volumes of Miſcellanies. About this time he narrowly eſcaped loſing his life, as he was returning home in a friend's chariot; which, on paſſing a bridge, happened to be overturned, and thrown with the horſes into the river. The glaſſes were up, and he was not able to break them: ſo that he had immediately been drowned, if the poſtillion had not broken them, and dragged him out to the bank. A fragment of the glaſs, however, cut him ſo deſperately, that he ever after loſt the uſe of two of his fingers. In 1727 his Dunciad appeared in Ireland; and the year after in England, with notes by Swift, under the name of *Scriblerus*. This edition was preſented to the king and queen by Sir Robert Walpole; who, probably about this time, offered to procure Pope a penſion, which however he refuſed, as he had formerly done a propoſal of the ſame kind made him by Lord Halifax. He greatly cultivated the ſpirit of independency; and "Unplaced, unpenſioned, no man's heir or ſlave," was frequently his boaſt. He ſomewhere obſerves, that the life of an author is a ſtate of warfare: he has ſhown himſelf a complete general in this way of warring. He bore the inſults and injuries of his enemies long; but at length, in the Dunciad, made an abſolutely univerſal ſlaughter of them: for even Cibber, who was afterwards advanced to be the hero of it, could not forbear owning, that nothing was ever more perfect and finiſhed in its kind than this poem. In 1729, by the advice of lord Bolingbroke, he turned his pen to ſubjects of morality; and accordingly we find him, with the aſſiſtance of that noble friend, who furniſhed him with the materials, at work this year upon the Eſſay on Man. The following extract of a letter to Swift diſcovers the reaſon of his lordſhip's advice: "Bid him (ſays Bolingbroke) talk to you of the work he is about, I hope in good earneſt; it is a fine one, and will be, in his hands, an original. His ſole complaint is, that he finds it too eaſy in the execution. This flatters his lazineſs: it flatters my judgment; who always thought, that, univerſal as his talents are, this is eminently and peculiarly his, above all the writers I know, living or dead; I do not except Horace." Pope tells the dean in the next letter, that "the work lord Bolingbroke ſpeaks of with ſuch abundant partiality, is a ſyſtem of ethics, in the Horatian way." In purſuing the ſame deſign, he wrote his Ethic Epiſtles; the fourth of which, upon Taſte, giving great offence, as he was ſuppoſed to ridicule the duke of Chandos under the character of Timon, is ſaid to have put him upon writing ſatires, which he continued till 1739. He ventured to attack perſons of the higheſt rank, and ſet no bounds to his ſatirical rage. A genuine collection of his letters was publiſhed in 1737. In 1738, a French tranſlation of the Eſſay on Man, by the Abbé Reſnel, was printed at Paris; and Mr. Crouſaz, a German profeſſor, animadverted upon this ſyſtem of ethics, which he repreſented as nothing elſe but a ſyſtem of naturaliſm. Mr. Warburton, afterwards biſhop of Glouceſter, wrote a commentary upon the Eſſay; in which he defends it againſt Crouſaz, whoſe objections he ſuppoſes owing to the faultineſs of the Abbé Reſnel's tranſlation. The poem was republiſhed in 1740, with the commentary. Our author now added a fourth book to the Dunciad, which was firſt printed ſeparately in 1742: but the year after, the whole poem came out together, as a ſpecimen of a more correct edition of his works. He had made ſome progreſs in that deſign, but did not live to complete it. He had all his life long been ſubject to the head-ach; and that complaint, which he derived from his mother, was now greatly increaſed by a dropſy in his breaſt, under which he expired the 30th of May 1744, in the 56th year of his age. In his will, dated December 12, 1743, miſs Blount, a lady to whom he was always devoted, was made his heir during her life: and, among other legacies, he bequeathed to Mr. Warburton the property of all ſuch of his works, already printed, as he had written or ſhould write commentaries upon, and which had not otherwiſe been diſpoſed of or alienated; with this condition, that they were publiſhed without future alterations. In diſcharge of this truſt, that gentleman gave a complete edition of all Mr. Pope's works, 1751, in 9 vols. 8vo. A work entitled *An Eſſay on the Writings and Genius of Pope*, by Mr. Warton, 2 vols. 8vo. will be read with pleaſure by thoſe who deſire to know more of the perſon, character, and writings of this excellent poet. Lord Orrery's account of him is very flattering: "If we may judge of him by his works (ſays this noble author), his chief aim was to be eſteemed a man of virtue. His letters are written in that ſtyle; his laſt volumes are all of the moral kind; he has avoided trifles, and conſequently has eſcaped a rock which has proved very injurious to Swift's reputation. He has given his imagination full ſcope, and yet has preſerved a perpetual guard upon his conduct. The conſtitution of his body and mind might really incline him to the habits of caution and reſerve. The treatment which he met with afterwards, from an innumerable tribe of adverſaries, confirmed this habit; and made him ſlower than the dean in pronouncing his judgment upon perſons and things. His proſe-writings are little leſs harmonious than his verſe; and his voice, in common converſation, was ſo naturally muſical, that I remember honeſt Tom Southern uſed to call him the *little nightingale*. His manners were delicate, eaſy, and engaging; and he treated his friends with a politeneſs that charmed, and a generoſity that was much to his honour. Every gueſt was made happy within his doors; pleaſure dwelt under his roof, and elegance preſided at his table."

Yet, from Dr. Johnſon's account of his domeſtic habits, we have reaſon to doubt the latter part of this character. His parſimony (he informs us) appeared in very petty matters, ſuch as writing his compoſitions on the backs of letters, or in a niggardly reception of his friends, and a ſcantineſs of entertainment—as the ſetting a ſingle pint on the table to two friends, when, having himſelf taken two ſmall glaſſes, he would retire, ſaying, I leave you to your wine. He ſometimes, however, the Doctor acknowledges, made a ſplendid dinner; but this happened ſeldom. He was very full of his fortune, and frequently ridiculed poverty; and he ſeems to have been of an opinion not very uncommon in the world, that to want money is to want every thing. He was almoſt equally proud of his connection with the great, and often boaſted that he obtained their notice by no meanneſs or ſervility. This admiration of the great increaſed in the advance of life; yet we muſt acknowledge that he could derive but little honour from the notice of Cobham, Burlington, or Bolingbroke.

By natural deformity, or accidental diſtortion, his vital functions were ſo much diſordered, that his life was a long diſeaſe; and from this cauſe aroſe many of his peculiarities and weakneſſes. He ſtood conſtantly in need of female attendance; and to avoid cold, of which he was very ſenſible, he wore a fur doublet under his ſhirt, &c. The indulgence and accommodation which his ſickneſs required, had taught him all the unpleaſing and unſocial qualities of a valetudinary man.—When he wanted to ſleep, he nodded in company; and once ſlumbered at his own table when the prince of Wales was talking of poetry. He was extremely troubleſome to ſuch of his friends as aſked him out, which many of them frequently did, and plagued the ſervants beyond deſcription. His love of eating is another fault to which he is ſaid to have fallen a ſacrifice. In all his intercourſe with mankind he had great delight in artifice, and endeavoured to attain all his purpoſes by indirect and unſuſpected methods.

In familiar converſation it is ſaid he never excelled; and he was ſo fretful and ſo eaſily diſpleaſed, that he would ſometimes leave lord Oxford's ſilently without any apparent reaſon, and was to be courted back by more letters and meſſages than the ſervants were willing to carry.

Dr. Johnſon alſo gives a view of the intellectual character of Pope, and draws a parallel between Dryden and him. For particulars, however, we muſt refer our readers to *Johnſon's Lives of the Poets.*

POPE's *Dominions*, or *Eccleſiaſtical States*, a country of Italy, bounded on the north by the gulph of Venice and the Venetian dominions, on the ſouth by the Mediterranean, on the eaſt by the kingdom of Naples and the Adriatic, and on the weſt by Tuſcany and Modena. It is 400 miles long on the coaſt of the Adriatic from Naples to the Venetian territory. It is but narrow, however, from north to ſouth, not being more than 80 miles broad from the gulph of Venice to the Tuſcan ſea.

The ſoil, in general, of the pope's dominions is very fertile, but ill cultivated; and there are many fens and marſhy grounds which are very prejudicial to the air. That the lands are badly cultivated and inhabited, the air bad, and the inhabitants poor, idle, lazy, and groſsly ſuperſtitious, is owing to a variety of cauſes. With reſpect to the accommodations of life, this country is but in a very indifferent condition; for, notwithſtanding the fertility of its ſoil, its advantageous ſituation for traffic, the large ſums ſpent in it by travellers, or remitted to it from foreign countries, and its having, for its ruler, the ſucceſſor of St. Peter, the prince of the apoſtles, and the vicar of Jeſus Chriſt; yet it is poor, and thin of inhabitants, ill cultivated, and without trade and manufactures. This is partly owing to the great number of holidays, of ſturdy beggars called *pilgrims*, and of hoſpitals and convents, with the amazing but perhaps uſeleſs wealth of churches and convents, and the inquiſition: but the chief cauſe is the ſeverity of the government, and the grievous exactions and hardſhips to which the ſubjects are expoſed. The legates, though moſtly clergymen, whoſe thoughts ſhould be chiefly employed about laying up treaſures in heaven, and who ought to ſet an example to the laity of diſintereſtedneſs and a contempt of this world, too often, it is ſaid, ſcruple no kind of rapaciouſneſs: even the holy father himſelf, and the cardinals, frequently make the enriching of their nephews and other relations, and the aggrandizing their families, too much the buſineſs of their lives. The extenſive claims and great pretenſions of the pope are well known, and by a large part of Chriſtendom are now treated with contempt and mockery. The Reformation gave a great blow to this ſpiritual power; and the French revolution has leſſened it ſtill more. His temporal dominions, however, ſtill continue much the ſame; though how long this may be the caſe, conſidering how much he hath loſt, and is daily loſing, of his ghoſtly empire, and the veneration in which he was formerly held, it is difficult to ſay. See Pope. The Campania of Rome is under the pope's immediate government; but the other provinces are governed by legates and vice-legates, and there is a commander in chief of the pope's forces in every province. The pope is choſen by the cardinals in the conclave: ſee this particularly deſcribed under Pope. The pope holds a conſiſtory of cardinals on eccleſiaſtical affairs; but the cardinals do not meddle with his civil government. The pope's chief miniſter is the cardinal-patron, uſually his nephew, who amaſſes an immenſe eſtate if the reign be of any long duration. The cardinal that is choſen pope muſt generally be an Italian, and at leaſt 55 years of age. The ſpiritual power of the pope, though far ſhort of what it was before the Reformation, is ſtill conſiderable. It is computed that the monks and regular clergy, who are abſolutely at his devotion, do not amount to leſs than 2,000,000 of people, diſperſed through all the Roman Catholic countries, to aſſert his ſupremacy over princes, and promote the intereſt of the church. The revenues of theſe monks do not fall ſhort of 20,000,000l. ſterling, beſides the caſual profits ariſing from offerings, and the people's bounty to the church, who are taught that their ſalvation depends on this kind of benevolence.

The pope's revenues, as a temporal prince, may amount to about 1,000,000l. ſterling *per annum*, ariſing chiefly from the monopoly of corn, the duties on wine and other proviſions. Over and above theſe, vaſt ſums are continually flowing into the papal treaſury from all the Roman Catholic countries, for diſpenſations, indulgences, canonizations, annates, the pallia, and inveſtitures of archbiſhops, biſhops, &c.

The pope has a conſiderable body of regular forces, well clothed and paid; but his fleet conſiſts only of a few galleys. His life-guards are 40 Switzers, 75 cuiraſſiers, and as many light horſe. Since the beginning of this war, we are told, he has likewiſe had a guard of Engliſh horſe.

POPERY, in eccleſiaſtical hiſtory, comprehends the religious doctrines and practices adopted and maintained by the church of Rome. The following ſummary, extracted chiefly from the decrees of the council of Trent, continued under Paul III. Julius III. and Pius IV. from the year 1545 to 1563, by ſucceſſive ſeſſions, and the creed of Pope Pius IV. ſubjoined to it, and bearing date November 1564, may not be unacceptable to the reader. One of the fundamental tenets, ſtrenuouſly maintained by popiſh writers, is the infallibility of the church of Rome; though they are not agreed whether this privilege belongs to the pope or a general council, or to both united; but they pretend that an infallible living judge is abſolutely neceſſary to determine controverſies, and to ſecure peace in the Chriſtian church. However, Proteſtants allege, that the claim of infallibility in any church is not juſtified by the authority of Scripture; much leſs does it pertain to the church of Rome; and that it is inconſiſtent with the nature of religion, and the perſonal obligations of its profeſſors; and that it has proved ineffectual to the end for which it is ſuppoſed to be granted, ſince popes and councils have diſagreed in matters of importance, and they have been incapable, with the advantage of this pretended infallibility, of maintaining union and peace.

Another eſſential article of the popiſh creed is the ſupremacy of the pope, or his ſovereign power over the univerſal church. See Pope. Further, the doctrine of the ſeven ſacraments is a peculiar and diſtinguiſhing doctrine of the church of Rome: theſe are baptiſm, confirmation, the euchariſt, penance, extreme unction, orders, and matrimony.

The council of Trent (ſeſſ. 7. can. 1.) pronounces an anathema on thoſe who ſay, that the ſacraments are more or fewer than ſeven, or that any one of the above number is not truly and properly a ſacrament. And yet it does not appear that they amounted to this number before the 12th century, when Hugo de St. Victore and Peter Lombard, about the year 1144, taught that there were ſeven ſacraments. The council of Florence, held in 1438, was the firſt council that determined this number. Theſe ſacraments confer grace, according to the decree of the council of Trent (ſeſ. 7. can. 8.) *ex opere operato*, by the mere adminiſtration of them: three of them, viz. baptiſm, confirmation, and orders, are ſaid (can. 9.) to impreſs an indelible character, ſo that they cannot be repeated without ſacrilege; and the efficacy of every ſacrament depends on the intention of the prieſt by whom it is adminiſtered (can. 11.). Pope Pius expreſsly enjoins, that all theſe ſacraments ſhould be adminiſtered according to the received and approved rites of the Catholic church. With regard to the euchariſt in particular, we may here obſerve, that the church of Rome holds the doctrine of tranſubſtantiation; the neceſſity of paying divine worſhip to Chriſt under the form of the conſecrated bread, or hoſt; the propitiatory ſacrifice of the maſs, according to their ideas of which Chriſt is truly and properly offered as a ſacrifice as often as the prieſt ſays maſs; it practiſes likewiſe ſolitary maſs, in which the prieſt alone, who conſecrates, communicates, and allows communion only in one kind, viz. the bread, to the laity. Seſſ. 14.

The doctrine of merits is another diſtinguiſhing tenet of popery; with regard to which the council of Trent has expreſsly decreed (ſeſſ. 6. can. 32.) that the good works of juſtified perſons are truly meritorious; deſerving not only an increaſe of grace, but eternal life, and an increaſe of glory; and it has anathematized all who deny this doctrine. Of this ſame kind is the doctrine of ſatisfactions; which ſuppoſes that penitents may truly ſatisfy, by the afflictions they endure under the diſpenſations of Providence, or by voluntary penances to which they ſubmit, for the temporal penalties of ſin, to which they are ſubject, even after the remiſſion of their eternal puniſhment. Seſſ. 6. can. 30. and ſeſſ. 14. can. 8. and 9. In this connection we may mention the popiſh diſtinction of venial and mortal ſins: the greateſt evils ariſing from the former are the temporary pains of purgatory; but no man, it is ſaid, can obtain the pardon ot the latter without confeſſing to a prieſt, and performing the penances which he impoſes.

The council of Trent (ſeſſ. 14. can. 1.) has expreſsly decreed, that every one is accurſed who ſhall affirm that penance is not truly and properly a ſacrament, inſtituted by Chriſt in the univerſal church, for reconciling thoſe Chriſtians to the divine majeſty who have fallen into ſin after baptiſm: and this ſacrament, it is declared, conſiſts of two parts, the matter and the form; the matter is the act of the penitent, including contrition, confeſſion, and ſatisfaction; the form of it is the act of abſolution on the part of the prieſt. Accordingly it is enjoined, that it is the duty of every man, who hath fallen after baptiſm, to confeſs his ſins once a year, at leaſt, to a prieſt: that this confeſſion is to be ſecret; for public confeſſion is neither commanded nor expedient: and that it muſt be exact and particular, including every kind and act of ſin, with all the circumſtances attending it. When the penitent has ſo done, the prieſt pronounces an abſolution; which is not conditional or declarative only, but abſolute and judicial. This ſecret, or auricular confeſſion, was firſt decreed and eſtabliſhed in the fourth council of Lateran, under Innocent III. in 1215, (cap. 21.) And the decree of this council was afterwards confirmed and enlarged in the council of Florence, and in that of Trent; which ordains, that confeſſion was inſtituted by Chriſt, that by the law of God it is neceſſary to ſalvation, and that it has been always practiſed in the Chriſtian church. As for the penances impoſed on the penitent by way of ſatisfaction, they have been commonly the repetition of certain forms of devotion, as pater-noſters, or ave-marias, the payment of ſtipulated ſums, pilgrimages, faſts, or various ſpecies of corporal diſcipline. But the moſt formidable penance, in the eſtimation of many who have belonged to the Romiſh communion, has been the temporary pains of purgatory. But under all the penalties which are inflicted or threatened in the Romiſh church, it has provided relief by its indulgences, and by its prayers or maſſes for the dead, performed profeſſedly for relieving and reſcuing the ſouls that are detained in purgatory.

Another article that has been long authoritatively enjoined and obſerved in the church of Rome, is the celibacy of her clergy. This was firſt enjoined at Rome by Gregory VII. about the year 1074, and eſtabliſhed in England by Anſelm archbiſhop of Canterbury about the year 1175; though his predeceſſor Lanfranc had impoſed it upon the prebendaries and clergy that lived in towns. And though the council of Trent was repeatedly petitioned by ſeveral princes and ſtates to aboliſh this reſtraint, the obligation of celibacy was rather eſtabliſhed than relaxed by this council; for they decreed, that marriage contracted after a vow of continence, is neither lawful nor valid; and thus deprived the church of the poſſibility of ever reſtoring marriage to the clergy. For, if marriage, after a vow, be in itſelf unlawful, the greateſt authority upon earth cannot diſpenſe with it, nor permit marriage to the clergy, who have already vowed continence.

To the doctrines and practices above recited may be further added the worſhip of images, of which Proteſtants accuſe the Papiſts. But to this accuſation the Papiſt replies, that he keeps images by him to preſerve in his mind the memory of the perſons repreſented by them; as people are wont to preſerve the memory of their deceaſed friends by keeping their pictures. He is taught (he ſays) to uſe them ſo as to caſt his eyes upon the pictures or images, and thence to raiſe his heart to the things repreſented, and there to employ it in meditation, love, and thankſgiving, deſire of imitation, &c. as the object requires.

Theſe pictures or images have this advantage, that they inform the mind by one glance of what in reading might require a whole chapter; there being no other difference between them, than that reading repreſents leiſurely and by degrees; and a picture, all at once. Hence he finds a convenience in ſaying his prayers with ſome devout pictures before him, he being no ſooner diſtracted, but the ſight of theſe recalls his wandering thoughts to the right object; and as certainly brings ſomething good into his mind, as an immodeſt picture diſturbs his heart with filthy thoughts. And becauſe he is ſenſible that theſe holy pictures and images repreſent and bring to his mind ſuch objects as in his heart he loves, honours, and venerates; he cannot but upon that account love, honour, and reſpect the images themſelves.

The council of Trent likewiſe decreed, that all biſhops and paſtors who have the cure of ſouls, do diligently inſtruct their flocks, *that it is good and profitable to deſire the interceſſion of ſaints reigning with Chriſt in heaven.* And this decree the Papiſts endeavour to defend by the following obſervations. They confeſs that we have but one Mediator of redemption; but affirm that it is acceptable to God that we ſhould have many mediators of interceſſion. Moſes (ſay they) was ſuch a mediator for the Iſraelites; Job for his three friends; Stephen for his perſecutors. The Romans were thus deſired by St. Paul to be his mediators; ſo were the Corinthians, ſo the Epheſians, *Ep. ad Rom. Cor. Eph.*; ſo almoſt every ſick man deſires the congregation to be his mediators, by remembering him in their prayers. And ſo the Papiſt deſires the bleſſed in heaven to be his mediators; that is, that they would pray to God for him. But between theſe living and dead mediators there is no ſimilarity: the living mediator is preſent, and certainly hears the requeſt of thoſe who deſire him to intercede for them; the dead mediator is as certainly abſent, and cannot poſſibly hear the requeſts of all thoſe who at the ſame inſtant may be begging him to intercede for them, unleſs he be poſſeſſed of the divine attribute of omnipreſence; and he who gives that attribute to any creature is unqueſtionably guilty of idolatry. And as this decree is contrary to one of the firſt principles of natural religion, ſo does it receive no countenance from Scripture, or any Chriſtian writer of the three firſt centuries. Other practices peculiar to the Papiſts are the religious honour and reſpect that they pay to ſacred relicks; by which they underſtand not only the bodies and parts of the bodies of the ſaints, but any of thoſe things that appertained to them, and which they touched; and the celebration of divine ſervice in an unknown tongue: to which purpoſe the council of Trent hath denounced an anathema on any one who ſhall ſay that maſs ought to be celebrated only in the vulgar tongue; ſeſſ. 25. and ſeſſ. 22. can. 9. Though the council of Lateran under Innocent III. in 1215 (can. 9.) had expreſsly decreed, that becauſe in many parts within the ſame city and dioceſe there are many people of different manners and rites mixed together, but of one faith, the biſhops of ſuch cities or dioceſes ſhould provide fit men for celebrating divine offices, according to the diverſity of tongues and rites, and for adminiſtering the ſacraments.

We ſhall only add, that the church of Rome maintains, that unwritten traditions ought to be added to the holy Scriptures, in order to ſupply their defect, and to be regarded as of equal authority; that the books of the Apocrypha are canonical ſcripture; that the vulgate edition of the Bible is to be deemed authentic; and that the Scriptures are to be received and interpreted according to that ſenſe which the holy mother church, to whom it belongs to judge of the true ſenſe, hath held, and doth hold, and according to the unanimous conſent of the fathers.

Such are the principal and diſtinguiſhing doctrines of Popery, moſt of which have received the ſanction of the council of Trent, and that of the creed of pope Pius IV. which is received, profeſſed, and ſworn to by every one who enters into holy orders in the church of Rome; and at the cloſe of this creed we are told that the faith contained in it is ſo abſolutely and indiſpenſably neceſſary, that no man can be ſaved without it.

Many of the doctrines of Popery were relaxed, and very favourably interpreted by M. de Meaux, biſhop of Condom, in his Expoſition of the Doctrine of the Catholic Church, firſt printed in the year 1671: but this edition, which was charged with perverting, in endeavouring to palliate, the doctrine of the church, was cenſured by the doctors of the Sorbonne, and actually ſuppreſſed; nor does it appear that they ever teſtified their approbation in the uſual form of ſubſequent and altered editions. It has, however, been lately publiſhed in this country by a clergyman of the Romiſh church, whoſe integrity, piety and benevolence would do honour to any communion.

POPHAM (Sir JOHN), lord chief juſtice of the common pleas in the reign of queen Elizabeth, was the eldeſt ſon of Edward Popham, eſq. of Huntworth in Somerſetſhire, and born in the year 1531. He was ſome time a ſtudent of Baliol college in Oxford; "being then (ſays Ant. Wood) given at leiſure hours to many ſports and exerciſes." After quitting the univerſity, he fixed in the Middle Temple; where, during his novitiate, he is ſaid to have indulged in that kind of diſſipation to which youth and a vigorous conſtitution more naturally incline than to the ſtudy of voluminous *reports*: but, ſatiated at length with what are called the *pleaſures of the town*, he applied ſeduloufly to the ſtudy of his profeſſion, was called to the bar, and in 1568 became ſummer or autumn reader. He was ſoon after made ſerjeant at law, and ſolicitor-general in 1579. In 1581 he was appointed attorney-general, and treaſurer of the Middle Temple. In 1592 he was made lord chief juſtice of the king's bench, and the ſame year received the honour of knighthood. In the year 1601 his lordſhip was one of the counſel detained by the unfortunate earl of Eſſex when he formed the ridiculous project of defending himſelf in his houſe: and, on the earl's trial, he gave evidence againſt him relative to their detention. He died in the year 1607, aged 76; and was buried in the ſouth aiſle of the church at Wellington in Somerſetſhire, where he generally reſided as often as it was in his power to retire. He was thought ſomewhat ſevere in the execution of the law againſt capital offenders: but his ſeverity had the happy effect of reducing the number of highway robbers. He wrote, 1. Reports and caſes adjudged in the time of queen Elizabeth. 2. Reſolutions and judgements upon caſes and matters agitated in all the courts at Weſtminſter in the latter end of queen Elizabeth's reign.

POPLAR, in botany. See POPULUS.

POPLITÆUS, in anatomy, a ſmall muſcle obliquely pyramidal, ſituated under the ham. See ANATOMY, *Table of the Muſcles*.

POPPY, in botany. See OPIUM and PAPAVER.

POPULAR, ſomething that relates to the common people.

POPULATION, means the ſtate of a country with reſpect to the number of people. See *Bills of* MORTALITY and POLITICAL *Arithmetic*. The queſtion concerning the number of men exiſting upon earth, has been variouſly determined by different writers. Riccioli ſtates the population of the globe at 1000 millions, Voſſius at 500; the Journaliſts of Trevoux at 700; and the editor (Xavier de Feller) of the ſmall Geographical Dictionary of Voſgien, reprinted at Paris in 1778, at 370 millions. This laſt eſtimate is perhaps too low, although the writer profeſſes to have taken conſiderable pains to aſcertain the points with as much accuracy as the nature of the ſubject will admit. It may, perhaps, not be deemed unworthy the attention of the curious ſpeculatiſt to obſerve, that, aſſuming the more probable ſtatement of the learned Jeſuits of Trevoux, and that the world has exiſted about 6006 years in its preſent ſtate of population, then the whole number of perſons who have ever exiſted upon earth ſince the days of Adam amounts only to about one hundred and thirty thouſand millions; becauſe 720 000,000 × 182 (the number of generations in 6006 years) = 131,040,000,000. See on this ſubject the authors above mentioned, as likewiſe Beauſobre's *Etude de la Politique*. With regard to the population of England, the reader may conſult, together with our article POLITICAL-*Arithmetic*, An Inquiry into the preſent State of Population, &c. by W. Wales, F. R. S. and Mr. Howlett's Examination of Dr. Price's Eſſay, on the ſame ſubject.

POPULUS, the POPLAR: A genus of the octandria order, belonging to the diœcia claſs of plants; and in the natural method ranking under the 50th order, *Amentaceæ*. The calyx of the amentum is a lacerated, oblong, and ſquamous leaf; the corolla is turbinated, oblique, and entire. The female has the calyx of the amentum and corolla the ſame as in the male; the ſtigma is quadrifid; the capſule bilocular, with many pappous ſeeds. The poplar, one of the moſt beautiful of the aquatic trees, has frequently been introduced into the poetical deſcriptions of the ancients; as by Virgil, *Ecl.* vii. 66. ix. 41. *Georg.* ii. 66. iv. 511. *Æn.* viii. 31. 276. by Ovid, *Amom. Parid.* 27. by Horace, *Carm.* ii. 3. and by Catullus, *Nupt. Pil. et Thet.* 290, &c. &c.

The ſpecies are, 1. The *alba*, or abele-tree, grows naturally in the temperate parts of Europe. Its leaves are large, and divided into three, four, or five lobes, indented on their edges, of a very dark colour on their upper ſide, but very white and downy on the under ſide; ſtanding upon footſtalks an inch long. The young branches have a purple bark, and are covered with a white down; but the bark of the ſtem and older branches is grey. In the beginning of April the male flowers or catkins appear, which are cylindrical, and about three inches long. About a week after come out the female flowers or catkins, which have no ſtamina like thoſe of the male. Soon after theſe come out the male catkins fall off; and in five or ſix weeks after the female flowers will have ripe ſeeds incloſed in a hairy covering. The catkins will then drop, and the ſeeds be wafted by the winds to a great diſtance. 2. The *major*, or white poplar, has its leaves rounder than the firſt, and not much above half their ſize: they are indented on their edges, and are downy on their under ſide, but not ſo white as thoſe of the former, nor are their upper ſurfaces of ſuch a deep green colour. 3. The *nigra*, or black poplar, has oval heart-ſhaped leaves, ſlightly crenated on their edges; they are ſmooth on both ſides, and of a light green colour. 4. The *tremula*, or aſpen-tree, has roundiſh, angularly indented leaves: they are ſmooth on both ſides, and ſtand on long footſtalks, and ſo are ſhaken by the leaſt wind; from whence it has the title of the *trembling poplar*, or *aſpen-tree*. 5. The *balſamifera*, or Carolina poplar, is a native of Carolina, where it becomes a large tree. The ſhoots of this ſort grow very ſtrong in Britain, and are generally angular; with a light green bark like the willow. The leaves on young trees, and alſo thoſe on the lower ſhoots, are very large, almoſt heart-ſhaped, and crenated; but thoſe upon the older trees are ſmaller: as the trees advance, their bark becomes lighter, approaching to a grayiſh colour. 6. The *tacamahaca*, grows naturally in Canada and other parts of North America. This is a tree of a middling growth, ſending out on every ſide many ſhort thick ſhoots, which are covered with a light brown bark, garniſhed with leaves differing from one another in ſhape and ſize; moſt of them are almoſt heart-ſhaped; but ſome are oval, and others nearly ſpear-ſhaped; they are whitiſh on their under ſide, but green on their upper.

Theſe trees may be *propagated* either by layers or cuttings, as alſo from the ſuckers which the white poplars ſend up from their roots in great plenty. The beſt time for tranſplanting theſe ſuckers is in October, when their leaves begin to decay. Theſe may be placed in a nurſery for two or three years, to get ſtrength before they are planted out where they are deſigned to remain; but if they are propagated from cuttings, it is better to defer the doing of that until February, at which time truncheons of two or three feet long ſhould be thruſt about a foot and a half into the ground. Theſe will readily take root; and if the ſoil in which they are planted be moiſt, they will arrive at a conſiderable bulk in a few years. The black poplar is leſs apt to take root from large truncheons; therefore it is a better method to plant cuttings of it about a foot and a half in length, thruſting them a foot deep in the ground. This ſort will grow almoſt on any ſoil, but will thrive beſt in moiſt places. The Carolina poplar may alſo be propagated by cuttings or layers; but the laſt is the method generally practiſed, and the plants raiſed by it are leſs moiſt than others. The ſhoots of this tree, while young, are frequently killed down to a conſiderable length by the froſt in winter; but as the trees grow older, their ſhoots are not ſo vigorous, and become more ligneous, ſo are not liable to the ſame diſaſter. But the trees ſhould be planted in a ſheltered ſituation: for, as their leaves are very large, the wind has great power over them; and the branches being tender, they are frequently broken or ſplit by the winds in ſummer, when they are much expoſed. The tacamahaca ſends up a great number of ſuckers from its roots, by which it multiplies in plenty; and every cutting which is planted will take root.

The wood of theſe trees, eſpecially of the abele, is good for laying floors, where it will laſt for many years, and, on account of its extreme whiteneſs, is by many preferred to oak; yet, on account of its ſoft contexture, being very ſubject to take the impreſſion of nails, &c. it is leſs proper on this account than the harder woods. The ABELE likewiſe deſerves particular notice, on account of the virtue of its bark in curing intermitting fevers, as ſtated by the Reverend Mr. Stone, in Phil. Tranſ. vol. liii. p. 195. This bark will alſo tan leather.

The inner bark of the black poplar is uſed by the inhabitants of Kamtſchatka as a material for bread; and paper has ſometimes been made of the cottony down of the ſeeds. The roots have been obſerved to diſſolve into a kind of gelatinous ſubſtance, and to be coated over with a tubular cruſtaceous ſpar, called by naturaliſts OSTEOCOLLA, formerly imagined to have ſome virtue in producing the callus of a fractured bone. The buds of the ſixth ſpecies are covered with a glutinous reſin, which ſmells very ſtrong, and is the gum tacamahaca of the ſhops. The beſt, called, from its being collected in a kind of gourd-ſhells, *tacamahaca in ſhells*, is ſomewhat unctuous and ſoftiſh, of a pale yellowiſh or greeniſh colour, an aromatic taſte, and a fragrant delightful ſmell, approaching to that of lavender or ambergriſe. This ſort is very rare; that commonly found in the ſhops is in ſemitranſparent globes or grains, of a whitiſh, yellowiſh, browniſh, or greeniſh colour, of a leſs grateful ſmell than the foregoing. This reſin is ſaid to be employed externally by the Indians for diſcuſſing and maturating tumours, and abating pains in the limbs. It is an ingredient in ſome anodyne, hyſteric, cephalic, and ſtomachic plaſters; but the fragrance of the finer ſort ſufficiently points out its utility in other reſpects.

M. Fougeroux de Bondaroy, from a ſet of experiments on the ſubject, gives an account of the uſes of the ſeveral kinds of poplar, the ſubſtance of which is as follows: He finds that the wood of the black poplar is good and uſeful for many purpoſes; that the Lombardy poplar, *populus faſtigata*, is of very little value; that the Virginia poplar, *populus Virginiana*, affords a wood of excellent quality, that may be applied to many uſes. The Carolina poplar, *populus Carolinenſis—heterophylla*, (Lin.) is a very quick grower; beautiful when ſound, but liable to be hurt by cold. Its wood appeared to M. de Bondaroy to be of little value; but M. Maleſherbes, who cut down a large tree of this ſort, was aſſured by his carpenter that the wood was very good.—That the tacamahaca, *populus tacamahaca balſamifera*, is a dwarfiſh plant of little value.—That the liard, *populus Canadenſis*, is a large tree, the wood light, not eaſy to be ſplit, and fit for ſeveral uſes.—That the white poplar, *populus alba*, is a large growing tree, affording a wood of excellent quality, and is among the moſt valuable of this ſpecies.—That the trembling poplar, *populus tremula*, (Lin.) is neither ſo large a tree, nor affords ſuch wood as the former. Theſe are in few words the principal reſult of the experiments of this gentleman on this claſs of plants. A few other ſorts are mentioned, but nothing deciſive with regard to them is determined.

From ſome experiments made by M. Dambourney, it appears that the poplar may be uſefully employed in dyeing. The Italian poplar gives a dye of as fine a luſtre, and equally durable, as that of the fineſt yellow wood, and its colour is more eaſily extracted. It is likewiſe very apt to unite with other colours in compoſition. Beſide the *populus faſtigata*, M. Dambourney tried alſo the black poplar, the Virginian ditto, the balſam ditto or *liard*, the white ditto, and the trembling poplar; and found that all theſe dyed wool of a nut-colour, fawn-colour (*vigogne*), Nankin, muſk, and other grave ſhades, according to the quantity of wood employed, and the length of time it was boiled.

POQUELIN or POCQUELIN (JOHN BAPTIST.) See MOLIERE.

PORANA, in botany; a genus of the monogynia order, belonging to the pentandria claſs of plants. The corolla is campanulated; the calyx is quinquefid, and larger than the fruit; the ſtyle ſemibifid, long, and permanent; the ſtigmata globular; the perianthium bivalved.

PORCELAIN, a fine kind of earthen ware, chiefly manufactured in China, and thence called *China-ware*. All earthen wares which are white and ſemitranſparent are generally called *porcelains*: but amongſt theſe ſo great differences may be obſerved, that, notwithſtanding the ſimilarity of their external appearance, they cannot be coſindered as matters of the ſame kind. Theſe differences are ſo evident, that even perſons who are not connoiſſeurs in this way prefer much the porcelain of ſome countries to that of others.

The word *porcelain* is of European derivation; none of the ſyllables which compoſe it can even be pronounced or written by the Chineſe, whoſe language comprehends no ſuch ſounds. It is probable that we are indebted to the Portugueſe for it: the word *porcellana*, however, in their language, ſignifies properly a cup or diſh; and they themſelves diſtinguiſh all works of porcelain by the general name of *loca*. Porcelain is called in China *tsé-ki*.

The art of making porcelain is one of thoſe in which Europe has been excelled by oriental nations. The firſt porcelain that was ſeen in Europe was brought from Japan and China. The whiteneſs, tranſparency, fineneſs, neatneſs, and even magnificence of this pottery, which ſoon became the ornament of ſumptuous tables, did not fail to excite the admiration and induſtry of Europeans; and their attempts have ſucceeded ſo well, that in different parts of Europe earthen wares have been made ſo like the oriental, that they have acquired the name of *porcelain*. The firſt European porcelains were made in Saxony and in France; and afterwards in England, Germany, and Italy: but as all theſe were different from the Japaneſe, ſo each of them had its peculiar character.

The fineſt and beſt porcelain of China is made in a village called *King-te-tching*, in the province of Kiang-ſi. This celebrated village is a league and a half in length, and we are aſſured that it contains a million of inhabitants. The workmen of King-te-tching, invited by the attracting allurements of the European trade, have eſtabliſhed manufactories alſo in the provinces of Fokien and Canton; but this porcelain is not eſteemed.

—The emperor Kang-hi was deſirous of having ſome made under his own inſpection at Pe-king. For this purpoſe he collected workmen, together with tools, and all materials neceſſary; furnaces were alſo erected, but the attempt miſcarried. The village of *King-te-tching* ſtill continues the moſt celebrated place in the empire for beautiful porcelain, which is tranſported to all parts of the world, and even to Japan.

We are unable to diſcover who firſt found out the art of making porcelain, nor is it known whether the Chineſe were indebted to chance for it, or to the repeated efforts of inventive genius; we cannot even determine its antiquity with preciſion; we know only from the annals of Fee-leang, a city in the diſtrict to which King-te-tching belongs, that, ſince the year 442 of our era, the workmen of this village have always furniſhed the emperors with porcelain; and that one or two mandarins were ſent from court to inſpect their labours. It is, however, ſuppoſed that the invention of porcelain is much older than that epocha.

We are indebted to Father d'Entrecolles, a Romiſh miſſionary, for a very accurate account of the manner in which porcelain is made in China; and as he lived in King-te-tching, his information muſt have been the very beſt poſſible. We ſhall therefore give his account of the Chineſe manner of making it, as abridged by Groſier in his *General Deſcription of China*. The principal ingredients of the fine porcelain are *pe-tun-tſe* and *kao-lin*, two kinds of earth from the mixture of which the paſte is produced. The *kao-lin* is intermixed with ſmall ſhining particles; the other is purely white, and very fine to the touch. Theſe firſt materials are carried to the manufactories in the ſhape of bricks. The pe-tun-tſe, which is ſo fine, is nothing elſe but fragments of rock taken from certain quarries, and reduced to powder. Every kind of ſtone is not fit for this purpoſe. The colour of that which is good, ſay the Chineſe, ought to incline a little towards green. A large iron club is uſed for breaking theſe pieces of rock: they are afterwards put into mortars; and, by means of levers headed with ſtone bound round with iron, they are reduced to a very fine powder. Theſe levers are put in action either by the labour of men, or by water, in the ſame manner as the hammers of our paper-mills. The duſt afterwards collected is thrown into a large veſſel full of water, which is ſtrongly ſtirred with an iron ſhovel. When it has been left to ſettle for ſome time, a kind of cream riſes on the top, about four inches in thickneſs, which is ſkimmed off, and poured into another veſſel filled with water: the water in the firſt veſſel is ſtirred ſeveral times; and the cream which ariſes is ſtill collected, until nothing remains but the coarſe dregs, which, by their own weight, precipitate to the bottom: theſe dregs are carefully collected, and pounded anew.

With regard to what is taken from the firſt veſſel, it is ſuffered to remain in the ſecond until it is formed into a kind of cruſt at the bottom. When the water above it ſeems quite clear, it is poured off by gently inclining the veſſel, that the ſediment may not be diſturbed; and the paſte is thrown into large moulds proper for drying it. Before it is entirely hard, it is divided into ſmall ſquare cakes, which are ſold by the hundred. The colour of this paſte, and its form, have occaſioned it to receive the name of *pe-tun-tſe*.

The kao-lin, which is uſed in the compoſition of porcelain, requires leſs labour than the pe-tun-tſe. Nature has a greater ſhare in the preparation of it. There are large mines of it in the boſoms of certain mountains, the exterior ſtrata of which conſiſt of a kind of red earth. Theſe mines are very deep, and the kao-lin is found in ſmall lumps, that are formed into bricks after having gone through the ſame proceſs as the pe-tun-tſe. Father d'Entrecolles thinks, that the earth called *terre de Malte*, or St. Paul's earth, has much affinity to the kao-lin, although thoſe ſmall ſhining particles are not obſerved in it which are interſperſed in the latter.

It is from the kao-lin that fine porcelain derives all its ſtrength; if we may be allowed the expreſſion, it ſtands it in the ſtead of nerves. It is very extraordinary, that a ſoft earth ſhould give ſtrength and conſiſtency to the pe-tun-tſe, which is procured from the hardeſt rocks. A rich Chineſe merchant told F. d'Entrecolles, that the Engliſh and Dutch had purchaſed ſome of the pe-tun-tſe, which they tranſported to Europe with a deſign of making porcelain; but having carried with them none of the kao-lin, their attempt proved abortive, as they have ſince acknowledged. "They wanted (ſaid this Chineſe laughing) to form a body, the fleſh of which ſhould ſupport itſelf without bones."

The Chineſe have diſcovered, within theſe few years, a new ſubſtance proper to be employed in the compoſition of porcelain. It is a ſtone, or rather ſpecies of chalk, called *hoa-che*, from which the phyſicians prepare a kind of draught that is ſaid to be deterſive, aperient, and cooling. The manufacturers of porcelain have thought proper to employ this ſtone inſtead of kao-lin. It is called *hoa*, becauſe it is glutinous, and has a great reſemblance to ſoap. Porcelain made with hoa-che is very rare, and much dearer than any other. It has an exceeding fine grain; and with regard to the painting, if it be compared with that of the common porcelain, it appears to ſurpaſs it as much as vellum does paper. This porcelain is, beſides, ſo light, that it ſurpriſes thoſe who are accuſtomed to handle other kinds; it is alſo much more brittle; and it is very difficult to hit upon the proper degree of tempering it.

Hoa che is ſeldom uſed in forming the body of the work; the artiſt is contented ſometimes with making it into a very fine ſize, in which the veſſel is plunged when dry, in order that it may receive a coat before it is painted and varniſhed: by theſe means it acquires a ſuperior degree of beauty.

When hoa-che is taken from the mine, it is waſhed in rain or river water, to ſeparate it from a kind of yellow earth which adheres to it. It is then pounded, put into a tub filled with water to diſſolve it, and afterwards formed into cakes like kao-lin. We are aſſured that hoa-che, when prepared in this manner, without the mixture of any other earth, is alone ſufficient to make porcelain. It ſerves inſtead of kao-lin; but it is much dearer. Kao-lin coſts only ten-pence ſterling; the price of hoa-che is half-a-crown: this difference, therefore, greatly enhances the value of porcelain made with the latter.

To pe-tun-tſe and kao-lin, the two principal elements, muſt be added the oil or varniſh from which it derives its ſplendor and whiteneſs. This oil is of a whitiſh colour, and is extracted from the ſame kind of ſtone which produces the pe-tun-tſe; but the whiteſt is always choſen, and that which has the greeneſt ſpots. The oil is obtained from it by the ſame proceſs uſed in making the pe-tun-tſe: the ſtone is firſt waſhed and pulverized; it is then thrown into water, and after it has been purified it throws up a kind of cream. To 100 pounds of this cream is added one pound of che-kao, a mineral ſomething like alum, which is put into the fire till it becomes red-hot, and then pounded. This mineral is a kind of runnet, and gives a conſiſtence to the oil, which is however carefully preſerved in its ſtate of fluidity. The oil thus prepared is never employed alone; another oil muſt be mixed with it, which is extracted from lime and fern-aſhes, to 100 pounds of which is alſo added a pound of che-kao. When theſe two oils are mixed, they muſt be equally thick; and in order to aſcertain this, the workmen dip into each of them ſome cakes of the pe-tun-tſe, and, by inſpecting their ſurfaces cloſely after they are drawn out, thence judge of the thickneſs of the liquors. With regard to the quantity neceſſary to be employed, it is uſual to mix 10 meaſures of ſtone-oil with one meaſure of the oil made from lime and fern aſhes.

The firſt labour conſiſts in again purifying the pe-tun-tſe and the kao-lin. The workmen then proceed to mix theſe two ſubſtances together. For fine porcelain they put an equal quantity of the kao-lin and the pe-tun-tſe; for the middling ſort they uſe four parts of the kao-lin and ſix of the pe-tun-tſe. The leaſt quantity put of the former is one part to three of the pe-tun-tſe. When this mixture is finiſhed, the maſs is thrown into a large pit, well paved and cemented in every part; it is then trod upon, and kneaded until it becomes hard. This labour is ſo much the more fatiguing, as it muſt be continued without intermiſſion: were it interrupted, all the other labourers would remain unemployed. From this maſs, thus prepared, the workmen detach different pieces, which they ſpread out upon large ſlates, where they knead and roll them in every direction, carefully obſerving to leave no vacuum in them, and to keep them free from the mixture of any extraneous body. A hair or a grain of ſand would ſpoil the whole work. When this paſte has not been properly prepared, the porcelain cracks, and melts or becomes warped.

All plain works are faſhioned with the wheel. When a cup has undergone this operation, the outſide of its bottom is quite round. The workman firſt gives it the requiſite height and diameter, and it comes from his hands almoſt the moment he has received it. He is under the neceſſity of uſing expedition, as he is paid not quite a farthing per board, and each board contains 26 pieces. This cup paſſes then to a ſecond workman, who forms its baſe. A little after it is delivered to a third, who applies it to his mould, and gives it a proper form: when he takes it off the mould, he muſt turn it very ſoftly, and be careful not to preſs it more on one ſide than on another: without this precaution it would become warped or disfigured. A fourth workman poliſhes it with a chiſel, eſpecially around the edges, and diminiſhes its thickneſs, in order to give it a certain degree of tranſparency. At length, after having paſſed through all the hands neceſſary for giving it all its ornaments, it is received, when dry, by the laſt workman, who faſhions its bottom with a chiſel. It is aſtoniſhing to ſee with what dexterity and expedition the workmen convey theſe vaſes from one to another. We are aſſured, that a piece of porcelain, before it is finiſhed, muſt paſs through the hands of 70 perſons.

Large works are executed in parts, which are faſhioned ſeparately. When all the pieces are finiſhed, and almoſt dry, they are put together, and cemented with paſte made of the ſame ſubſtance and ſoftened with water. Some time after, the ſeams are poliſhed with a knife, both without and within; and when the veſſel is covered with varniſh, it entirely conceals them, ſo that the leaſt trace of them is not to be ſeen. It is in this manner that ſpouts, handles, rings, and other parts of the ſame nature, are added. This is the caſe particularly in thoſe pieces which are faſhioned upon moulds or modelled with the hands, ſuch as emboſſed works, groteſque images, idols, figures of trees or animals, and buſts, which the Europeans order. All theſe are formed of four or five pieces joined together, which are afterwards brought to perfection with inſtruments proper for carving, poliſhing, and finiſhing, the different traces which the mould has left imperfect. With regard to thoſe flowers and ornaments which are not in relief, they are either engraven or imprinted with a ſtamp. Ornaments in relief, prepared ſeparately, are alſo added to pieces of porcelain, almoſt in the ſame manner as lace is put upon a coat.

After a piece of porcelain has been properly faſhioned, it then paſſes into the hands of the painters. Theſe hoa-pei, or painters in porcelain, are equally indigent as the other workmen; they follow no certain plan in their art, nor are they acquainted with any of the rules of drawing; all their knowledge is the effect of practice, aſſiſted by a whimſical imagination. Some of them, however, ſhow no inconſiderable ſhare of taſte in painting flowers, animals, and landſcapes, on porcelain, as well as upon the paper of fans, and the ſilk uſed for filling up the ſquares of lanterns. The labour of painting, in the manufactories of which we have ſpoken, is divided among a great number of hands. The buſineſs of one is entirely confined to tracing out the firſt coloured circle, which ornaments the brims of the veſſel; another deſigns the flowers, and a third paints them; one delineates waters and mountains, and another birds and other animals: human figures are generally the worſt executed.

The tſou-you, which is a kind of oil procured from white flint, has the peculiar property of making thoſe pieces of porcelain upon which it is laid appear to be covered with an infinitude of veins in every direction; at a diſtance one would take them for cracked vaſes, the fragments of which have not been diſplaced. The colour communicated by this oil is a white, ſomewhat inclining to that of aſhes. If it be laid upon porcelain, entirely of an azure blue, it will appear in the ſame manner to be variegated with beautiful veins. This kind of porcelain is called *tſoui-ki*.

The Chineſe make vaſes alſo ornamented with a kind of fretwork, perforated in ſuch a manner as to reſemble very fine lace. In the middle is placed a cup proper for holding any liquid; and this cup makes only one body with the former, which appears like lace wrapped round it. The Chineſe workmen had formerly the ſecret of making a ſtill more ſingular kind of porcelain: they painted upon the ſides of the veſſel fiſhes, inſects, and other animals, which could not be perceived until it was filled with water. This ſecret is in a great meaſure loſt: the following part of the proceſs is, however, preſerved. The porcelain which the workman intends to paint in this manner muſt be extremely thin and delicate. When it is dry, the colour is laid on pretty thick, not on the outſide, as is generally done, but on the inſide. The figures painted upon it, for the moſt part, are fiſhes, as being more analogous to the water with which the veſſel is filled. When the colour is thoroughly dry, it is coated over with a kind of ſize, made from porcelain-earth; ſo that the azure is entirely incloſed between two laminæ of earth. When the ſize becomes dry, the workman pours ſome oil into the veſſel, and afterwards puts it upon a mould and applies it to the lathe. As this piece of porcelain has received its conſiſtence and body within, it is made as thin on the outſide as poſſible, without penetrating to the colour; its exterior ſurface is then dipped in oil, and when dry it is baked in a common furnace. The art of making theſe vaſes requires the moſt delicate care, and a dexterity which the Chineſe perhaps do not at preſent poſſeſs. They have, however, from time to time made ſeveral attempts to revive the ſecret of this magic painting, but their ſucceſs has been very imperfect. This kind of porcelain is known by the name of *kia-tſing*, "preſſed azure."

After the porcelain has received its proper form, its colours, and all the intended ornaments, it is tranſported from the manufactory to the furnace, which is ſituated ſometimes at the other end of King-te-tching. In a kind of portico, which is erected before it, may be ſeen heaps of boxes and caſes made of earth, for the purpoſe of incloſing the porcelain. Each piece, however inconſiderable it may be, has its caſe; and the Chineſe workman, by this procedure, imitates nature, which, in order to bring the fruits of the earth to proper maturity, clothes them in a covering, to defend them from the exceſſive heat of the ſun during the day, and from the ſeverity of the cold during the night.

In the bottom of theſe boxes is put a layer of fine ſand, which is covered over with powder of the kao-lin, to prevent the ſand from adhering too cloſely to the bottom of the veſſel. The piece of porcelain is then placed upon this bed of ſand, and preſſed gently down, in order that the ſand may take the form of the bottom of the veſſel, which does not touch the ſides of its caſe : the caſe has no cover. A ſecond, prepared in the ſame manner, and containing its veſſel, is fitted into the firſt, ſo that it entirely ſhuts it, without touching the porcelain which is below ; and thus the furnace is filled with piles of caſes, which defend the pieces they contain from the too direct action of the fire.

With regard to ſmall pieces of porcelain, ſuch as tea-cups, they are incloſed in common caſes about four inches in height. Each piece is placed upon a ſaucer of earth about twice as thick as a crown-piece, and equal in breadth to its bottom. Theſe ſmall baſes are alſo ſprinkled over with the duſt of the kao-lin. When the caſes are large, the porcelain is not placed in the middle, becauſe it would be too far removed from the ſides, and conſequently from the action of the fire.

Theſe piles of caſes are put into the furnace, and placed upon a bed of coarſe ſand, half a foot in thickneſs ; thoſe which occupy the middle ſpace are at leaſt ſeven feet high. The two boxes which are at the bottom of each pile remain empty, becauſe the fire acts too feebly upon them, and becauſe they are partly covered by the ſand. For the ſame reaſon, the caſe placed at the top of each pile is alſo ſuffered to be empty. The piles which contain the fineſt porcelain are placed in the middle part of the furnace ; the coarſeſt are put at its further extremity ; and thoſe pieces which have the moſt body and the ſtrongeſt colouring are near its mouth.

Theſe different piles are placed very cloſely in the furnace ; they ſupport each other mutually by pieces of earth, which bind them at the top, bottom, and middle ; but in ſuch a manner that a free paſſage is left for the flame to inſinuate itſelf everywhere around them.

Before each of theſe furnaces for baking porcelain there is a long porch, which conveys air, and ſupplies in certain reſpects the place of a bellows. It ſerves for the ſame purpoſes as the arch of a glaſs-houſe. “ Theſe furnaces (ſays Father d'Entrecolles), which were formerly only ſix feet in height and the ſame in length, are conſtructed now upon a much larger plan : at preſent they are two fathoms in height, and almoſt four in breadth ; and the ſides and roof are ſo thick, that one may lay the hand upon them without being incommoded by the heat. The dome or roof is ſhaped like a funnel, and has a large aperture at the top, through which clouds of flame and ſmoke inceſſantly iſſue. Beſides this principal aperture there are five others ſmaller, which are covered with broken pots, but in ſuch a manner that the workman can increaſe or diminiſh the heat according as it may be found moſt convenient : through theſe alſo he is enabled to diſcover when the porcelain is ſufficiently baked. Having uncovered that hole which is neareſt the principal aperture, he takes a pair of pincers, and opens one of the caſes : if he obſerves a bright fire in the furnace, if all the caſes be red-hot, and if the colours of the porcelain appear with full luſtre, he judges that it is in a proper ſtate ; he then diſcontinues the fire, and entirely cloſes up the mouth of the furnace for ſome time. In the bottom of the furnace there is a deep hearth about two feet in breadth, over which a plank is laid, in order that the workman may enter to arrange the porcelain. When the fire is kindled on this hearth, the mouth of the furnace is immediately cloſed up, and an aperture is left only ſufficient for the admiſſion of faggots about a foot in length, but very narrow. The furnace is firſt heated for a day and night ; after which two men keep continually throwing wood into it, and relieve each other by turns : 180 loads are generally conſumed for one baking. As the porcelain is burning hot, the workman employs for the purpoſe of taking it out long ſcarfs or pieces of cloth, which are ſuſpended from his neck.”

The Chineſe divide their porcelain into ſeveral claſſes, according to its different degrees of fineneſs and beauty. The whole of the firſt is reſerved for the emperor. None of theſe works ever come into the hands of the public, unleſs they have blemiſhes or imperfections which render them unworthy of being preſented to the ſovereign. It is much to be doubted whether any of the largeſt and fineſt porcelain of China has ever been brought to Europe ; the miſſionaries at leaſt aſſure us that none of that kind is ſold at Canton. The Chineſe ſet ſome value upon the Dreſden porcelain, and ſtill more upon that which comes from the manufactories of France.

The illuſtrious Reaumur firſt attended to the manufacture of porcelain as a ſcience, and communicated his reſearches in two memoirs before the Academy of Sciences in 1727 and 1729. He did not ſatisfy himſelf with conſidering the external appearance, the painting and gilding, which are only ornaments not eſſential to the porcelain, but he endeavoured to examine it internally ; and having broken pieces of the Japaneſe, Saxon, and French porcelains, he examined the difference of their grains (which name is given to their internal ſtructure). The grain of the Japaneſe porcelain appeared to him to be fine, cloſe, compact, moderately ſmooth, and ſomewhat ſhining. The grain of the Saxon porcelain was found to be ſtill more compact, not granulous, ſmooth, ſhining like enamel. Laſtly, the porcelain of St. Cloud had a grain much leſs cloſe and fine than that of Japan ; not, or but little, ſhining ; and reſembling the grain of ſugar.

From theſe firſt obſervations Mr. Reaumur perceived that porcelains differed conſiderably. That he might examine them further, he expoſed them to a violent heat. More eſſential differences than thoſe of the grain appeared upon this trial ; for the Japaneſe porcelain was unalterable by the fire, and all the European were melted.

This eſſential difference betwixt the Japaneſe and European porcelains ſuggeſted to Mr. Reaumur a very ingenious thought, and in many reſpects true, concerning the nature of porcelain in general. As all porcelains ſomewhat reſemble glaſs in conſiſtence and tranſparency, though they are leſs compact and much leſs tranſparent, Mr. Reaumur conſidered them as ſemivitrifications. But every ſubſtance may appear, and may actually be, in a ſemivitrified ſtate in two ways : for, firſt, it may be entirely compoſed of vitrifiable or fuſible matters ; and in this caſe, by expoſing it to the action of fire, it will be actually melted or vitrified, if the heat be ſufficiently ſtrong and long continued. But as this change is not made inſtantly, eſpecially when the heat is not very violent ; and as it paſſes through different ſtages or degrees, which may be more eaſily obſerved as the heat is better managed : hence, by ſtopping in proper time the application of heat to porcelain made in this manner, we may obtain it in an intermediate ſtate betwixt thoſe of crude earths and of completely vitrified ſubſtances, and alſo poſſeſſed of the ſemitranſparency and of the other ſenſible qualities of porcelain. We know alſo, that if ſuch porcelain be expoſed to a ſtronger degree of heat, it will then be completely fuſed and entirely vitrified. But the European porcelains tried by Mr. Reaumur had this fuſibility ; from which he concluded, that their compoſition is founded upon the above-mentioned principle.

In the ſecond place, a paſte of porcelain may be compoſed of fuſible and vitrifiable matter, mixed with a certain proportion of another matter which is abſolutely unfuſible in the fires of our furnaces. We may eaſily perceive, that if ſuch a mixture be expoſed to a heat ſufficient to melt entirely the vitrifiable ingredient, this matter will actually melt : but as it is intermixed with another matter which does not melt, and which conſequently preſerves its conſiſtency and opacity, the whole muſt form a compound partly opaque and partly tranſparent, or rather a ſemitranſparent maſs ; that is, a ſemivitrified ſubſtance or porcelain, but of a kind very different from the former ; for, as the fuſible part of this latter has produced all its effect, and as it has been as much fuſed as it can be during the baking of the porcelain, the compound may be expoſed a ſecond time to a more violent fire, without approaching nearer to a complete vitrification, or without departing from its ſtate of porcelain. But as oriental porcelain has preciſely theſe appearances and properties, Mr. Reaumur concludes with reaſon, that it is compoſed upon this principle; and he afterwards confirmed his opinion by undeniable facts.

Mr. Reaumur examined the pe-tun-tſe and kao-lin of the Chineſe; and having expoſed them ſeparately to a violent fire, he diſcovered that the pe-tun-tſe had fuſed without addition, and that the kao-lin had given no ſign of fuſibility. He afterwards mixed theſe matters, and formed cakes of them, which by baking were converted into porcelain ſimilar to that of China. Mr. Reaumur eaſily found, that the pe-tun-tſe of the Chineſe was a hard ſtone of the kind called *vitrifiable*, but much more fuſible than any of thoſe which were known in Europe; and that the kao-lin was a talky matter reduced to a very fine powder. From that time he hoped to make a porcelain of the ſame kind as the Chineſe, with materials found in France. Whether he could not find any materials equal to thoſe of China, particularly that material analogous to the pe-tun-tſe of the Chineſe, or becauſe other occupations prevented the continuance of his reſearches, we do not know; but we find, from his ſecond memoir upon porcelain, that he afterwards attempted to make an artificial pe-tun-tſe, by mixing our vitrifiable ſtones with ſalts capable of rendering them fuſible, or even by ſubſtituting for it glaſs ready formed, and by adding to theſe ſuch ſubſtances as he thought might be ſubſtituted for kao-lin. But he probably found he could not execute theſe intentions; for he did not reſume this ſubject from the year 1729 to 1739, when he gave a proceſs for converting common glaſs to a ſingular kind of porcelain, to which he had given his name. See the article GLASS-*Porcelain*.

Although Mr. Reaumur has ſurmounted many difficulties, and has given juſt notions concerning this ſubject, yet he has been miſtaken, or rather miſled, in two important points. His firſt error concerns the Saxon porcelain, which he confounds with the other fuſible porcelains made in Europe. Formerly, indeed, a porcelain might be made in Saxony, compoſed entirely of fuſible or vitrifiable materials, the vitrification of which was ſtopt in proper time, and which Mr. Reaumur had examined. But now we are certainly informed, that all of that country is capable of reſiſting the moſt violent fires without fuſion, as well at leaſt as thoſe of China and Japan. Mr. Reaumur might have been miſled by the appearance of the internal texture of this porcelain. For, when a piece of it is broken, its internal ſurface does not appear granulous, but compact, uniform, ſmooth, ſhining, and much reſembling white enamel. But this appearance, ſo far from ſhowing that Saxon porcelain is a fuſed or vitrified ſubſtance, proves that it is not entirely compoſed of fuſible matters. All who have comſidered attentively this ſubject know, that the internal ſurface of the moſt fuſible porcelains is alſo the leaſt denſe and leaſt compact; the reaſon of which is, that no vitreous matter can be ſmooth and denſe internally, unleſs it has been completely fuſed. But if the denſity and ſhining appearance of the internal ſurface of the Saxon porcelain were only the effects of the fuſion of a vitreous matter, how could we conceive that veſſels formed of that matter ſhould have ſuſtained the neceſſary fuſion for giving this denſity and ſhining appearance, without having entirely loſt their ſhape? The impoſſibility of this is evident to any perſons who have been converſant in theſe matters and in the fuſion of glaſs.

This quality of the Saxon porcelain muſt therefore proceed from another cauſe. It does indeed contain, as every porcelain does, particularly thoſe of China and Japan, a fuſible ſubſtance, which has been even completely fuſed during the baking. Its denſity alſo, and its internal luſtre, proceed chiefly from this fuſed matter; but we are alſo certain, that it contains a large quantity of a ſubſtance abſolutely unfuſible, from which it receives its admirable whiteneſs, its firmneſs and ſolidity, during the baking; in a word, which ſupplies the place of the oriental kao-lin, and which has the property of contracting its dimenſions conſiderably while it incorporates with the fuſible ſubſtance. If it be ſubjected to the moſt deciſive trial, namely, the action of a violent fire, capable of melting every porcelain compoſed of fuſible matters alone, "I affirm (ſays Mr. Macquer), after many experiments, that it cannot be fuſed, unleſs by a fire capable alſo of melting the beſt Japaneſe porcelain." The Saxon porcelain is therefore not to be confounded with thoſe which are vitreous and fuſible; but is in its kind as excellent as that of Japan, and perhaps ſuperior, as we ſhall ſee when we enumerate the qualities which conſtitute the excellence of porcelain. The ſubject of Mr. Reaumur's ſecond error, or at leaſt that which he has not ſufficiently explained, is the kao-lin of China. According to him, this matter is a fine talky powder, from the mixture of which with pe-tun-tſe the oriental porcelain is formed. Poſſibly a very fine ground talky ſubſtance mixed with pe-tun-tſe might form a porcelain ſimilar to the oriental; but perſons acquainted with the manufacture of any porcelain muſt perceive the impoſſibility of forming veſſels, unleſs the paſte of which they are made be ſo ductile and tenacious that it may be worked upon a potter's lathe, or at leaſt that it may be moulded. But talks, or any kinds of ſtones, however finely ground, cannot acquire the requiſite tenacity, which clays only, of all known earthy ſubſtances, poſſeſs. The Chineſe porcelain veſſels evidently appear to be turned upon the lathe, ſince they retain the marks of it: hence they muſt have been formed of a very tenacious paſte, and conſequently the kao-lin is not a purely talky matter, but is mixed with clay; or elſe the pe-tun-tſe and kao-lin are not, as Mr. Reaumur ſuppoſes, the only ingredients of which Chineſe porcelain is formed, but a ſufficient quantity of ſome binding matter, unknown to Father d'Entrecolles and Mr. Reaumur, muſt be alſo added.

Although, ſince Mr. Reaumur, no ſcientific perſon has written concerning porcelain, many have attempted to make it. Manufactories have been eſtabliſhed in almoſt all the ſtates of Europe. Beſides that of Saxony, which has been long eſtabliſhed, porcelain is alſo made at Vienna, at Frankendal, and lately in the neighbourhood of Berlin. All theſe German porcelains are ſimilar to the Saxon; and are made of materials of the ſame kind, although they differ ſomewhat from each other. England and Italy alſo have their porcelains, the chief of which are thoſe of Chelſea and of Naples. M. de la Condamine, in his laſt journey into Italy, viſited a manufacture of porcelain eſtabliſhed at Florence by the marquis de la Ginori, then governor of Leghorn. M. de la Condamine obſerved particularly the large ſize of ſome pieces of this porcelain. He ſays he ſaw ſtatues and groups half as large as nature, modelled from ſome of the fineſt antiques. The furnaces in which the porcelain was baked were conſtructed with much art, and lined with bricks made of the porcelain materials. The paſte of this porcelain is very beautiful; and from the grain of broken pieces, it appears to have all the qualities of the beſt Chineſe porcelain. A whiter glazing would be deſirable; which they might probably attain, if the marquis Ginori was not determined to uſe thoſe materials only which were found in that country.

But in no ſtate of Europe have ſuch attempts been made to diſcover porcelain, or ſo many manufactories of it been eſtabliſhed, as in France. Before even Mr. Reaumur had publiſhed on this ſubject, porcelain was made at St. Cloud, and in the ſuburb of St. Antoine at Paris, which was of the vitreous and fuſible kind, but conſiderably beautiful. Since that time, conſiderable manufactories of it have been eſtabliſhed at Chantilly, at Villeroi, and at Orleans; the porcelains of which have a diſtinguiſhed merit. But the porcelain produced in the king's manufacture at Sévres holds at preſent the firſt rank, from its ſhining white, its beautiful glazing, and coloured grounds, in which no porcelain has ever equalled it. The magnificence of the gilding, the regularity and elegance of its forms, ſurpaſs every thing of the kind.

Mr. Guettard has publiſhed an account of his diſcoveries on this ſubject, in the Memoirs of the Academy of Sciences for the year 1765. The kao-lin which he employed was a white argillaceous earth, filled with mica, which he found in the neighbourhood of Alençon; and his pe-tun-tſe is a hard, quartzoſe, grit ſtone, found abundantly in the ſame country, with which the ſtreets of Alençon are paved. We alſo know that Mr. Guettard had begun to make his experiments on porcelain with theſe materials in the year 1751, together with the then duke of Orleans, to whom he was attached. The count de Lauraguais, of the Academy of Sciences, engaged in the purſuit of porcelain for ſeveral years with uncommon ardour and conſtancy. He ſpared no trouble nor expenſe to attain his purpoſe, which was, to make porcelain equal in all reſpects to that of China and Japan. He ſhowed ſome pieces made by him in the year 1766 to the members of the Academy of Sciences. The perſons appointed by them to examine it gave their opinion, "that of all the porcelains made in the country, that of the count de Lauraguais moſt reſembles the porcelain of China and Japan in ſolidity, grain, and unfuſibility." It were to be wiſhed that it poſſeſſed equally the other qualities eſſential to the excellence of porcelain, namely, the whiteneſs and luſtre obſervable in the ancient Japaneſe porcelain.

We ſhall now ſhow what thoſe qualities are which conſtitute the perfection of porcelain. We muſt firſt carefully diſtinguiſh the qualities which only contribute to the beauty and external appearance, from the intrinſic and eſſential properties in which the goodneſs and ſolidity of porcelain conſiſt. All perſons who have made experiments in this way have ſoon diſcovered the poſſibility of making compounds very white, beautifully ſemitranſparent, and covered with a ſhining glazing; but which cannot be worked for want of tenacity, are not ſufficiently compact, are eſſentially fuſible, are ſubject to break by ſudden application of heat and cold; and, laſtly, the glazing of which cracks, becomes rough, and conſequently loſes its luſtre by uſe, becauſe it is too ſoft.

On the other ſide, we ſhall alſo find it not difficult to compoſe very tenacious paſtes which ſhall be capable of being eaſily worked and well baked; which in the baking ſhall acquire the deſirable hardneſs and denſity; which are unfuſible, and capable of ſuſtaining very well the ſudden change of heat and cold; and, in a word, which ſhall have all the qualities of the moſt excellent porcelain, excepting whiteneſs and beauty. We ſhall ſoon ſee that the materials fit for the compoſition of ſuch porcelains may be found abundantly in every country. The only difficulty, then, in this inquiry concerning porcelain, is to unite beauty and goodneſs in one compoſition; and indeed nature ſeems to be very ſparing of materials fit for this purpoſe, and therefore perfect porcelain will always be a dear and valuable commodity.

Thoſe potteries which we call *ſtone-ware* are not of modern invention, and have all the eſſential qualities of the beſt Japaneſe. For, if we except whiteneſs, on which alone the ſemi-tranſparency depends, and compare all the properties of Japaneſe porcelain with thoſe of our ſtone-ware, no difference can be found betwixt them. The ſame grain appears internally in both; the ſame ſound is produced by ſtriking them when properly ſuſpended; the ſame denſity, the ſame hardneſs by which they ſtrike fire with ſteel, the ſame faculty of ſuſtaining the heat of boiling liquors without breaking, and the ſame unfuſibility in fire, are obſervable. Laſtly, if the earths of which ſtone-ware is made were free from heterogeneous colouring matters, which prevent their whiteneſs and ſemi-tranſparency; if veſſels were carefully formed; if all the proper attentions were given; and if theſe veſſels were covered over with a fine glazing—they would be as perfect porcelain as that of Japan. The moſt perfect porcelain, therefore, is nothing elſe than a fine white ſtone-ware.

Earths of this kind are probably more rare in Europe than in Japan and China. And probably alſo the want of theſe earths was the cauſe that the firſt makers of porcelain in this country confined themſelves to an external imitation, by employing nothing but vitrifiable matters, with fuſible ſalts and a ſmall quantity of white earth; from which fuſible and vitreous porcelains were compoſed, which might be called *falſe porcelains*. But things are much changed ſince theſe firſt attempts. Beſides the diſcoveries of the count de Lauraguais and of Mr. Guettard, genuine white porcelains have been made a long time ago in Germany, eſpecially in Saxony and at Frankendal.

Theſe porcelains are not inferior in any reſpect to the oriental; they are even much ſuperior in beauty and whiteneſs to the modern oriental porcelain, which is much degenerated in theſe reſpects; they ſeem even to excel the oriental in the moſt valuable quality of porcelain, namely, the property of ſuſtaining the ſudden change of heat and cold. We cannot judge of the quality of porcelain by a ſlight trial: for ſo many circumſtances concur to make a piece of porcelain capable or incapable of ſuſtaining the ſudden application of heat and of cold, that if at the ſame time boiling water be poured into two veſſels, one of which is good porcelain and the other bad, the former may poſſibly break and the latter remain entire. The only true method of diſcovering good porcelain in this reſpect is, to examine ſeveral pieces of it which are daily uſed; for inſtance, a ſet of coffee-cups. But it has been obſerved, that in many ſuch pieces of oriental porcelain, which have been long and daily uſed, cracks in the direction of their height may be always perceived, which are never ſeen in the good European porcelains.

Every one talks of porcelain, and yet few are connoiſſeurs of it. None can be conſidered as ſuch but thoſe who have long made it an object of their inquiries. That the ancient Japaneſe porcelain is the moſt perfect is a general opinion. This porcelain is indeed very beautiful, and we muſt alſo acknowledge that its quality is excellent. It has been our model, and has long been the object of our admiration and emulation; but which we have never been able to equal, and which many perſons believe never can be equalled. Some perſons even decry the Saxon porcelain for a quality which really gives it a ſuperiority to the Japaneſe, namely, the greater ſmoothneſs, luſtre, and leſs granulous appearance of its internal ſurface than the oriental. The reſemblance of this ſurface to that of glaſs has evidently ſuggeſted this notion; and it would be well founded if the denſity and luſtre of this porcelain proceeded only from a fuſible and vitreous quality; but as they do not, and as this porcelain is as fixed and as unfuſible as the Japaneſe, its denſity, ſo far from being a fault, is a valuable quality: for we muſt allow, that, of porcelains equal in other reſpects, thoſe are beſt which are moſt firm and compact. Hence the interior ſubſtance of the Japaneſe porcelain is eſteemed for its greater denſity, compactneſs, and luſtre, than thoſe of our vitreous ſand or fritt porcelains; becauſe theſe qualities indicate greater coheſion, and more intimate incorporation of its parts. For the ſame reaſon, alſo, the ſuperior denſity of the Saxon porcelain ought to give it the preference to the Japaneſe. Beſides, nothing would be eaſier than to give the Saxon porcelain the granulous texture of the Japaneſe, by mixing with the paſte a certain quantity of ſand. But the perſons who perfected that manufacture were certainly ſenſible that ſuch a conformity to the Japaneſe porcelain would leſſen the merit of theirs: for we know, that in general porcelains are better in proportion as they contain a larger proportion of clay or earth, and leſs of ſand, flints, or other matters of that kind.

What we have ſaid concerning porcelain in general, and the principal kinds of it, ſeems ſufficient to give juſt notions of it, if not to perſons who without conſidering the ſubject are determined to prefer the moſt antient, to thoſe, at leaſt, who have made experiments on this ſubject, or who, having a ſufficient knowledge of chemiſtry, are capable of ſtudying and examining it thoroughly. We ſhall finiſh this article by giving a ſhort deſcription of the method of manufacturing porcelain as practiſed in Europe.

The baſis of the porcelains which we have called *fuſible*, *vitreous*, or *falſe porcelains*, is called by artiſts a *fritt*; which is nothing elſe than a mixture of ſand or of powdered flints, with ſalts capable of diſpoſing them to fuſion, and of giving them a great whiteneſs by means of a ſufficient heat. This fritt is to be then mixed with as much, and no more, of a white tenacious earth of an argillaceous or marly nature, than is ſufficient to make it capable of being worked upon the wheel. The whole mixture is to be well ground together in a mill, and made into a paſte, which is to be formed, either upon the wheel or in moulds, into pieces of ſuch forms as are required.

Each of theſe pieces, when dry, is to be put into a caſe made of earthen ware *; which caſes are to be ranged in piles one upon another, in a furnace or kiln, which is to be filled with theſe to the roof. The furnaces are chambers or cavities of various forms and ſizes; and are ſo diſpoſed, that their fire-place is placed on the outſide oppoſite to one or more openings, which communicate within the furnace. The flame of the fuel is drawn within the furnace, the air of which rarefying, determines a current of air from without inwards, as in all furnaces. At firſt a very little fire is made, that the furnace may be heated gradually, and is to be increaſed more and more till the porcelain is baked, that is, till it has acquired its proper hardneſs and tranſparency; which is known by taking out of the furnace from time to time, and examining, ſmall pieces of porcelain, placed for that purpoſe in caſes which have lateral openings. When theſe pieces ſhow that the porcelain is ſufficiently baked, the fire is no longer to be ſupplied with fuel, the furnace is to be cooled, and the porcelain taken out, which in this ſtate reſembles white marble not having a ſhining ſurface, which is afterwards to be given by covering them with a vitreous compoſition called the *glazing*.

The porcelain when baked and not glazed is called *biſcuit*, which is more or leſs beautiful according to the nature of the porcelain. The manufacture of Sévres excells all others in this reſpect, and it is therefore the only one which can produce very fine pieces of ſculpture; that is, in which all the fineneſs of the workmanſhip is preſerved, and which are preferable in ſmoothneſs and whiteneſs to the fineſt marble of Italy.

As no piece of ſculpture of this kind can preſerve all the delicacy of its workmanſhip when covered with a glazing, and as ſculptors avoid poliſhing their marble figures, becauſe the luſtre of the poliſh is diſadvantageous; therefore, in the manufactures of Sévres, all figures or little ſtatues, and even ſome ornamental vaſes, are left in the ſtate of biſcuit. The other pieces of porcelain are to be glazed in the following manner:

A glaſs is firſt to be compoſed ſuited to the nature of the porcelain to which it is to be applied; for every glaſs is not fit for this purpoſe. We frequently find that a glaſs which makes a fine glazing for one porcelain ſhall make a very bad glazing for another porcelain; ſhall crack in many places, ſhall have no luſtre, or ſhall contain bubbles. The glazing, then, muſt be appropriated to each porcelain, that is, to the hardneſs and denſity of the ware, and to the ingredients of its compoſition, &c.

Theſe glazings are prepared by previouſly fuſing together all the ſubſtances of which they conſiſt, ſo as to form vitreous maſſes. Theſe maſſes are to be ground very finely in a mill. This vitreous powder is to be mixed with a ſufficient quantity of water, or other proper liquor, ſo that the mixture ſhall have the conſiſtence of cream of milk. The pieces of porcelain are to be covered with a thin ſtratum of this matter; and when very dry, they are to be again put into the furnace in the ſame manner as before for the forming of the biſcuit, and to be continued there till the glazing be well fuſed. The neceſſary degree of fire for fuſing the glazing is much leſs than that for baking the paſte.

The pieces of porcelain which are intended to remain white are now finiſhed; but thoſe which are to be painted and gilded muſt undergo further operations. The colours to be applied are the ſame as thoſe uſed for enamel painting. They all conſiſt of metallic calces bruiſed and incorporated with a very fuſible glaſs. Crocus of iron furniſhes a red colour; gold precipitated by tin makes the purple and violet; copper calcined by acids and precipitated by an alkali gives a fine green; zaffre makes the blue; earths ſlightly ferruginous produce a yellow; and, laſtly, brown and black colours are produced by calcined iron, together with a deep blue of zaffre. Theſe colours being ground with gum-water, or with oil of ſpike, are to be employed for the painting of the porcelain with deſigns of flowers and other figures. For gilding, a powder or calx of gold is to be applied in the ſame manner as the coloured enamels. The painted and gilded porcelains are to be then expoſed to a fire capable of fuſing the glaſs, with which the metallic colours are mixed. Thus the colours are made to adhere, and at the ſame time acquire a gloſs equal to that of the glazing. The gold alone has not then a ſhining appearance, which muſt be afterwards given to it by burniſhing with a blood-ſtone.

The operations for the unfuſible porcelains, and alſo for ſuch as are of the nature of ſtone-ware, are ſomewhat more ſimple. The ſands and ſtones which enter into their compoſition are to be ground in a mill: the earths or clays are to be waſhed: the materials are to be well mixed, and formed into a paſte: the pieces are firſt rudely formed upon a potter's wheel; and when dry, or half dry, they are turned again upon the wheel, and their form is made more perfect: they are then placed in the furnace; not to bake them, but only to apply a ſufficient heat to give them ſuch a ſolidity that they may be handled without breaking, and may receive the glazing. As the pieces of porcelain after this ſlight heat are very dry, they imbibe water readily. This diſpoſition aſſiſts the application of the glazing. The vitrifiable or vitrified matter of this glazing, which has been previouſly ground in a mill, is to be mixed with ſuch a quantity of water, that the liquor ſhall have the conſiſtence of milk. The pieces of porcelain are haſtily dipt in this liquor, the water of which they imbibe, and thus on their ſurface is left an uniform covering of the glazing materials. This covering, which ought to be very thin, will ſoon become ſo dry, that it cannot ſtick to the fingers when the pieces are handled.

The pieces of this porcelain are then put into the furnace to be perfectly baked. The heat is to be raiſed to ſuch a height, that all within the furnace ſhall be white, and the caſes ſhall be undiſtinguiſhable from the flame. When, by taking out ſmall pieces, the porcelain is known to be ſufficiently baked, the fire is diſcontinued, and the furnace cooled. If the baking has been well performed, the pieces of porcelain will be found by this ſingle operation to be rendered compact, ſonorous, cloſe grained, moderately gloſſy, and covered externally with a fine glazing. The painting and gilding of this porcelain are to be executed in a manner ſimilar to that already deſcribed.

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* The caſes are called by Engliſh potters *ſeggars*. They are generally formed of coarſer clays, but which muſt be alſo capable of ſuſtaining the heat required without fuſion. By means of theſe caſes the contained porcelain is preſerved from the ſmoke of the burning fuel. The whiteneſs of the porcelain depends much on their compactneſs of texture, by which the ſmoke is excluded, and on the purity of the clay of which they are made.

Porcelain-*Shell*, a ſpecies of Cypræa.

PORCH, in architecture, a kind of veſtibule ſupported by columns; much uſed at the entrance of the ancient temples, halls, churches, &c. A porch, in the ancient architecture, was a veſtibule, or a diſpoſition of inſulated columns uſually crowned with a pediment, forming a covert place before the principal door of a temple or court of juſtice. Such was that before the door of St. Paul's, Covent-Garden, the work of Inigo Jones. When a porch had four columns in front, it was called a *tetraſtyle*; when ſix, *hexaſtyle*; when eight, *octoſtyle*, &c.

Porch, in Greek ϛοα, a public portico in Athens adorned with the pictures of Polygnotus and other eminent painters. It was in this portico that Zeno the philoſopher taught; and hence his followers were called *Stoics*. See Stoics and Zeno.

PORCUPINE, in zoology. See Hystrix.

Porcupine-*Man*, the name by which one Edward Lambert, who had a diſtempered ſkin, went in London. We have the following account of him in the Philoſophical Tranſactions for 1755, by Mr. Henry Baker, F. R. S. "He is now (ſays he) 40 years of age, and it is 24 years ſince he was firſt ſhown to the ſociety. The ſkin of this man, except on his head and face, the palms of his hands, and the ſoles of his feet, is covered with excreſcences that reſemble an innumerable company of warts, of a brown colour and cylindrical figure; all riſing to an equal height, which is about an inch, and growing as cloſe as poſſible to each other at their baſes; but ſo ſtiff and elaſtic as to make a ruſtling noiſe when the hand is drawn over them. Theſe excreſcences are annually ſhed, and renewed in ſome of the autumn or winter months. The new ones, which are of a paler colour, gradually riſe up from beneath as the old ones fall off; and at this time it has been found neceſſary for him to loſe a little blood, to prevent a ſlight ſickneſs which he had been uſed to ſuffer before this precaution was taken. He has had the ſmall-pox, and he has been twice ſalivated, in hopes to get rid of this diſagreeable covering; but though, juſt when the puſtules of the ſmall-pox had ſcaled off, and immediately after his ſalivations, his ſkin appeared white and ſmooth, yet the excreſcences ſoon returned by a gradual increaſe, and his ſkin became as it was before. His health during his whole life has been remarkably good: but there is one particular of this caſe more extraordinary than all the reſt: this man has had ſix children, and all of them had the ſame rugged covering as himſelf, which came on like his own about nine weeks after the birth. Of theſe children only one is now living, a pretty boy, who was ſhown with his father. It appears, therefore, as Mr. Baker remarks, that a race of people might be propagated by this man, as different from other men as an African is from an Engliſhman; and that if this ſhould have happened in any former age, and the accidental original have been forgotten, there would be the ſame objections againſt their being derived from the ſame common ſtock with others: it muſt therefore be admitted poſſible, that the differences now ſubſiſting between one part of mankind and another, may have been produced by ſome ſuch accidental cauſe, long after the earth has been peopled by one common progenitor."

PORE, in anatomy, a little interſtice or ſpace between the parts of the ſkin, ſerving for perſpiration.

PORELLA, in botany; a genus of the natural order of muſci, belonging to the cryptogamia claſs of plants. The antheræ are multilocular, full of natural pores, with an operculum; there is no calyptra, nor pedicle; the capſules contain a powder like thoſe of the other moſſes; and their manner of ſhedding this powder is not by ſeparating into two parts, like thoſe of the ſelago and lycopodium, but by opening into ſeveral holes on all ſides.

PORENTRU, is a town of Swiſſerland, in Elſgaw, and capital of the territory of the biſhop of Baſle. It has a good caſtle, where he reſides. It has in it, however, nothing elſe worth taking notice of, except the cathedral. The biſhop is a prince of the empire. It is ſeated on the river Halle, near mount Jura, 22 miles ſouth of Baſle. E. lon. 7. 2. N. lat. 47. 34.

PORISM, in geometry, is a name given by the ancient geometers to two claſſes of mathematical propoſitions. Euclid gives this name to propoſitions which are involved in others which he is profeſſedly inveſtigating, and which, although not his principal object, are yet obtained along with it, as is expreſſed by their name *poriſmata*, "acquiſitions." Such propoſitions are now called *corollaries*. But he gives the ſame name, by way of eminence, to a particular claſs of propoſitions which he collected in the courſe of his reſearches, and ſelected from among many others on account of their great ſubſerviency to the buſineſs of geometrical inveſtigation in general. Theſe propoſitions were ſo named by him, either from the way in which he diſcovered them, while he was inveſtigating ſomething elſe, by which means they might be conſidered as gains or acquiſitions, or from their utility in acquiring further knowledge as ſteps in the inveſtigation. In this ſenſe they are poriſmata; for ϖορίζω ſignifies both to inveſtigate and to acquire by inveſtigation. Theſe propoſitions formed a collection, which was familiarly known to the ancient geometers by the name of Euclid's *poriſms*; and Pappus of Alexandria ſays, that it was a moſt ingenious collection of many things conducive to the analyſis or ſolution of the moſt difficult problems, and which afforded great delight to thoſe who were able to underſtand and to inveſtigate them.

Unfortunately for mathematical ſcience, however, this valuable collection is now loſt, and it ſtill remains a doubtful queſtion in what manner the ancients conducted their reſearches upon this curious ſubject. We have, however, reaſon to believe that their method was excellent both in principle and extent; for their analyſis led them to many profound diſcoveries, and was reſtricted by the ſevereſt logic. The only account we have of this claſs of geometrical propoſitions is in a fragment of Pappus, in which he attempts a general definition of them, as a ſet of mathematical propoſitions diſtinguiſhable in kind from all others; but of this diſtinction nothing remains, except a criticiſm on a definition of them given by ſome geometers, and with which he finds fault, as defining them only by an accidental circumſtance, "*Poriſma eſt quòd deficit hypotheſi a theoremate locali.*"

Pappus then proceeds to give an account of Euclid's poriſms; but the enunciations are ſo extremely defective, at the ſame time that they refer to a figure now loſt, that Dr. Halley confeſſes the fragment in queſtion to be beyond his comprehenſion.

The high encomiums given by Pappus to theſe propoſitions have excited the curioſity of the greateſt geometers of modern times, who have attempted to diſcover their nature and manner of inveſtigation. M. Fermat, a French mathematician of the laſt century, attaching himſelf to the definition which Pappus criticiſes, publiſhed an introduction (for this is its modeſt title) to this ſubject, which many others tried to elucidate in vain. At length Dr. Simſon of Glaſgow, by patient inquiry and ſome lucky thoughts, obtained reſtoration of the poriſms of Euclid, which has all the appearance of being juſt. It preciſely correſponds to Pappus's deſcription of them. All the lemmas which Pappus has given for the better underſtanding of Euclid's propoſitions are equally applicable to thoſe of Dr. Simſon, which are found to differ from local theorems preciſely as Pappus affirms thoſe of Euclid to have done. They require a particular mode of analyſis, and are of immenſe ſervice in geometrical inveſtigation; on which account they may juſtly claim our attention.

While Dr. Simſon was employed in this inquiry, he carried on a correſpondence upon the ſubject with the late Dr. M. Stewart, profeſſor of mathematics in the univerſity of Edinburgh; who, beſides entering into Dr. Simſon's views, and communicating to him many curious poriſms, purſued the ſame ſubject in a new and very different direction. He publiſhed the reſult of his inquiries in 1746, under the title of General Theorems, not caring to give them any other name, leſt he might appear to anticipate the labours of his friend and former preceptor. The greater part of the propoſitions contained in that work are poriſms, but without demonſtrations; therefore, whoever wiſhes to inveſtigate one of the moſt curious ſubjects in geometry, will there find abundance of materials, and an ample field for diſcuſſion.

Dr. Simſon defines a poriſm to be "a propoſition, in which it is propoſed to demonſtrate, that one or more things are given, between which, and every one of innumerable other things not given, but aſſumed according to a given law, a certain relation deſcribed in the propoſition is ſhown to take place."

This definition is not a little obſcure, but will be plainer if expreſſed thus: "A poriſm is a propoſition affirming the poſſibility of finding ſuch conditions as will render a certain problem indeterminate, or capable of innumerable ſolutions." This definition agrees with Pappus's idea of theſe propoſitions, ſo far at leaſt as they can be underſtood from the fragment already mentioned; for the propoſitions here defined, like thoſe which he deſcribes, are, ſtrictly ſpeaking, neither theorems nor problems, but of an intermediate nature between both; for they neither ſimply enunciate a truth to be demonſtrated, nor propoſe a queſtion to be reſolved, but are affirmations of a truth in which the determination of an unknown quantity is involved. In as far, therefore, as they aſſert that a certain problem may become indeterminate, they are of the nature of theorems; and, in as far as they ſeek to diſcover the conditions by which that is brought about, they are of the nature of problems.

We ſhall endeavour to make our readers underſtand this ſubject diſtinctly, by conſidering them in the way in which it is probable they occurred to the ancient geometers in the courſe of their reſearches: this will at the ſame time ſhow the nature of the analyſis peculiar to them, and their great uſe in the ſolution of problems.

It appears to be certain, that it has been the ſolution of problems which, in all ſtates of the mathematical ſciences, has led to the diſcovery of geometrical truths: the firſt mathematical inquiries, in particular, muſt have occurred in the form of queſtions, where ſomething was given, and ſomething required to be done; and by the reaſoning neceſſary to anſwer theſe queſtions, or to diſcover the relation between the things given and thoſe to be found, many truths were ſuggeſted, which came afterwards to be the ſubject of ſeparate demonſtrations.

The number of theſe was the greater, becauſe the ancient geometers always undertook the ſolution of problems with a ſcrupulous and minute attention, inſomuch that they would ſcarcely ſuffer any of the collateral truths to eſcape their obſervation.

Now, as this cautious manner of proceeding gave an opportunity of laying hold of every collateral truth connected with the main object of inquiry, theſe geometers ſoon perceived, that there were many problems which in certain caſes would admit of no ſolution whatever, in conſequence of a particular relation taking place among the quantities which were given. Such problems were ſaid to become impoſſible: and it was ſoon perceived, that this always happened when one of the conditions of the problem was inconſiſtent with the reſt. Thus, when it was required to divide a line, ſo that the rectangle contained by its ſegments might be equal to a given ſpace, it is evident that this was poſſible only when the given ſpace was leſs than the ſquare of half the line; for, when it was otherwiſe, the two conditions defining, the one the magnitude of the line, and the other the rectangle of its ſegments, were inconſiſtent with each other. Such caſes would occur in the ſolution of the moſt ſimple problems; but if they were more complicated, it muſt have been remarked, that the conſtructions would ſometimes fail, for a reaſon directly contrary to that juſt now aſſigned. Caſes would occur, where the lines, which by their interſection were to determine the thing ſought, inſtead of interſecting each other as they did commonly, or of not meeting at all as in the above-mentioned caſe of impoſſibility, would coincide with one another entirely, and of courſe leave the problem unreſolved. It would appear to geometers, upon a little reflection, that ſince, in the caſe of determinate problems, the thing required was determined by the interſection of the two lines already mentioned, that is, by the points common to both; ſo, in the caſe of their coincidence, as all their parts were in common, every one of theſe points muſt give a ſolution, or, in other words, the ſolutions muſt be indefinite in number.

Upon inquiry, it would be found that this proceeded from ſome condition of the problem having been involved in another, ſo that, in fact, there was but one; which did not leave a ſufficient number of independent conditions to limit the problem to a ſingle or to any determinate number of ſolutions. It would ſoon be perceived, that theſe caſes formed very curious propoſitions of an intermediate nature between problems and theorems; and that they admitted of being enunciated in a manner peculiarly elegant and conciſe. It was to ſuch propoſitions that the ancients gave the name of *poriſms*. This deduction requires to be illuſtrated by an example: ſuppoſe, therefore, that it were required to reſolve the following problem.

A circle ABC (plate 18. fig. 1.), a ſtraight line DE, and a point F, being given in poſition, to find a point G in the ſtraight line DE ſuch, that GF, the line drawn from it to the given point, ſhall be equal to GB, the line drawn from it touching the given circle.

Suppoſe G to be found, and GB to be drawn touching the given circle ABC in B, let H be its centre, join HB, and let HD be perpendicular to DE. From D draw DL, touching the circle ABC in L, and join HL; alſo from the centre G, with the diſtance GB or GF, deſcribe the circle BKF, meeting HD in the points K and K′. Then HD and DL are given in poſition and magnitude; and becauſe GB touches the circle ABC, HBG is a right angle; and ſince G is the centre of the circle BKF, therefore HB touches the circle BKF, and $HB^2 =$ the rectangle K′HK; which rectangle $+ DK^2 = HD^2$, becauſe K′K is biſected in D, therefore $HL^2 + KD^2 = DH^2 = HL^2$ and $= LD^2$; therefore $DK^2 = DL^2$, and $DK = DL$; and ſince DL is given in magnitude, DK is alſo given, and K is a given point: for the ſame reaſon K′ is a given point, and the point F being given by hypotheſis, the circle BKP is given by poſition. The point G, the centre of the circle, is therefore given, which was to be found. Hence this conſtruction:

Having drawn HD perpendicular to DE, and DL touching the circle ABC, make DK and DK′ each equal to DL, and find G the centre of the circle deſcribed through the points K′FK; that is, let FK′ be joined and biſected at right angles by MN, which meets DE in G, G will be the point required; that is, if GB be drawn touching the circle ABC, and GF to the given point, GB is equal to GF.

The ſynthetical demonſtration is eaſily derived from the preceding analyſis; but it muſt be remarked, that in ſome caſes this conſtruction fails. For, firſt, if F fall anywhere in DH, as at F′, the line MN becomes parallel to DE, and the point G is nowhere to be found; or, in other words, it is at an infinite diſtance from D. This is true in general; but if the given point F coincides with K, then MN evidently coincides with DE; ſo that, agreeable to a remark already made, every point of the line DE may be taken for G, and will ſatisfy the conditions of the problem; that is to ſay, GB will be equal to GK, wherever the point G be taken in the line DE: the ſame is true if F coincide with K. Thus, we have an inſtance of a problem, and that too a very ſimple one, which, in general, admits but of one ſolution; but which, in one particular caſe, when a certain relation takes place among the things given, becomes indefinite, and admits of innumerable ſolutions. The propoſition which reſults from this caſe of the problem is a poriſm, and may be thus enunciated:

“A circle ABC being given by poſition, and alſo a ſtraight line DE, which does not cut the circle, a point K may be found, ſuch, that if G be any point whatever in DE, the ſtraight line drawn from G to the point K ſhall be equal to the ſtraight line drawn from G touching the given circle ABC.”

The problem which follows appears to have led to the diſcovery of many poriſms.

A circle ABC (fig. 2.) and two points D, E, in a diameter of it being given, to find a point F in the circumference of the given circle; from which, if ſtraight lines be drawn to the given points E, D, theſe ſtraight lines ſhall have to one another the given ratio of α to β, which is ſuppoſed to be that of a greater to a leſs. Suppoſe the problem reſolved, and that F is found, ſo that FE has to FD the given ratio of α to β, produce EF towards B, biſect the angle EFD by FL, and DFB by FM: therefore EL : LD : : EF : FD, that is in a given ratio; and ſince ED is given, each of the ſegments EL, LD, is given, and the point L is alſo given; becauſe DFB is biſected by FM, EM : MD : : EF : FD, that is, in a given ratio, and therefore M is given. Since DFL is half of DFE, and DFM half of DFB, therefore LFM is half of (DFE + DFB), therefore LFM is a right angle; and ſince the points L, M, are given, the point F is in the circumference of a circle deſcribed upon LM as a diameter, and therefore given in poſition. Now the point F is alſo in the circumference of the given circle ABC, therefore it is in the interſection of the two given circumferences, and therefore is found. Hence this conſtruction: divide ED in L, ſo that EL may be to LD in the given ratio of α to β, and produce ED alſo to M, ſo that EM may be to MD in the ſame given ratio of α to β; biſect LM in N, and from the centre N, with the diſtance NL, deſcribe the ſemicircle LFM; and the point F, in which it interſects the circle ABC, is the point required.

The ſynthetical demonſtration is eaſily derived from the preceding analyſis. It muſt, however, be remarked, that the conſtruction fails when the circle LFM falls either wholly within or wholly without the circle ABC, ſo that the circumferences do not interſect; and in theſe caſes the problem cannot be ſolved. It is alſo obvious that the conſtruction will fail in another caſe, viz. when the two circumferences LFM, ABC, entirely coincide. In this caſe, it is further evident, that every point in the circumference ABC will anſwer the conditions of the problem, which is therefore capable of numberleſs ſolutions, and may, as in the former inſtances, be converted into a poriſm. We now inquire, therefore, in what circumſtances the point L will coincide with A, and alſo the point M with C, and of conſequence the circumference LFM with ABC. If we ſuppoſe that they coincide, EA : AD : : α : β : : EC : CD, and EA : EC : : AD : CD, or by converſion EA : AC : : AD : CD—AD : : AD : 2DO, O being the centre of the circle ABC; therefore, alſo, EA : AO : : AD : DO, and by compoſition EO : AO : : AO : DO, therefore $EO \times OD = AO^2$. Hence, if the given points E and D (fig. 3.) be ſo ſituated, that $EO \times OD = AO^2$, and at the ſame time α : β : : EA : AD : : EC : CD, the problem admits of numberleſs ſolutions; and if either of the points D or E be given, the other point, and alſo the ratio which will render the problem indeterminate, may be found. Hence we have this poriſm:

“A circle ABC, and alſo a point D being given, another point E may be found, ſuch that the two lines inflected from theſe points to any point in the circumference ABC, ſhall have to each other a given ratio, which ratio is alſo to be found.” Hence alſo we have an example of the derivation of poriſms from one another; for, the circle ABC, and the points D and E remaining as before (fig. 3.), if, through D, we draw any line whatever HDB, meeting the circle in B and H; and if the lines EB, EH, be alſo drawn, theſe lines will cut off equal circumferences BF, HG. Let FC be drawn, and it is plain from the foregoing analyſis, that the angles DFC, CFB, are equal; therefore if OG, OB, be drawn, the angles BOC, COG, are alſo equal; and conſequently the angles DOB, DOG. In the ſame manner, by joining AB, the angle DBE being biſected by BA, it is evident that the angle AOF is equal to AOH, and therefore the angle FOB to HOG, that is, the arch FB to the arch HG. This propoſition appears to have been the laſt but one in the third book of Euclid's Poriſms, and the manner of its enunciation in the poriſmatic form is obvious.

The preceding propoſition alſo affords an illuſtration of the remark, that the conditions of a problem are involved in one another in the poriſmatic or indefinite caſe; for here ſeveral independent conditions are laid down, by the help of which the problem is to be reſolved. Two points D and E are given, from which two lines are to be inflected, and a circumference ABC, in which theſe lines are to meet, as alſo a ratio which theſe lines are to have to each other. Now theſe conditions are all independent on one another, ſo that any one may be changed without any change whatever in the reſt. This is true in general; but yet in one caſe, viz. when the points are ſo related to one another that their rectangle under their diſtances from the centre is equal to the ſquare of the radius of the circle; it follows from the preceding analyſis, that the ratio of the inflected lines is no longer a matter of choice, but a neceſſary conſequence of this diſpoſition of the points.

From what has been already ſaid, we may trace the imperfect definition of a poriſm which Pappus aſcribes to the later geometers, viz. that it differs from a local theorem, by wanting the hypotheſis aſſumed in that theorem. Now, to underſtand this, it muſt be obſerved, that if we take one of the propoſitions called *loci*, and make the conſtruction of the figure a part of the hypotheſis, we get what was called by the ancient geometers a *local theorem*. If, again, in the enunciation of the theorem, that part of the hypotheſis which contains the conſtruction be ſuppreſſed, the propoſition thence ariſing will be a poriſm; for it will enunciate a truth, and will require to the full underſtanding and inveſtigation of that truth, that ſomething ſhould be found, viz. the circumſtances in the conſtruction ſuppoſed to be omitted.

Thus, when we ſay, if from two given points E, D, (fig. 3.) two ſtraight lines EF, FD, are inflected to a third point F, ſo as to be to one another in a given ratio, the point F is in the circumference of a given circle, we have a locus. But when converſely it is ſaid, if a circle ABC, of which the centre is O, be given by poſition, as alſo a point E; and if D be taken in the line EO, ſo that $EO \times OD = AO^2$; and if from E and D the lines EF, DF be inflected to any point of the circumference ABC, the ratio of EF to DF will be given, viz. the ſame with that of EA to AD, we have a local theorem.

Laſtly, when it is ſaid, if a circle ABC be given by poſition, and alſo a point E, a point D may be found, ſuch that if EF, FD be inflected from E and D to any point F in the circumference ABC, theſe lines ſhall have a given ratio to one another, the propoſition becomes a poriſm, and is the ſame that has juſt now been inveſtigated.

Hence it is evident, that the local theorem is changed into a poriſm, by leaving out what relates to the determination of D, and of the given ratio. But though all propoſitions formed in this way from the converſion of loci, are poriſms, yet all poriſms are not formed from the converſion of loci; the firſt, for inſtance, of the preceding cannot by converſion be changed into a locus; therefore Fermat's idea of poriſms, founded upon this circumſtance, could not fail to be imperfect.

To confirm the truth of the preceding theory, it may be added, that profeſſor Dr. Stewart, in a paper read a conſiderable time ago before the Philoſophical Society of Edinburgh, defines a poriſm to be "A propoſition affirming the poſſibility of finding one or more conditions of an indeterminate theorem;" where, by an indeterminate theorem, he meant one which expreſſes a relation between certain quantities that are determinate and certain others that are indeterminate; a definition which evidently agrees with the explanations which have been here given.

If the idea which we have given of theſe propoſitions be juſt, it follows, that they are to be diſcovered by conſidering thoſe caſes in which the conſtruction of a problem fails, in conſequence of the lines which by their interſection, or the points which by their poſition, were to determine the problem required, happening to coincide with one another. A poriſm may therefore be deduced from the problem to which it belongs, juſt as propoſitions concerning the *maxima* and *minima* of quantities are deduced from the problems of which they form limitations; and ſuch is the moſt natural and obvious analyſis of which this claſs of propoſitions admits.

The following poriſm is the firſt of Euclid's, and the firſt alſo which was reſtored. It is given here to exemplify the advantage which, in inveſtigations of this kind, may be derived from employing the *law of continuity* in its utmoſt extent, and purſuing poriſms to thoſe extreme caſes where the indeterminate magnitudes increaſe *ad infinitum*.

This poriſm may be conſidered as having occurred in the ſolution of the following problem: Two points A, B, (fig. 4.) and alſo three ſtraight lines DE, FK, KL, being given in poſition, together with two points H and M in two of theſe lines, to inflect from A and B to a point in the third, two lines that ſhall cut off from KF and KL two ſegments, adjacent to the given points H and M, having to one another the given ratio of α to β. Now, to find whether a poriſm be connected with this problem, ſuppoſe that there is, and that the following propoſition is true. Two points A and B, and two ſtraight lines DE, FK, being given in poſition, and alſo a point H in one of them, a line LK may be found, and alſo a point in it M, both given in poſition, ſuch that AE and BE inflected from the points A and B to any point whatever of the line DE, ſhall cut off from the other lines FK and LK ſegments HG and MN adjacent to the given points H and M, having to one another the given ratio of α to β.

Firſt, let AE′, BE′, be inflected to the point E′, ſo that AE′ may be parallel to FK, then ſhall E′B be parallel to KL, the line to be found; for, if it be not parallel to KL, the point of their interſection muſt be at a finite diſtance from the point M, and therefore making as β to α; ſo this diſtance to a fourth proportional, the diſtance from H at which AE′ interſects FK, will be equal to that fourth proportional. But AE′ does not interſect FK, for they are parallel by conſtruction; therefore BE′ cannot interſect KL, which is therefore parallel to BE′, a line given in poſition. Again, let AE″, BE″, be inflected to E″, ſo that AE″ may paſs through the given point H: then it is plain that BE″ muſt paſs through the point to be found M; for, if not, it may be demonſtrated juſt as above, that AE″ does not paſs through H, contrary to the ſuppoſition. The point to be found is therefore in the line E″B, which is given in poſition. Now, if from E there be drawn EP parallel to AE′, and ES parallel to BE′, BS : SE : : BL : LN $= \frac{\text{SE} \times \text{BL}}{\text{BS}}$, and AP : PE : : AF : FG $= \frac{\text{PE} \times \text{AF}}{\text{AP}}$; therefore FG : LN : : $\frac{\text{PE} \times \text{AF}}{\text{AP}} : \frac{\text{SE} \times \text{BL}}{\text{BS}}$: : PE × AF × BS : SE × BL × AP; wherefore the ratio of FG to LN is compounded of the ratios of AF to BL, BE to ES, and BS to AP; but PE : SE : : AE′ : BE′, and BS : AP : : DB : DA for DB : BS : : DE′ : E′E : : DA : AP; therefore the ratio of FG to LN is compounded of the ratios of AF to BL, AE′ to BE′, and DB to DA. In like manner, becauſe E″ is a point in the line DE, and AE″ BE″ are inflected to it, the ratio of FH to LM is compounded of the ſame ratios of AF to BL, AE′ to BE′, and DB to DA; therefore FH : LM : : FG : NL (and conſequently) : : HG : MN; but the ratio of HG to MN is given, being the ſame as that of α to β; the ratio of FH to LM is therefore alſo given, and FH being given, LM is given in magnitude. Now LM is parallel to BE′, a line given in poſition; therefore M is in a line QM, parallel to AB, and given in poſition; therefore the point M, and alſo the line KLM, drawn through it parallel to BE′, are given in poſition, which were to be found. Hence this conſtruction: From A draw AE′ parallel to FK, ſo as to meet DE in E′; join BE′, and take in it BQ, ſo that $\alpha : \beta$: : HF : BQ, and through Q draw QM parallel to AB. Let HA be drawn, and produced till it meet DE in E″, and draw BE″, meeting QM in M; through M draw KML parallel to BE′, then is KML the line and M the point which were to be found. There are two lines which will anſwer the conditions of this poriſm; for if in QB, produced on the other ſide of B, there be taken Bq = BQ, and if qm be drawn parallel to AB, cutting MB in m; and if $m\lambda$ be drawn parallel to BQ, the part mn, cut off by EB produced, will be equal to MN, and have to HG the ratio required. It is plain, that whatever be the ratio of α to β, and whatever be the magnitude of FH, if the other things given remain the ſame, the lines found will be all parallel to BE′. But if the ratio of α to β remain the ſame likewiſe, and if only the point H vary, the poſition of KL will remain the ſame, and the point M will vary.

Another general remark which may be made on the analyſis of poriſms is, that it often happens, as in the laſt example, that the magnitudes required may all, or a part of them, be found by conſidering the extreme caſes; but for the diſcovery of the relation between them, and the indefinite magnitudes, we muſt have recourſe to the hypotheſis of the poriſm in its moſt general or indefinite form; and muſt endeavour ſo to conduct the reaſoning, that the indefinite magnitudes may at length totally diſappear, and leave a propoſition aſſerting the relation between determinate magnitudes only.

For this purpoſe Dr. Simſon frequently employs two ſtatements of the general hypotheſis, which he compares together. As for inſtance, in his analyſis of the laſt poriſm, he aſſumes not only E, any point in the line DE, but alſo another point O, anywhere in the ſame line, to both of which he ſuppoſes lines to be inflected from the points A, B. This double ſtatement, however, cannot be made without rendering the inveſtigation long and complicated; nor is it even neceſſary, for it may be avoided by having recourſe to ſimpler *poriſms*, or to *loci*, or to propoſitions of the *data*. The following poriſm is given as an example where this is done with ſome difficulty, but with conſiderable advantage both with regard to the ſimplicity and ſhortneſs of the demonſtration. It will be proper to premiſe the following lemma. Let AB (fig. 7.) be a ſtraight line, and D, L any two points in it, one of which D is between A and B; let CL be any ſtraight line. $\frac{LB}{CL}.AD^2+\frac{LA}{CL}.BD^2=\frac{LB}{CL}\cdot AL^2+\frac{LA}{CL}\cdot BL^2+\frac{AB}{CL}\cdot DL^2$. Place CL perpendicular to AB, and through the points A, C, B, deſcribe a circle; and let CL meet it again in E, and join AE, BE. Draw DG parallel to CE, meeting AE and BE in H and G. Draw EK parallel to AB. $CL : LB :: (LA : LE ::) \; LA^2 : LA\times LE=\frac{LB}{CL}LA^2$ $CL : LA :: (LB : LE ::) \; LB^2 : LB\times LE=\frac{LA}{CL}\cdot BL^2$. Now $CL : LB :: LA : LE :: (EK) \; LD : KH$, and $CL : LA :: LB : LE :: (EK) \; LD : KG$; therefore, (V. 24.) $CL : AB :: (LD : GH ::) \; LD^2 : EK\times GH\cdot =\frac{AB}{CL}\cdot LD^2$; therefore $\frac{LB}{CL}\cdot LA^2+\frac{LA}{CL}L+\frac{AB}{CL}.LD^2=AB\times LE+EK\times GH$. Again, $CL : LA :: (LB : LE :: DB : DG ::) \; DB^2 : DB\times DG=\frac{LA}{CL}\cdot DB^2$, and $CL : LB :: (LA : LE :: DA : DH ::) \; DA^2 : DA\times DH=\frac{LB}{CL}.DA^2$; therefore $\frac{LB}{CL}DA^2+\frac{LA}{CL}DB^2=AD\times DH+DB\times DG=AB\times LE+EK\times GH$; wherefore $\frac{LB}{CL}DA^2+\frac{LA^2}{CL}DB^2=\frac{LB}{CL}LA^2+\frac{LA}{CL}LB^2+\frac{AB}{CL}LD^2$. *Q. E. D.*

Let there be three ſtraight lines AB, AC, CB given in poſition (fig. 5.); and from any point whatever in one of them, as D, let perpendiculars be drawn to the other two, as DF, DE, a point G may be found, ſuch, that if GD be drawn from it to the point D, the ſquare of that line ſhall have a given ratio to the ſum of the ſquares of the perpendiculars DF and DE, which ratio is be found.

Draw AH, BK perpendicular to BC and AC; and in AB take L, ſo that $AL : LB :: AH^2 : BK^2 :: AC^2 \; CB^2$. The point L is therefore given; and if N be taken, ſo as to have to AL the ſame ratio that AB^2 has to AH^2, N will be given in magnitude. Alſo, ſince $AH^2 : BK^2 :: AL : LB$, and $AH^2 : AB^2 :: AL : N$, *ex æquo* $BK^2 : AB^2 :: LB : N$. Draw LO, LM perpendicular to AC, CB; LO, LM are therefore given in magnitude. Now, becauſe $AB^2 : BK^2 :: AD^2 : DF^2$, $N : LB :: AD^2 : DF^2$, and $DF^2=\frac{LB}{N}\cdot AD^2$; and for the ſame reaſon $DE^2=\frac{AL}{N}\cdot BD^2$; but, by the preceding lemma, $\frac{LB}{N}\cdot AD^2+\frac{AL}{N}\cdot BD^2=\frac{LB}{N}\cdot AL^2+\frac{AL}{N}\cdot BL^2+\frac{AB}{N}\cdot DL^2$; that is, $DE^2+DF^2=LO^2+LM^2+\frac{AB}{N}\cdot DL^2$. Join LG; then by hypotheſis LO^2+LM^2, as to LG^2, the ſame ratio as DF^2+DE^2 has to DG^2; let it be that of R to N, then $LO^2+LM^2=\frac{R}{N}\cdot LG^2$; and therefore $DE^2+DF^2=\frac{R}{N}LG^2+\frac{AB}{N}\cdot DL^2$; but $DE^2+DF^2=\frac{R}{N}DG^2$; therefore, $\frac{R}{N}\cdot LG^2+\frac{BA}{N}\cdot DL^2=\frac{R}{N}\cdot DG^2$, and $\frac{AB}{N}\cdot DL^2=\frac{R}{N}(DG^2-LG^2)$; therefore DG^2-LG^2 has to DL^2 a conſtant ratio, viz. that of AB to R. The angle DLG is therefore a right angle, and the ratio of AB to R that of equality; otherwiſe LD would be given in magnitude, contrary to the ſuppoſition. LG is therefore given in poſition: and ſince $R : N :: AB : N :: LO^2+LM^2 : LG^2$; therefore the ſquare of LG, and conſequently LG, is given in magnitude. The point G is therefore given, and alſo the ratio of DE^2+DF^2 to DG^2, which is the ſame with that of AB to N.

The conſtruction eaſily follows from the analyſis, but it may be rendered more ſimple; for ſince $AH^2 : AB^2 :: AL : N$, and $BK^2 : AB^2 :: BL : N$; therefore $AH^2+BK^2 : AB^2 :: AB : N$. Likewiſe, if AG, BG, be joined, $AB : N :: AH^2 : AG^2$, and $AB : N :: BK^2 : BG^2$; wherefore $AB : N :: AK^2+BK^2 : AG^2+BG^2$ and $AG^2+BG^2=AB^2$; therefore the angle AGB is a right one, and $AL : LG :: LG : LB$. If therefore AB be divided in L, ſo that $AL : LB :: AH^2 : BK^2$; and if LG, a mean proportional between AL and LB, be placed perpendicular to AB, G will be the point required.

The ſtep in the analyſis, by which a ſecond introduction of the general hypotheſis is avoided, is that in which the angle GLD is concluded to be a right angle; which follows from DG^2-GL^2, having a given ratio to LD^2, at the ſame time that LD is of no determinate magnitude. For, if poſſible, let GLD be obtuſe (fig. 6.), and let the perpendicular from G to AB meet it in V, therefore V is given: and ſince $GD^2-LG^2=LD^2+2DL\times LV$; therefore, by the ſuppoſition, $LD^2+2DL\times LV$ muſt have a given ratio to LD^2; therefore the ratio of LD^2 to $DL\times VL$, that is, of LD to VL, is given, ſo that VL being given in magnitude, LD is alſo given. But this is contrary to the ſuppoſition; for LD is indefinite by hypotheſis, and therefore GLD cannot be obtuſe, nor any other than a right angle. The concluſion here drawn immediately from the indetermination of LD would be deduced, according to Dr. Simſon's method, by aſſuming another point D′ any how, and from the ſuppoſition that $GD'^2-GL^2 : LD'^2 :: GD^2-GL^2 : LD^2$, it would eaſily appear that GLD muſt be a right angle, and the ratio that of equality.

Theſe poriſms facilitate the ſolution of the general problems from which they are derived. For example, let three ſtraight lines AB, AC, BC (fig. 5.), be given in poſition, and alſo a point R, to find a point D in one of the given lines, ſo that DE and DF being drawn perpendicular to BC, AC, and DR, joined; DE^2+DF^2 may have to DR^2 a given ratio. It is plain, that having found G, the problem would be nothing more than to find D, ſuch that the ratio of GD^2 to DR^2, and therefore that of GD to DR, might be given, the point D being in the circumference of a given circle, as is well known to geometers.

The ſame poriſm alſo aſſiſts in the ſolution of another problem. For if it were required to find D ſuch that DE^2+DF^2 might be a given ſpace; having found G, DG^2 would have to DE^2+DF^2 a given ratio, and DG would therefore be given; whence the ſolution is obvious.

The connection of this poriſm with the impoſſible caſe of the problem is evident; the point L being that from which, if perpendiculars be drawn to AC and CB, the ſum of their ſquares is the leaſt poſſible. For ſince $DF^2+DE^2 : DG :: LO^2+LM^2 : LG^2$; and ſince LG is leſs than DG, LO^2+LM^2 muſt be leſs than DF^2+DE^2. It is evident from what has now appeared, that in ſome inſtances at leaſt there is a cloſe connection between theſe propoſitions and the *maxima* or *minima*, and of conſequence the impoſſible caſes of problems. The nature of this connection requires to be further inveſtigated, and is the more intereſting becauſe the tranſition from the indefinite to the impoſſible caſe ſeems to be made with wonderful rapidity. Thus, in the firſt propoſition, though there be not properly ſpeaking an impoſſible caſe, but only one where the point to be found

PORISM.

Fig. 1.

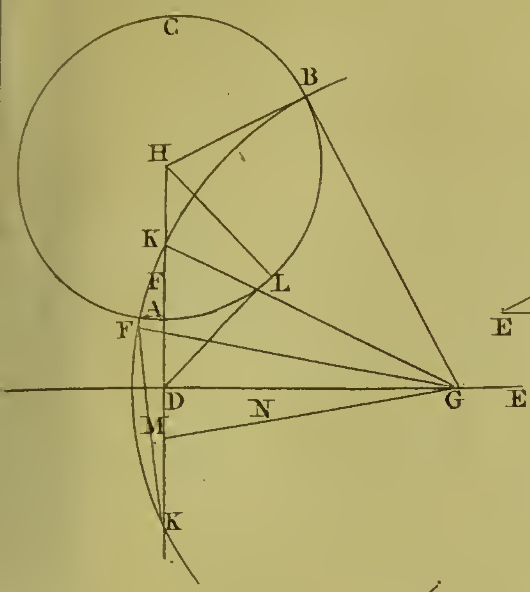


Fig. 2.

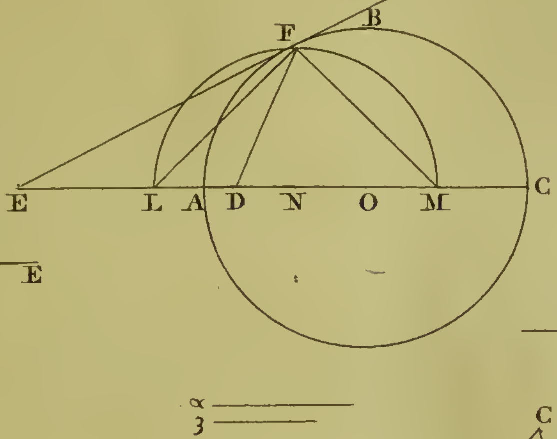


Fig. 3.

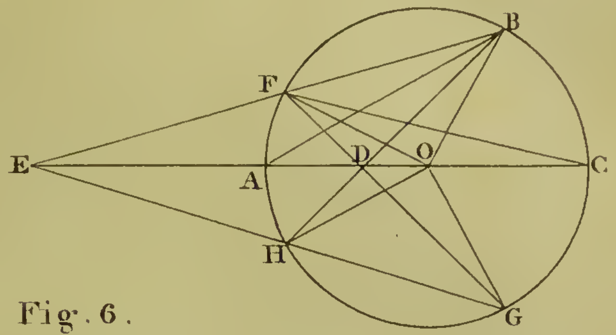


Fig. 6.

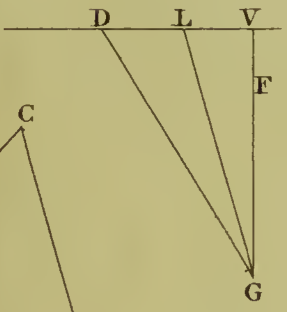


Fig. 4.

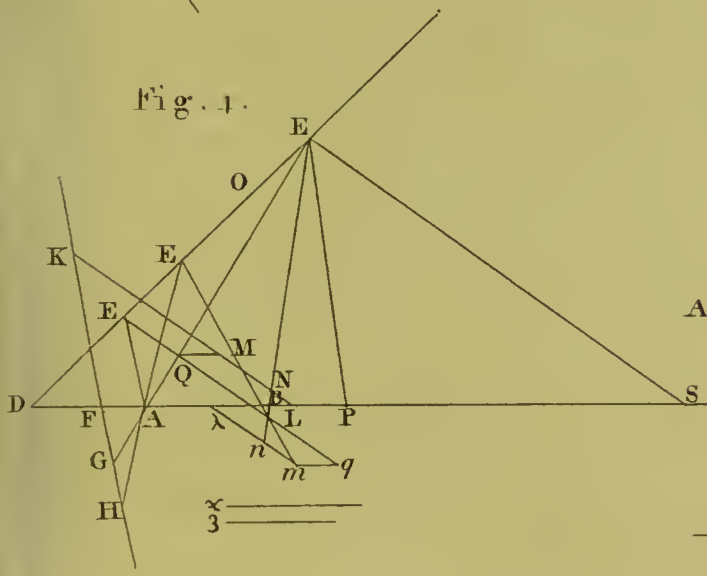


Fig. 5.

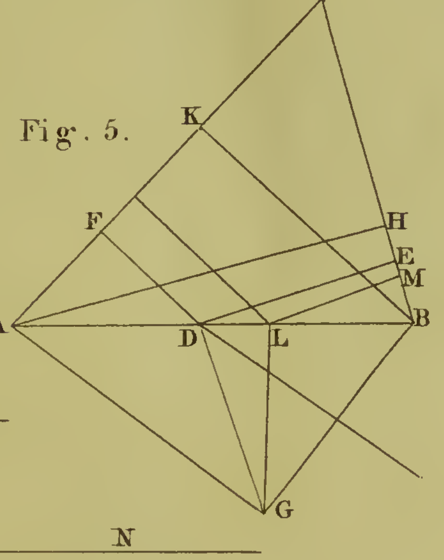
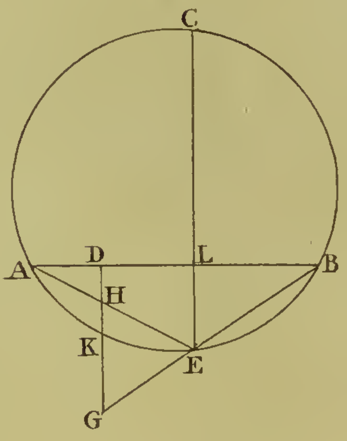
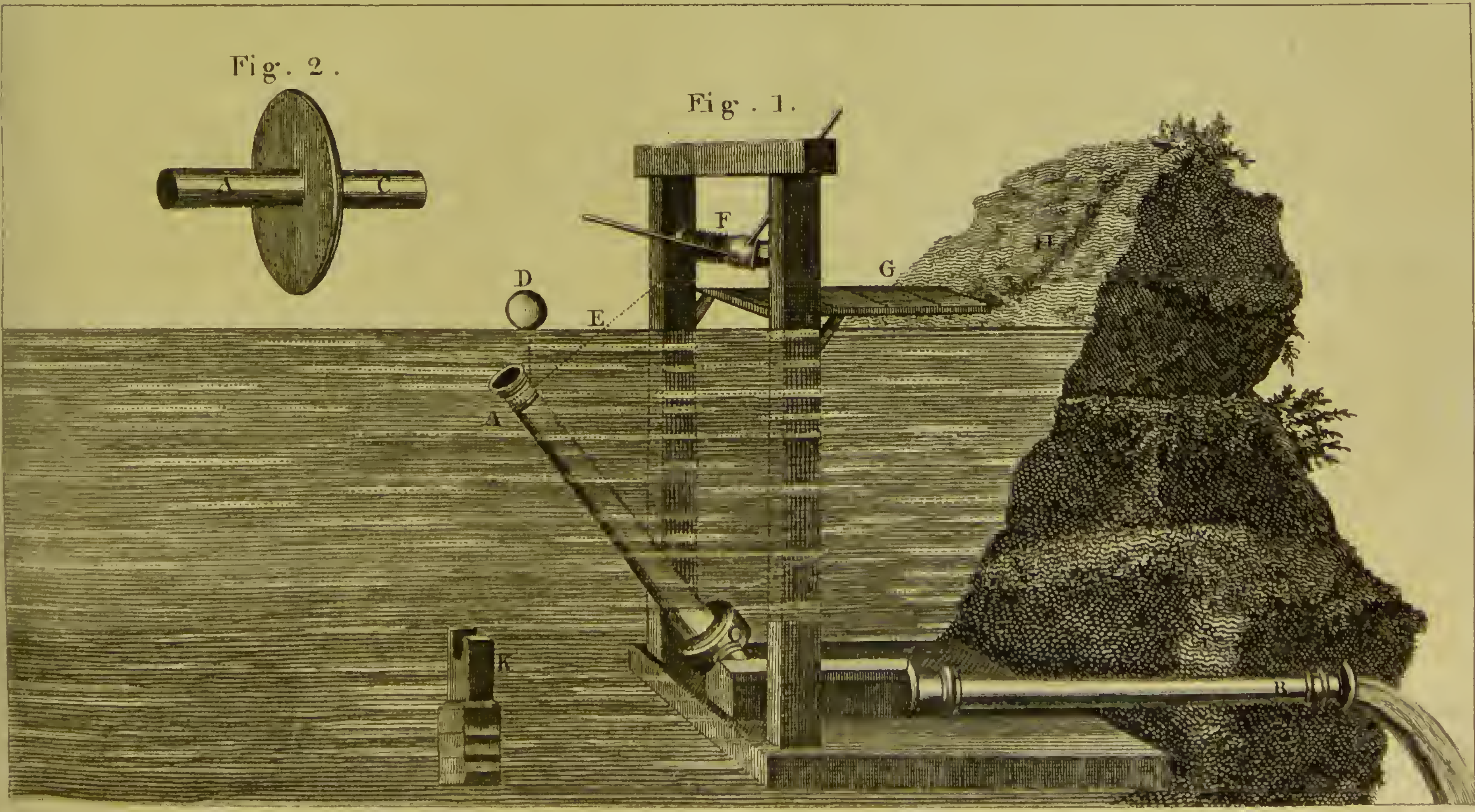


Fig. 7.



Machine for draining Ponds without disturbing the Mud.



Barlow sculp.

goes off *ad infinitum*, it may be remarked, that if the given point F be anywhere out of the line HD (Plate 18. fig. 1.), the problem of drawing GB equal to GF is always poſſible, and admits of juſt one ſolution; but if F be in DH, the problem admits of no ſolution at all, the point being then at an infinite diſtance, and therefore impoſſible to be aſſigned. There is however this exception, that if the given point be at K in this ſame line, DH is determined by making DK equal to DL. Then every point in the line DE gives a ſolution, and may be taken for the point G. Here therefore the caſe of numberleſs ſolutions, and of no ſolution at all, are as it were *conterminal*, and ſo cloſe to one another, that if the given point be at K the problem is indefinite; but if it remove ever ſo little from K, remaining at the ſame time in the line DH, the problem cannot be reſolved. This affinity might have been determined *à priori*: for it is, as we have ſeen, a general principle, that a problem is converted into a poriſm when one or when two of the conditions of it neceſſarily involve in them ſome one of the reſt. Suppoſe, then, that two of the conditions are exactly in that ſtate which determines the third; then, while they remain fixed or given, ſhould that third one vary or differ ever ſo little from the ſtate required by the other two, a contradiction will enſue: therefore if, in the hypotheſis of a problem, the conditions be ſo related to one another as to render it indeterminate, a poriſm is produced; but if, of the conditions thus related to one another, ſome one be ſuppoſed to vary, while the others continue the ſame, an abſurdity follows, and the problem becomes impoſſible. Wherever, therefore, any problem admits both of an indeterminate and an impoſſible caſe, it is certain, that theſe caſes are nearly related to one another, and that ſome of the conditions by which they are produced are common to both." It is ſuppoſed above, that *two* of the conditions of a problem involve in them a third; and wherever that happens, the concluſion which has been deduced will invariably take place. But a poriſm may in ſome caſes be ſo ſimple as to ariſe from the mere coincidence of *one* condition with another, though in no caſe whatever any inconſiſtency can take place between them. There are, however, comparatively few poriſms ſo ſimple in their origin, or that ariſe from problems where the conditions are but little complicated; for it uſually happens that a problem which can become indefinite may alſo become impoſſible; and if ſo, the connection already explained never fails to take place.

Another ſpecies of impoſſibility may frequently ariſe from the poriſmatic caſe of a problem which will affect in ſome meaſure the application of geometry to aſtronomy, or any of the ſciences depending on experiment or obſervation. For, when a problem is to be reſolved by help of data furniſhed by experiment or obſervation, the firſt thing to be conſidered is, whether the data ſo obtained be ſufficient for determining the thing ſought; and in this a very erroneous judgment may be formed, if we reſt ſatisfied with a general view of the ſubject; for though the problem may in general be reſolved from the data with which we are provided, yet theſe data may be ſo related to one another in the caſe under conſideration, that the problem will become indeterminate, and inſtead of one ſolution will admit of an indefinite number. This we have already found to be the caſe in the foregoing propoſitions. Such caſes may not indeed occur in any of the practical applications of geometry; but there is one of the ſame kind which has actually occurred in aſtronomy. Sir Iſaac Newton, in his *Principia*, has conſidered a ſmall part of the orbit of a comet as a ſtraight line deſcribed with an uniform motion. From this hypotheſis, by means of four obſervations made at proper intervals of time, the determination of the path of the comet is reduced to this geometrical problem: Four ſtraight lines being given in poſition, it is required to draw a fifth line acroſs them, ſo as to be cut by them into three parts, having given ratios to one another. Now, this problem had been conſtructed by Dr. Wallis and Sir Chriſtopher Wren, and alſo in three different ways by Sir Iſaac himſelf in different parts of his works; yet none of theſe geometers obſerved that there was a particular ſituation of the lines in which the problem admitted of innumerable ſolutions: and this happens to be the very caſe in which the problem is applicable to the determination of the comet's path, as was firſt diſcovered by the Abbé Boſcovich, who was led to it by finding, that in this way he could never determine the path of a comet with any degree of certainty.

Beſides the geometrical there is alſo an algebraical analyſis belonging to poriſms; which, however, does not belong to this place, becauſe we give this account of them merely as an article of ancient geometry; and the ancients never employed algebra in their inveſtigations. Mr. Playfair, profeſſor of mathematics in the univerſity of Edinburgh, has written a paper on the origin and geometrical inveſtigation of poriſms, which is publiſhed in the third volume of the Tranſactions of the Royal Society of Edinburgh, from which this account of the ſubject is taken. He has there promiſed a ſecond part to his paper, in which the algebraical inveſtigation of poriſms is to be conſidered. This will no doubt throw conſiderable light upon the ſubject, as we may readily judge from that gentleman's known abilities, and from the ſpecimen he has already given us in the firſt part.

PORK, the fleſh of ſwine killed for the purpoſes of food. See SUS. The hog is the only domeſtic animal that we know of no uſe to man when alive, and therefore ſeems properly deſigned for food. Beſides, as loathſome and ugly to every human eye, it is killed without reluctance. The Pythagoreans, whether to preſerve health, or on account of compaſſion, generally forbade the uſe of animal food; and yet it is alleged that Pythagoras reſerved the uſe of hog's fleſh for himſelf. The Jews, the Egyptians, &c. and other inhabitants of warm countries, and all the Mahometans at preſent, reject the uſe of pork. It is difficult to find a ſatisfactory reaſon for this, or for the precept given to the Jews reſpecting it, though unqueſtionably there was ſome good one for it. The Greeks gave great commendations to this food; and Galen, though indeed that is ſuſpected to be from a particular fondneſs, is everywhere full of it. The Romans conſidered it as one of their delicacies; and if ſome of the inhabitants of the northern climates have taken an averſion to it, that probably aroſe from the uncultivated ſtate of their country not being able to rear it. Pork is of a very tender ſtructure, increaſed perhaps from a peculiarity in its economy, viz. taking on fat more readily than any other animal. Pork is a white meat even in its adult ſtate, and then gives out a jelly in very great quantity. On account of its little perſpirability and tenderneſs it is very nutritious, and was given for that intention to the *athletæ*. With regard to its alkaleſcency, no proper experiments have yet been made; but as it is of a gelatinous and ſucculent nature, it is probably leſs ſo than many others. Upon the whole, it appears to be a very valuable nutriment; and the reaſon is not very obvious why it was in ſome countries forbid. It is ſaid that this animal is apt to be diſeaſed; but why were not inconveniences felt on that account in Greece? Again, it has been alleged, that as Paleſtine would not rear theſe animals, and as the Jews had learned the uſe of them in Egypt, it was neceſſary they ſhould have a precept to avoid them. But the Egyptians themſelves did not uſe this meat; and this religious precept, indeed, as well as many others, ſeems to have been borrowed from them. Poſſibly, as pork is not very perſpirable, it might increaſe the leproſy, which was ſaid to be epidemic in Paleſtine; though this is far from being certain.

PORLOCK, ſituated in the county of Somerſet, is a ſmall ſea-port town ſix miles weſt from Minehead. This whole pariſh, including hamlets, contains about 1[illegible]0 houſes, and nearly 600 inhabitants. The ſituation of the town is very romantic, being nearly ſurrounded on all ſides, except toward the ſea, by ſteep and lofty hills, interſected by deep vales and hollow glens. Some of the hills are beautifully wooded, and contain numbers of wild deer. The valleys are very deep and picturesque; the ſides being ſteep, ſcarred with wild rocks, and patched with woods and foreſt ſhrubs. Some of them are well cultivated, and ſtudded with villages or ſingle farms and cottages, although agriculture here is very imperfectly underſtood. Moſt of the roads and fields are ſo ſteep, that no carriages of any kind can be uſed; all the crops are therefore carried in with crocks on horſes, and the manure in wooden pots called *doſſels*. Many of the poor are employed in ſpinning yarn for the Dunſter manufactory. W. lon. 3. 32. N. lat. 51. 14.

PORO. See Calauria.

PORPESSE, in ichthyology. See Delphinus.

PORPHYRIUS, a famous Platonic philoſopher, was born at Tyre in 233, in the reign of Alexander Severus. He was the diſciple of Longinus, and became the ornament of his ſchool at Athens; from thence he went to Rome, and attended Plotinus, with whom he lived ſix years. After Plotinus's death he taught philoſophy at Rome with great applauſe; and became well ſkilled in polite literature, geography, aſtronomy, and muſic. He lived till the end of the third century, and died in the reign of Diocleſian. There are ſtill extant, his book on the Categories of Ariſtotle; a Treatiſe on Abſtinence from Fleſh; and ſeveral other pieces in Greek. He alſo compoſed a large treatiſe againſt the Chriſtian religion, which is loſt. That work was anſwered by Methodius biſhop of Tyre, and alſo by Euſebius, Apollinarius, St. Auguſtin, St. Jerome, St. Cyril, and Theodoret. The emperor Theodoſius the Great cauſed Porphyrius's book to be burned in 338. Thoſe of his works that are ſtill extant were printed at Cambridge in 1655, 8vo. with a Latin verſion.

"Porphyrius (ſays Dr. Enfield) was, it muſt be owned, a writer of deep erudition; and had his judgment and integrity been equal to his learning, he would have deſerved a diſtinguiſhed place among the ancients. But neither the ſplendor of his diction, nor the variety of his reading, can atone for the credulity or the diſhoneſty which filled the narrative parts of his works with ſo many extravagant tales, or intereſt the judicious reader in the abſtruſe ſubtleties and myſtical flights of his philoſophical writings."

PORPHYRY, a genus of ſtones belonging to the order of ſaxa. It is found of ſeveral different colours, as green, deep red, purple, black, dark brown, and gray. Under the name of *porphyry*, Mr. Kirwan and M. de Sauſſure include thoſe ſtones which contain either felt-ſpar, ſchoerl, quartz, or mica, with other ſpecies of cryſtallized ſtone on a ſiliceous or calcareous ground. There are a great many different kinds. M. Ferber deſcribes 20 varieties under four ſpecies; but in general it is conſidered with relation to its ground, which is met with of the colours already mentioned. When the ground is of jaſper, the porphyry is commonly very hard; the red generally contains felt-ſpar in ſmall white dots or ſpecks; and frequently, together with theſe, black ſpots of ſchoerl. The green is often magnetic, and is either a jaſper or ſchoerl, with ſpots of quartz. Sometimes a porphyry of one colour contains a fragment of another of a different colour. Thoſe that have chert for their ground are fuſible *per ſe*. The calcareous porphyry conſiſts of quartz, felt-ſpar, and mica, in ſeparate grains, united by a calcareous cement; and, laſtly, the micaceous porphyry conſiſts of a greeniſh gray micaceous ground, in which red felt-ſpar and greeniſh ſoap-rock are inſerted.

The porphyry of the ancients is a moſt elegant maſs of an extremely firm and compact ſtructure, remarkably heavy, and of a fine ſtrong purple, variegated more or leſs with pale red and white; its purple is of all degrees, from the claret-colour to that of the violet; and its variegations are rarely diſpoſed in veins, but ſpots, ſometimes very ſmall, and at others running into large blotches. It is leſs fine than many of the ordinary marbles; but it excels them all in hardneſs, and is capable of a moſt elegant poliſh. It is ſtill found in immenſe ſtrata in Egypt. The hard red-lead coloured porphyry, variegated with black, white, and green, is a moſt beautiful and valuable ſubſtance. It has the hardneſs and all the other characters of the oriental porphyry; and even greatly excels it in brightneſs and in the beauty and variegation of its colours. It is found in great plenty in the iſland of Minorca; and is well worth importing, being greatly ſuperior to all the Italian marbles. The hard, pale red porphyry, variegated with black, white, and green, is of a pale fleſh-colour, often approaching to white. It is variegated in blotches from half an inch to an inch broad. It takes a high poliſh, and emulates all the qualities of the oriental porphyry. It is found in immenſe ſtrata in Arabia Petræa, and in the Upper Egypt; and in ſeparate nodules in Germany, England, and Ireland.

Ficoroni takes notice of two exquiſitely fine columns of black porphyry in a church at Rome. In Egypt there are three celebrated obeliſks or pillars of porphyry; one near Cairo, and two at Alexandria. The French call them *aguglias*, and in England they are called *Cleopatra's needles*.

The art of cutting porphyry, practiſed by the ancients, appears now to be loſt. Indeed it is difficult to conceive what tools they uſed for faſhioning thoſe huge columns and other porphyry works in ſome of the ancient buildings in Rome. One of the moſt conſiderable of theſe, ſtill entire, is a tomb of Conſtantia, the emperor Conſtantine's daughter. It is in the church of St. Agnes, and is commonly called *the tomb of Bacchus*. In the palace of the Thuilleries there is alſo a buſt of Apollo and of twelve emperors, all in porphyry. Some ancient pieces ſeem to have been wrought with the chiſel, others with the ſaw, others with wheels, and others gradually ground down with emery: yet modern tools will ſcarce touch porphyry. Dr. Liſter therefore thinks (*Phil. Tranſ.* No. 203) that the ancients had the ſecret of tempering ſteel better than we; and not, as ſome imagine, that they had the art of ſoftening the porphyry; though it is probable that time and air have contributed to increaſe its hardneſs. Mr. Addiſon ſays, he ſaw a workman at Rome cutting porphyry; but his advances were extremely ſlow, and almoſt inſenſible. The Italian ſculptors work the pieces of old porphyry columns ſtill remaining (for the porphyry quarries are long ſince loſt) with a braſs ſaw without teeth. With this ſaw, emery, and water, they rub and wear the ſtone with infinite patience. Many perſons have endeavoured to retrieve the ancient art, and particularly Leon Baptiſta Alberti; who, ſearching for the neceſſary materials for temper, ſays, he found goats' blood the beſt of any: but even this availed not much; for, in working with chiſels tempered with it, ſparks of fire came much more plentifully than pieces of the ſtone. The ſculptors were thus, however, able to make a flat or oval form; but could never attain to any thing like a figure.

In the year 1555 Coſmo de Medicis is ſaid to have diſtilled a water from certain herbs, with which his ſculptor, Franceſco Tadda, gave his tools ſuch an admirable hardneſs and ſo fine a temper, that he performed ſome very exquiſite works with them; particularly our Saviour's head in demi-relievo, and Coſmo's head and his ducheſs's. The very hair and beard, how difficult ſoever, are here well conducted; and there is nothing of the kind ſuperior to it in all the works of the ancients; but the ſecret appears to have died with him. The

French have diſcovered another mode of cutting porphyry, *viz.* with an iron ſaw without teeth, and *grez*, a kind of free-ſtone pulverized, and water. The authors of this invention ſay, that they could form the whole contour of a column hereby if they had matter to work on. Others have propoſed to harden tools ſo as to cut porphyry, by ſteeping them in the juice of the plant called *bear's breech* or *brankurſine*. See Birch's *Hiſt. R. S.* vol. i. p. 238 ; vol. ii. p. 73, &c. Mr. Boyle ſays, that he cauſed porphyry to be cut by means of emery, ſteel ſaws, and water ; and obſerves, that in his time the Engliſh workmen were ignorant of the manner of working porphyry, and that none of them would undertake to cut or poliſh it. See his Works abr. vol. i. p. 111.

Da Coſta ſuppoſes, and perhaps with reaſon, that the method uſed by the ancients in cutting and engraving porphyry was extremely ſimple, and that it was performed without the aid of any ſcientific means that are now loſt. He imagines, that, by unwearied diligence, and with numbers of common tools at great expenſe, they rudely hewed or broke the ſtone into the intended figures, and by continued application reduced them into more regular deſigns ; and that they completed the work by poliſhing it with great labour, by the aid of particular hard ſands found in Egypt. And he thinks, that in the porphyry quarries there were layers of grit or looſe diſunited particles, analogous to the porphyry, which they carefully ſought for, and uſed for this work. See *Nat. Hiſt. of Foſſils*, p. 285.

Porphyry *Shell*, a ſpecies of Murex.

PORPITES, the Hair button Stone, in natural hiſtory, a name given by authors to a ſmall ſpecies of foſſil coral ; which is uſually of a rounded figure conſiderably flatted, and ſtriated from the centre every way to the circumference. Theſe are of different ſizes and of different colours, as grayiſh, whitiſh, browniſh, or blueiſh, and are uſually found immerſed in ſtone. See Plate 31. Vol. III.

PORRUM, the Leek ; a ſpecies of plants, belonging to the genus of Allium.

PORT, a harbour, river, or haven, formed either by nature or art to receive and ſhelter ſhipping from the ſtorms and waves of the open ſea. Artificial ports are thoſe which are either formed by throwing a ſtrong mound or rampire acroſs the harbour's mouth to ſome iſland or rock, or erecting two long barriers, which ſtretch from the land on each ſide like arms or the horns of a creſcent, and nearly encloſe the haven. The former of theſe are called *mole-heads*, and the latter *piers*.

Port, is alſo a name given on ſome occaſions to the larboard or left ſide of the ſhip, as in the following inſtances. Thus it is ſaid : "The ſhip heels to port ;" *i. e.* ſtoops or inclines to the larboard-ſide. "Top the yard to port!" the order to make the larboard extremity of a yard higher than the other. "Port the helm!" the order to put the helm over to the larboard-ſide of the veſſel. In all theſe ſenſes this phraſe appears intended to prevent any miſtakes happening from the ſimilarity of ſound in the words *ſtarboard* and *larboard*, particularly when they relate to the helm, where a miſapprehenſion might be attended with very dangerous conſequences.

Ports, the embraſures or openings in the ſide of a ſhip of war, wherein the artillery is ranged in battery upon the decks above and below. The ports are formed of a ſufficient extent to point and fire the cannon, without injuring the ſhip's ſide by the recoil ; and as it ſerves no end to enlarge them beyond what is neceſſary for that purpoſe, the ſhipwrights have eſtabliſhed certain dimenſions, by which they are cut in proportion to the ſize of the cannon. The ports are ſhut in at ſea by a ſort of hanging-doors called the *port-lids ;* which are faſtened by hinges to their upper edges, ſo as to let down when the cannon are drawn into the ſhip. By this means the water is prevented from entering the lower decks in a turbulent ſea. The lower and upper edges of the ports are always parallel to the deck, ſo that the guns, when levelled in their carriages, are all equally high above the lower extremity of the ports, which is called the *port-cells*.

Port, is alſo a ſtrong wine brought from Port-a-port, and alſo called *Porto* and *Oporto*.

Port *of the Voice*, in muſic, the faculty or habit of making the ſhakes, paſſages, and diminutions, in which the beauty of a ſong or piece of muſic conſiſts.

Port-*Crayon*, a pencil-caſe, which is uſually four or five inches long, and contrived ſo as that the pencil may ſlide up and down. Its inſide is round, and its outſide is ſometimes filed into eight ſides or faces, on which are drawn the ſector-lines ; ſometimes it is made round both without-ſide and within, and has its length divided into inches and parts of inches.

Port-*Fire*, a compoſition for ſetting fire to powder, &c. Port-fires are frequently uſed by the artillery in preference to matches ; and they are diſtinguiſhed into wet and dry port-fires. The compoſition of the former is ſaltpetre four, ſulphur one, and mealed powder four. When theſe materials are thoroughly mixed and ſifted, the whole is to be moiſtened with a little linſeed oil, and rubbed between the hands till all the oil is imbibed by the compoſition. The preparation for dry port-fires is ſaltpetre four, ſulphur one, mealed powder two, and antimony one. Theſe compoſitions are driven into ſmall paper caſes, to be uſed whenever neceſſary.

Port-*aux-Prune*, ſo called by the French; is a country on the coaſt of Africa, to the north of the iſland of Madagaſcar. It is a rich country, and fertile in rice and paſtures ; it is inhabited only by the negroes, who are an induſtrious good ſort of people, but very ſuperſtitious. There are no towns, but ſeveral villages, and they have ſome cuſtoms which ſeem to incline to Judaiſm.

Port-*Jackſon*, in New Holland. See *New* Holland.

Port-*Royal*, a ſea-port town in the iſland of Jamaica. It was once a place of the greateſt riches and importance in the Weſt Indies : but in 1692 it was deſtroyed by an earthquake ; in 1702 by fire ; in 1722 by an inundation of the ſea ; and in 1744 it ſuffered greatly by a hurricane. It is now reduced to three ſtreets, a few lanes, and about 200 houſes. It contains the royal navy-yard for heaving down and refitting the king's ſhips ; the navy-hoſpital, and barracks for a regiment of ſoldiers. The fortifications, which are very extenſive, being in excellent order, and having been lately ſtrengthened with many additional works, it may be ſaid to vie in point of ſtrength with any fortreſs in the king's dominions. The harbour is one of the beſt in the world, and 1000 ſhips may ride therein, ſecure from every wind that can blow. It is ſix miles eaſt of Spaniſh-town, and as much by water ſouth-eaſt of Kingſton. W. lon. 76. 40. N. lat. 18. 0.

Port-*Royal*, an iſland in North America, on the coaſt of South Carolina, which, with the neighbouring continent, forms one of the moſt commodious harbours in the Britiſh plantations. It is 15 miles in length ; and the town on the north ſhore is called *Beaufort*. W. lon. 80. 10. N. lat. 31. 40.

Port-*Royal*, the name of two monaſteries of Ciſtertian nuns formerly exiſting in the dioceſe of Paris ; the one near Chevreuſe, at the diſtance of five leagues from Paris, called *Port-Royal of the Fields ;* and the other in Paris, in the ſuburbs of St. James.—The nuns of the former of theſe monaſteries, proving refractory, were diſperſed ; when many eccleſiaſtics, and others, who were of the ſame ſentiments as theſe religious, retired to Port Royal, took apartments there, and printed many books. Hence the name of *Port-Royaliſts* was given to all their party, and their books were called *books of Port-Royal*. Hence we ſay the writers of Port-Royal, Meſſieurs de Port-Royal, and the tranſlations and grammars of Port-Royal.

PORTA, or *Vena* Porta, in anatomy, a large vein diſtributed through the liver in the manner of an artery. See Anatomy.

Porta-*Auguſta* (anc. geog.), mentioned only by Ptolemy; a town of the Vaccæi in the Hither Spain; thought by ſome to be *Torre Quemada*, in Old Caſtile; by others *Los Valvaſes*, a village between Burgos and Torre Quemada.

PORTÆ-Romanæ, (anc. geog.): According to Pliny, Romulus left but three, or at moſt four, gates of Rome: afterwards, on enlarging the Pomœria, or compaſs of the city, they amounted to 37.

PORTAL, in architecture, a little gate where there are two gates of a different bigneſs; alſo a little ſquare corner of a room cut off from the reſt by the wainſcot, and forming a ſhort paſſage into the room. The ſame name is alſo ſometimes given to a kind of arch of joiners' work before a door.

PORTATE, or a *Croſs* Portate, in heraldry, a croſs which does not ſtand upright, as croſſes generally do; but lies acroſs the eſcutcheon in bend, as if it were carried on a man's ſhoulder.

PORTCULLICE, in fortification, is an aſſemblage of ſeveral large pieces of wood, joined acroſs one another like a harrow, and each pointed with iron at the bottom. They are ſometimes hung over the gate-way of old fortified towns, ready to let down in caſe of ſurpriſe, when the gates could not be ſhut.

PORTER, a kind of malt liquor, which differs from ale and pale beer in its being made with high-dried malt. See Ale, Beer, and Brewing.

PORT-Glasgow. See Glasgow.

PORTGREVE, or Portgreve, was anciently the principal magiſtrate in ports and other maritime towns. The word is formed from the Saxon *port*, "a port or other town," and *geref*, "a governor."—It is ſometimes alſo written *port-reve*. Camden obſerves, that the chief magiſtrate of London was anciently called *port-greve*: inſtead of whom, Richard I. ordained two bailiffs; and ſoon afterwards king John granted them a mayor for their yearly magiſtrate.

PORTICI, a palace of the king of Naples, ſix miles from that capital. It has a charming ſituation, on the ſea-ſide, near mount Veſuvius. It is enriched with a vaſt number of fine ſtatues, and other remains of antiquity, taken out of the ruins of Herculaneum.

The muſeum conſiſts of 16 rooms, in which the different articles are arranged with very great taſte. The floors are paved with Moſaic, taken from the recovered towns, and the walls of the court are lined with inſcriptions. Beſides buſts, ſtatues, medals, intaglios, lamps, and tripods, there is ſcarcely an article uſed by the ancients of which a ſpecimen may not be ſeen in this muſeum. "But the moſt valuable room is the library, from the numerous manuſcript rolls which it contains. What a field is here for conjecture! what room for hope! Among this ineſtimable collection, how many great works are there, of which even the names are now unknown! how many unbroken volumes, whoſe very fragments, preſerved in the writings of the ancient ſcholiaſts, convey to us moral improvement, information, and delight! perhaps all the dramatic pieces of Menander and Philemon; perhaps, nay, certainly, the loſt Decades of Livy; for it is impoſſible to ſuppoſe, that among ſo many rolls, the moſt admired hiſtory of the people who poſſeſſed them is not to be found: what private library in Britain is without the beſt hiſtories of England? But how I tremble for their ſituation, as Portici is built on the lava that overwhelmed Herculaneum! How I tremble too for the indifference of the king of Naples towards this invaluable treaſure, in which all the moſt enlightened people of Europe are deeply intereſted! When I firſt ſaw them, I had no idea of what they were, as they reſemble wooden truncheons burnt almoſt to charcoal. They are ſo hard and brittle, that the greateſt caution muſt be uſed in removing them, leſt they crumble to duſt; nevertheleſs, an ingenious friar of Genoa, named *Raggio*, undertook to unroll them; and by a moſt curious, though tedious proceſs, ſo far ſucceeded, as to tranſcribe three Greek Treatiſes on Philoſophy and Muſic: but finding (as I hear) no other encouragement than his ſalary, which was but little more than you pay ſome of your ſervants, the work was unhappily diſcontinued. Were theſe manuſcripts in England, they would not long remain a ſecret to the world." *Watkins's Travels.*

PORTICO, in architecture, a kind of gallery on the ground; or a piazza encompaſſed with arches ſupported by columns, where people walk under cover. The roof is uſually vaulted, ſometimes flat. The ancients called it *lacunar*. Though the word *portico* be derived from *porta*, "gate, door;" yet it is applied to any diſpoſition of columns which form a gallery, without any immediate relation to doors or gates. The moſt celebrated porticoes of antiquity were, thoſe of Solomon's temple, which formed the atrium or court, and encompaſſed the ſanctuary; that of Athens, built for the people to divert themſelves in, and wherein the philoſophers held their diſputes and converſations (ſee Porch); and that of Pompey at Rome, raiſed merely for magnificence, conſiſting of ſeveral rows of columns ſupporting a platform of vaſt extent; a draught whereof, Serlio gives us in his antique buildings. Among the modern porticoes, the moſt celebrated is the piazza of St. Peter of the Vatican.—That of Covent-Garden, London, the work of Inigo Jones, is alſo much admired.

PORTII. See Pompeii.

PORTLAND, a peninſula in Dorſetſhire, of great ſtrength both by nature and art, being ſurrounded with inacceſſible rocks, except at the landing-place, where there is a ſtrong caſtle, called *Portland caſtle*, built by king Henry VIII. There is but one church in the iſland: and that ſtands ſo near the ſea, that it is often in danger from it. It is now chiefly noted for the freeſtone which is found there, and which is greatly employed in London, and other parts of England, for building the fineſt ſtructures. St. Paul's church, in particular, was built therewith. W. lon. 2. 35. N. lat. 50. 30.

The following cuſtom at Portland is worthy of notice: "While I was looking over the quarries at Portland (ſays Mr. Smeaton), and attentively conſidering the operations, obſerving how ſoon the quarrymen would cut half a ton of ſpawls from an unformed block, and what large pieces flew off at every ſtroke; how ſpeedily their blows followed one another, and how inceſſantly they purſued this labour with a tool of from 18 to 20 pounds weight; I was naturally led to view and conſider the figure of the operative agent; and after having obſerved, that by far the greateſt number of the quarrymen were of a very robuſt hardy form, in whoſe hands the tool I have mentioned ſeemed a mere play-thing, I at laſt broke out with ſurpriſe, and inquired of my guide, Mr. Roper, where they could poſſibly pick up ſuch a ſet of ſtout fellows to handle the *kevel*, which in their hands ſeemed nothing? for I obſerved, that in the ſpace of 15 minutes they would knock off as much waſte matter from a maſs of ſtone, as any of that occupation I had ever ſeen before would do in an hour. Says Roper, 'We do not go to fetch thoſe men from a diſtance; they are all born upon the iſland, and many of them have never been further upon the main land than to Weymouth.' I told him, I thought the air of that iſland muſt be very propitious, to furniſh a breed of men ſo particularly formed for the buſineſs they followed. 'The air (he replied), though very ſharp from our elevated ſituation, is certainly very healthy to working men; yet, if you knew how theſe men are produced, you would wonder the leſs; for all our marriages here are productive of children.' On deſiring an explanation how this happened, he proceeded; 'Our people here, as they are bred to hard labour, are very early in a condition to marry and provide for a family; they intermarry with one another, very rarely going to the main-land to ſeek a wife; and it has been the cuſtom of the iſland, from time immemorial, that they never marry till the woman is pregnant.' But pray (ſaid I) does not this ſubject you to a great number of baſtards? Have not your Portlanders the ſame kind of fickleneſs in their attachments that Engliſhmen are ſubject to? and, in conſequence, does not this produce many inconveniences? 'None at all (replies Roper); for, previous to my arrival here, there was but one child on record of the pariſh regiſter that had been born a baſtard in the compaſs of 150 years. The mode of courtſhip here is, that a young woman never admits of the ſerious addreſſes of a young man, but on ſuppoſition of a thorough probation. When ſhe becomes with child, ſhe tells her mother, the mother tells her father, her father tells his father, and he tells his ſon, that it is then proper time to be married.' But ſuppoſe, Mr. Roper, ſhe does not prove to be with child, what happens then? Do they live together without marriage? or, if they ſeparate, is not this ſuch an imputation upon her, as to prevent her getting another ſuitor? 'The caſe is thus managed (anſwered my friend): if the woman does not prove with child after a competent time of courtſhip, they conclude they are not deſtined by Providence for each other; they therefore ſeparate; and as it is an eſtabliſhed maxim, which the Portland women obſerve with great ſtrictneſs, never to admit a plurality of lovers at one time, their honour is no way tarniſhed: ſhe juſt as ſoon (after the affair is declared to be broke off) gets another ſuitor, as if ſhe had been left a widow, or that nothing had ever happened, but that ſhe had remained an immaculate virgin.' But pray, ſir, did nothing particular happen upon your men coming down from London? 'Yes (ſays he); our men were much ſtruck, and mightily pleaſed with the facility of the Portland ladies, and it was not long before ſeveral of the women proved with child; but the men being called upon to marry them, this part of the leſſon they were uninſtructed in; and on their refuſal, the Portland women aroſe to ſtone them out of the iſland; inſomuch, that thoſe few who did not chooſe to take their ſweethearts for *better or for worſe*, after ſo fair a trial, were in reality obliged to decamp; and on this account ſome few baſtards were born: but ſince then matters have gone on according to the ancient cuſtom."

PORTLAND VASE, a celebrated funeral vaſe which was long in poſſeſſion of the Barberini family; but which was lately purchaſed for 1000 guineas by the duke of Portland, from whom it has derived its preſent name. Its height is about ten inches, and its diameter where broadeſt ſix. There are a variety of figures upon it of moſt exquiſite workmanſhip, in bas relief of white opake glaſs, raiſed on a ground of deep blue glaſs, which appears black except when held againſt the light. It appears to have been the work of many years, and there are antiquarians who date its production ſeveral centuries before the Chriſtian era; ſince, as has been ſaid, ſculpture was declining in excellence in the time of Alexander the Great.

Reſpecting the purpoſe of this vaſe, and what the figures on it were meant to repreſent, there have been a variety of conjectures, which it is not our buſineſs to enumerate. We think with Dr. Darwin, that it was not made for the aſhes of any particular perſon deceaſed; and therefore that the ſubject of its embelliſhments is not a private hiſtory, but of a general nature. But we are not ſure that he is right in conjecturing it to repreſent a part of the Eleuſinian myſteries; becauſe that conjecture depends on Warburton's explanation of the 6th book of the Æneid, which does not now command that reſpect which it did when it was firſt propoſed. We ſhall therefore give a ſhort account of the ſeveral figures, without noticing any of the theories or conjectures that have been made about them.

In one compartment three exquiſite figures are placed on a ruined column, the capital of which is fallen, and lies at their feet among other disjointed ſtones: they ſit under a tree on looſe piles of ſtone. The middle figure is a female in a reclining and dying attitude, with an inverted torch in her left hand, the elbow of which ſupports her as ſhe ſinks, while the right hand is raiſed and thrown over her drooping head. The figure on her right hand is a man, and that on the left a woman, both ſupporting themſelves on their arms, and apparently thinking intenſely. Their backs are to the dying figure, and their faces are turned to her, but without an attempt to aſſiſt her. On another compartment of the vaſe is a figure coming through a portal, and going down with great timidity into a darker region, where he is received by a beautiful female, who ſtretches forth her hand to help him: between her knees is a large and playful ſerpent. She ſits with her feet towards an aged figure, having one foot ſunk into the earth, and the other raiſed on a column, with his chin reſting on his hand. Above the female figure is a Cupid preceding the firſt figure, and beckoning him to advance. This firſt figure holds a cloke or garment, which he ſeems anxious to bring with him, but which adheres to the ſide of the portal through which he has paſſed. In this compartment there are two trees, one of which bends over the female figure and the other over the aged one. On the bottom of the vaſe there is another figure on a larger ſcale than the one we have already mentioned, but not ſo well finiſhed nor ſo elevated. This figure points with its finger to its mouth. The dreſs appears to be curious and cumberſome, and above there is the foliage of a tree. On the head of the figure there is a Phrygian cap: it is not eaſy to ſay whether this figure be male or female. On the handles of the vaſe are repreſented two aged heads with the ears of a quadruped, and from the middle of the forehead riſes a kind of tree without leaves: theſe figures are in all probability mere ornaments, and have no connection with the reſt of the figures, or the ſtory repreſented on the vaſe.

PORTLANDIA, in botany: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking with thoſe of which the order is doubtful. The corolla is elevated and funnel-ſhaped; the antheræ are longitudinal; the capſule pentagonal, and retuſe at top; bilocular, and crowned with a pentaphyllous calyx. There are two ſpecies, viz. the *grandiflora* and *hexandra*; the former of which has been particularly deſcribed by Dr. Browne, who has alſo given a good figure of it. It has frequently flowered in the royal garden at Kew, and in Dr. Pitcairn's at Iſlington. The external bark is remarkably rough, furrowed, and thick; it has no taſte. The inner bark is very thin, and of a dark brown colour. Its taſte is bitter and aſtringent, and its virtues are the ſame as thoſe of the Jeſuit's bark. Infuſed in ſpirits or wine with a little orange-peel, it makes an excellent ſtomachic tincture.

PORT-Louis, a ſtrong town of France, in the department of Morbihan and late province of Bretagne, with a citadel, and a good harbour. It is a ſtation for part of the French navy, and the E. India company's ſhips; and is ſeated at the mouth of the Blanet, 27 miles W. of Vannes. W. lon. 3. 18. N. lat. 47. 40.

PORT-*Mahon*. See MINORCA.

PORTO. See OPORTO.

PORTO-*Bello*, a ſeaport of S. America, on the N. coaſt of the iſthmus of Darien, with a large and commodious harbour.

It is a very unhealthy place; and the country around it ſwarms with toads in ſuch multitudes, as hide the ſurface of the earth. Before the abolition of the trade by the galleons, in 1748, and the introduction of regiſter ſhips, Porto Bello was the great mart for the rich commerce of Peru and Chili. At the ſeaſon when the galleons were expected, the product of all the mines, and other valuable commodities, of thoſe countries, were ſent by ſea to Panama, and thence conveyed acroſs the iſthmus, partly on mules, and partly down the river Chagre, to Porto Bello. This paltry village, the reſidence of a few negroes and mulattoes, and of a wretched garriſon relieved every three months, was then ſuddenly crowded with the moſt opulent merchants; and a fair was opened which laſted 40 days, during which was begun and finiſhed the richeſt traffic on the face of the earth. Porto Bello was taken in 1742 by admiral Vernon, who demoliſhed the fortifications. It is 70 miles N. of Panama, and 300 W. of Carthagena. W. lon. 80. 45. N. lat. 9. 33.

PORTO-*Farina*, a port about 12 miles from Cape Carthage, in the bay of Tunis, where formerly the large veſſels belonging to the bey were fitted out, and laid up on their return from a cruize. This harbour is ſafe from the weather, and opens into a large lake, formed by the Mejerdah, which runs through into the ſea.—The north-weſt wind, which blows right upon the ſhore, together with the ſoil brought down by the river, which has the ſame quality as the Nile of overflowing its banks, has formed a bar, ſo that only ſmall veſſels can now enter. It is ſtill the arſenal where the naval ſtores are kept. E. lon. 10. 16. N. lat. 37. 12.

PORTO-*Farraio*, a handſome town of Italy, in the iſle of Elba, with a good citadel. It is very ſtrong, and ſeated on a long, high, ſteep point of land, to the weſt of the bay of the ſame name, which has two forts. It belongs to the great duke of Tuſcany, who always keeps a good garriſon there. E. lon. 10. 37. N. lat. 48. 55.

PORTO-*Longone*, a ſmall but very ſtrong town of Italy, and in the iſle of Elba, with a good harbour, and a fortreſs upon a rock almoſt inacceſſible. The king of Naples has a right to put a garriſon therein, though the place belongs to the prince of Piombino. It is ſeated on the eaſt end of the iſland, eight miles ſouth-weſt of Piombino. E. lon. 10. 10. N. lat. 42. 52.

PORTO-*Santo*, an iſland of the Atlantic Ocean, on the coaſt of Africa, and the leaſt of thoſe called the *Madeiras*. It is about 15 miles in circumference, and produces but little corn; however, there are oxen and wild hogs, and a vaſt number of rabbits. There are trees which produce the gum or reſin called *dragon's blood*; and there is likewiſe a little honey and wax, which are extremely good. It has no harbour, but good mooring in the road. It belongs to the Portugueſe, and is 300 miles weſt of the coaſt of Africa. W. lon. 16. 20. N. lat. 32. 58.

PORTO-*Seguro*, a government of South America, on the eaſtern coaſt of Braſil; bounded on the north by the government of Rio-dos-Hilios, on the eaſt by the North Sea, on the ſouth by the government of Spiritu-Santo, and on the weſt by the Tupicks. It is a very fertile country, and the capital town is of the ſame name. It is built on the top of a rock, at the mouth of a river, on the coaſt of the North Sea, and is inhabited by Portugueſe. W. lon. 38. 50. S. lat. 17. 0.

PORTO-*Vecchio*, is a ſea-port town of Corſica, in the Mediterranean Sea, ſeated on a bay on the eaſtern coaſt of the iſland. It is 12 miles from Bonifacio, and 40 north of Sardinia. E. lon. 9. 20. N. lat. 41. 42.

PORTO-*Venereo*, is a town of Italy, on the coaſt of Genoa, at the entrance of the gulph of Spetia. It is ſeated on the ſide of a hill, at the top of which there is a fort. It has a very good harbour, and is 45 miles ſouth-eaſt of Genoa. E. lon. 9. 38. N. lat. 44. 5.

PORTRAIT, or PORTRAITURE, in painting, the repreſentation of a perſon, and eſpecially of a face, done from the life. In this ſenſe we muſt uſe the term *portrait-painting*, in contradiſtinction to *hiſtory-painting*, where a reſemblance of perſons is uſually diſregarded. Portraits, when as large as the life, are uſually painted in oil-colours; ſometimes they are painted in miniature with water colours, crayons, paſtils, &c. See the article PAINTING.

PORTREE, is a ſmall village, containing a church and a very few houſes, with an excellent bay and a good harbour, in the Iſle of Sky. Here the late Sir James Macdonald had marked out the lines of a town; and government, it is ſaid, promiſed to aſſiſt him in the work with 500l.; but the death of that gentleman put an end to theſe promiſing appearances, and matters remain in *ſtatu quo*.

PORTSMOUTH, a ſea-port town in Hampſhire, with one of the moſt ſecure and capacious harbours in England, being defended by a numerous artillery, both on the ſea and land-ſide, and very good fortifications. A great part of the royal navy is built here; and here are ſome of the fineſt docks, yards, and magazines of naval ſtores, in Europe. It is ſeated in the iſle of Portſy, being ſurrounded by the ſea except on the north ſide, where there is a river which runs from one arm of it to the other. It is much reſorted to on account of the royal navy, whoſe uſual rendezvous is at Spithead, which is at the eaſt end of the iſle of Wight, and oppoſite to Portſmouth. There is a draw-bridge over the river, and it has always a good garriſon. It is governed by a mayor, 12 aldermen, and burgeſſes, and ſends two members to parliament. It has one church, and two chapels, one in the garriſon, and one in the Common, for the uſe of the dock, and others, beſides ſeveral meeting-houſes of the diſſenters. The houſes of Portſmouth amout to about 2000, and the inhabitants to about 12,000. W. lon. 1. 1. N. lat. 50. 47.

The town is ſuppoſed to receive its name from Port, a famous Saxon chieftain, who, A. D. 501, landed here with his two ſons. It made a conſiderable figure in the time of the Saxons; and, from the utility of its ſituation, was highly favoured by all the monarchs of the Norman line. It was incorporated, and became alſo a parliamentary borough. In the reign of Edward III. it was in a very flouriſhing ſtate; but, A. D. 1338, in the very ſame reign, was burned by the French, when that monarch, which was afterwards ratified by king Richard II. forgave the inhabitants a debt, and remitted their fee-farm for 10 years; within which ſpace they ſo recovered themſelves, as to equip a ſquadron, which ſailed into the mouth of the Seine, ſunk two ſhips, and brought away a great booty. The ſingular excellence of its port, and the convenience of fitting out fleets from thence in the time of a French war, induced Edward IV. to think of fortifying it, as he actually, in ſome meaſure, did; which fortifications were further carried on by Richard III. But king Henry VII. was the firſt who ſettled a garriſon therein; which was increaſed, and the place made ſtill ſtronger, in the reign of Henry VIII. who had a great dock there, wherein was built the Henry Grace de Dieu, which was the largeſt ſhip in the navy of his time. The ſame monarch, remarkably attentive to the ſecurity of all maritime places, built what is now called *South-Sea Caſtle*, for the protection of this.—The improvements made here in the reign of Q. Elizabeth were much ſuperior to all theſe. King Charles II. after his reſtoration, directed great alterations, eſtabliſhed new docks and yards, raiſed ſeveral forts, and fortified them after the modern manner; which works were augmented under his brother's reign. Notwithſtanding this, king William directed likewiſe freſh alterations and additions; and ſucceeding princes, following his example, have, at a large expenſe, extended theſe fortifications, and taken in a vaſt deal of ground: ſo that it is at preſent, as the importance of the place deſerves, the moſt regular fortreſs in Britain; and, as it cannot be effectually attacked by ſea, may be juſtly eſteemed impregnable.

PORTSMOUTH, the largeſt town in the ſtate of New Hampſhire in North America. It ſtands on the ſouth-eaſt ſide of Piſcataqua river, about two miles from the ſea, and contains about 600 houſes, and 4400 inhabitants. The town is handſomely built, and pleaſantly ſituated. Its public buildings are, a court-houſe, two churches for Congregationaliſts, one for Epiſcopalians, and one other houſe for public worſhip. Its harbour is one of the fineſt on the continent, having a ſufficient depth of water for veſſels of any burthen. It is defended againſt ſtorms by the adjacent land, in ſuch a manner, as that ſhips may ſecurely ride there in any ſeaſon of the year. Beſides, the harbour is ſo well fortified by nature, that very little art will be neceſſary to render it impregnable. Its vicinity to the ſea renders it very convenient for naval trade. A light-houſe, with a ſingle light, ſtands at the entrance of the harbour.

PORTSOY, is a handſome ſea-port town, ſituated on a ſmall promontory running into the ſea, on the ſouth ſide of the Murray Frith, in Scotland, about ſix miles from Cullen, and ſeven weſt from Banff. It ſends out ſeveral fiſhing veſſels, particularly for the Hebride white fiſhery, and exports a conſiderable quantity of grain. A manufacture of ſtocking and ſewing thread is alſo carried on to a conſiderable amount for the London and Nottingham markets. In the neighbourhood is a ſtratum of marble, of a dark greeniſh colour, in which, it is ſaid, the curious ſubſtance called ASBESTOS, or earthflax, has been found. From the aſbeſtos a ſort of incombuſtible cloth is made, which is purified by throwing it into the fire. W. lon. 2. 5. N. lat. 57. 50.

PORTUGAL, a country of Europe, bounded on the north and eaſt by Spain, and on the ſouth and weſt by the Atlantic Ocean; about 400 miles in length, from north to ſouth, and 130 in its mean breadth, from eaſt to weſt. It was anciently called *Luſitania*, but its boundaries were then different from what they now are. The name of Portugal is by ſome thought to ſignify *Portus Gallus*, or *Portus Gallorum*, on account of the multitudes of French, which came to the city of Porto, on the river Duero, in order to aſſiſt the Chriſtians againſt the Moors. But others, with more probability, derive it from a town on the river Duero, by the ancients called *Cale*. Oppoſite to this place ſome of the inhabitants afterwards built a new town with a harbour, and gave it the name of *Portucale*, or *The Harbour* or *Port of Cale*; which, by an uninterrupted proſperity, proved the origin of the preſent flouriſhing city of Porto; and from hence the whole country has received the name of Portugal. The old name of Luſitania was aboliſhed, and the new one took place under Ferdinand the Great, king of Caſtile and Leon, who gave this country and Galicia to his third ſon Garcia. The moſt ancient writing now extant, in which the name of Portugal is uſed for the whole kingdom, is dated in the year 1069. The climate in Portugal is much more temperate than in Spain, though with ſome little difference in the ſeveral provinces. The northern parts feel a kind of a painful cold in winter, though this is chiefly owing to the rains of that ſeaſon; and in the ſouthern the ſummer heats are very great. Both winter and ſummer, however, are very ſupportable, cooling ſea-breezes during the latter refreſhing the country, and the ſpring is extremely delightful. Though the ſoil be very fruitful, ſo much is agriculture neglected here, that above half the country lies waſte; and the inhabitants are ſupplied with a great part of their corn by importation. Portugal, however, abounds in wine and oil, of the latter of which the greateſt part is made in the province of Alentejo, but reckoned inferior to that of Spain. Olive-trees thrive better here near the ſea, than up the country. Here is alſo great plenty of fine honey, and conſequently of wax. Portugal alſo produces abundance of lemons, pomegranates, oranges, figs, raiſins, almonds, cheſnuts, and other fine fruits. It has likewiſe variety of ſea and river fiſh, and large quantities of ſea-ſalt. And the mountains contain many kinds of ores, as ſilver, copper, tin, and iron. But the Portugueſe being ſupplied with metals from their poſſeſſions in other parts of the globe, and particularly with abundance of gold from America, no mines are worked in their own country. Gems of various kinds are found, and the mountains contain a beautiful variegated marble. On the hill of Alcantara, not far from Liſbon, is a remarkable mine of ſalt-petre. The principal rivers are the Minho, the Lima, the Duero, the Tagus, and the Guadiana. All abound in fiſh. The whole kingdom contains nineteen cividads or cities; 527 villas or ſmaller towns, 3344 pariſhes, and 2,000,000 of ſouls. Their language is a compound of the Spaniſh, Latin, Mooriſh, and French. The high or titled nobility (titulados) conſiſt of dukes, marquiſes, counts, viſcounts, and barons. All thoſe who are grandees and ſtyled dons, like thoſe of Spain, conſiſt of three claſſes, and receive from the royal treaſury a penſion, ſufficient to ſupport their reſpective dignities. The inferior nobility or gentry are termed Fidalgos; and are incapable of bearing the title of don, unleſs by permiſſion from the king. In the ſecond century, Chriſtianity was received all over Spain, to which Portugal was then annexed. In ſucceeding times, the Moors and Jews increaſed greatly, and lived intermingled with the Chriſtians. And though all exerciſe of the Jewiſh religion be prohibited by the fundamental laws of the kingdom, yet there ſtill remain great numbers of ſecret Jews among the Portugueſe, and thoſe too even among the nobility, clergy, and the very inquiſitors themſelves. Many, unable to conceal themſelves, eſcape to Holland, and there openly profeſs Judaiſm. The eſtabliſhed religion, however, of the country is the Roman Catholic. And the inquiſition, which was introduced by king John III, and has ſince been ſet up throughout all the Portugueſe dominions, Braſil excepted, is very active in detecting hereſies and heretics, and no leſs rigorous in puniſhing them. The number of convents in Portugal is ſaid to be no leſs than 900, and moſt of them very rich. Portugal contains one patriarch, three archbiſhops, and ten biſhops, beſides others in America, Africa, the Eaſt Indies, and the iſlands ſubject to the king of Portugal. The king too, beſides the nomination of all biſhops, receives a fourth of their revenue; but this is generally given away in penſions. The pope confirms the biſhops; publiſhes his bulls in the kingdom, without any previous conſent of the king, and by his legate governs the clergy, who, with reſpect to taxes and contributions, depend on him. Coimbra and Evora, indeed, are univerſities, and Liſbon has a royal academy eſtabliſhed for Portugueſe hiſtory. At Santaren is an academy of hiſtory, antiquity, and languages; and, at St. Thomas, an academy of ſciences on the footing of that at Paris, of which the king was pleaſed to declare himſelf preſident. The Portugueſe carry on a very extenſive trade, but reap no great profit from it, being obliged to vend not only their own products, but all the merchandize and riches brought home to them from their ſettlements in other parts of the globe, and eſpecially from America, to the Europeans trading with them, particularly the Engliſh, in exchange for grain, and ſmall and large quantities of manufactured goods of all kinds, with which they ſupply both Portugal and its poſſeſſions abroad. The goods which they ſell to foreigners are ſea-ſalt, oil, wine, lemons, Seville and China oranges, figs, raiſins, almonds, cheſtnuts, and other fruits; together with wool, ſilk, and other materials for manufactures; but their chief commodities conſiſt of imports from their own colonies, particularly from Braſil; ſuch as ſugars, tobacco, cocoa-nuts, ivory, ebony, Braſil-wood, hides, ſpices, drugs, gold, pearls, diamonds, and valuable gems. The Portugueſe ſhipping little frequent the other countries of Europe or the

Levant, their voyages lying rather to the coaſts of Africa, particularly the Gold Coaſt, whence they carry negroes to Braſil: they meet there alſo with ſome gold and ivory. They trade likewiſe to their Eaſt India colonies of Goa, Diu, and Macao; but this traffic, once ſo very important, is now greatly declined. The whole annual produce of gold in Braſil may, without any exaggeration, be eſtimated at near 2,000,000l. ſterling. The fleet which ſails every year to Braſil, goes and returns in ſeven or eight months; and, when homeward bound, is convoyed by ſome men of war which are ſent to meet it. Ships from Africa, or the Eaſt Indies, come alſo in company. Portugal, or, as it was anciently called, *Luſitania*, paſſed from the Phenicians and Carthaginians into the hands of the Romans, and, by the emperor Auguſtus, was made a Roman province. Towards the beginning of the fifth century the Alans, about the year 440 the Swabians, and about the year 582 the Viſigoths, made themſelves maſters of this country. In the eighth century Portugal was over-run by the Moors and Saracens, but gradually reſcued from them by the Chriſtians. Henry, duke of Burgundy, performed ſuch eminent ſervices to Alphonſo VI, king of Caſtile, againſt the Moors, that he gave him his daughter Thereſa in marriage, and in the year 1093 created him earl of Portugal; and in 1110 it became, by his father-in-law's will, his abſolute property. Alphonſo Henriques, his ſon and ſucceſſor, obtained a ſignal victory, in the year 1130, over the Moors near Ourique. About the ſame time, too, he aſſumed the title of king, and in the year 1179 confirmed his right to the throne. In the year 1181 he held an aſſembly of the ſtates at Lamego, in which the ſucceſſion to the crown was ſettled. In the year 1580 the male line of the kings failing, the kingdom was united to Spain; but under the kings of this monarchy the Portugueſe loſt moſt of their foreign acquiſitions, and were ſo intolerably oppreſſed, that in the year 1640 they ſhook off the Spaniſh yoke, electing John duke of Braganza for their king. The government of Portugal is an unlimited monarchy; but with reſpect to the impoſition of new taxes, the ſettlement of the ſucceſſion, and other important concerns, the conſent of the eſtates, which conſiſt of the clergy, the high nobility, and the commons, is neceſſary. The military forces of the Portugueſe are but in an indifferent condition, nor is the navy more formidable. Liſbon is the capital.

PORTUGALLICA TERRA, earth of Portugal; the name of a fine aſtringent bole, dug in great plenty in the northern part of Portugal.

PORTULACA, PURSLANE: A genus of the monogynia order, belonging to the dodecandria claſs of plants; and in the natural method ranking under the 13th order, *Succulentæ*. The corolla is pentapetalous; the calyx bifid; the capſule unilocular, and cut round. There are ſeveral ſpecies, but the two following are the moſt remarkable. 1. The *oleracea*, annual, or common culinary purſlane, riſes with herbaceous, low, ſucculent, branchy ſtalks, ſix or eight inches high, garniſhed with wedge-ſhaped, thick, ſucculent leaves, and ſmall cloſe-ſetting flowers. There are two varieties; one with deep green leaves, the other with yellow leaves; both of which riſe from the ſame ſeed. 2. The *anacampſeros*, perennial, or ſhrubby cape purſlane, riſes with a ſhrubby branchy ſtalk, about ſix inches high, with oval, gibbous, ſucculent leaves, and the ſtalks terminated by ſmall cluſters of red flowers. Both theſe plants are of a ſucculent nature: the firſt is an herbaceous annual, for culinary uſes; and the ſecond a ſhrubby perennial, raiſed by the curious for variety. They are both exotics of a tender quality, of the temperature of green-houſe or ſtove plants. The common culinary purſlane is raiſed annually from ſeed for ſummer uſe, and is an excellent ingredient in ſummer ſalads, but improper for winter on account of its cold moiſt nature. The plant being tender, muſt be raiſed either on a hot-bed or in a warm border; in which laſt it will not ſucceed before April or May. The ſhrubby ſort muſt be kept in the hot-houſe, in pots of a dry ſoil.

PORTUMNA, a town of Ireland, in the county of Galway and province of Connaught, is 74 miles from Dublin. The caſtle of Portumna, the ſeat of the earl of Clanricarde, is at this place, and near it are the ruins of an ancient caſtle. There is alſo a garriſon for a troop of horſe and two companies of foot. The town is ſeated on the river Shannon, where it falls into Lough Derg. The monks of the Ciſtertian abbey of Dunbrody, in the county of Wexford, had for a long time a chapel here, dedicated to St. Peter and St. Paul; but having at length forſaken it, O'Madden, dynaſt of the country, gave it to the Dominican friars, who, with the approbation of the monks of Dunbrody, erected a friary here and a church, which they dedicated to the bleſſed Virgin and the original patron ſaints; at the ſame time they built a ſteeple, and all other neceſſary offices. Pope Martin V. granted a bull to confirm their poſſeſſions, dated 8th October 1426; and on the 23d of November following he granted indulgences to all who had contributed to the building. The walls are ſtill nearly entire, and ſhow that the monaſtery of Portumna was by no means an ignoble ſtructure. The ancient choir is now the pariſh-church.

POSE, in heraldry, denotes a lion, horſe, or other beaſt, ſtanding ſtill, with all his four feet on the ground. See Hollingſhead's *Deſcription of Britain*, chap. xvi.

POSITIVE, a term of relation oppoſed to negative. It is alſo uſed in oppoſition to relative or arbitrary: thus we ſay, Beauty is no poſitive thing, but depends on the different taſtes of people.

POSITIVE *Degree*, in grammar, is the adjective in its ſimple ſignification, without any compariſon.

POSITIVE *Electricity*. In the Franklinian ſyſtem, all bodies ſuppoſed to contain more than their natural quantity of electric matter are ſaid to be *poſitively* electrified; and thoſe from whom ſome part of their electricity is ſuppoſed to be taken away are ſaid to be electrified *negatively*. Theſe two electricities being firſt produced, one from glaſs, the other from amber or roſin, the former was called *vitreous*, the other *reſinous*, electricity.

POSPOLITE, in the military eſtabliſhment of Poland, is the name given to a kind of militia. It is the moſt numerous and the moſt uſeleſs of the Poliſh armies. It conſiſts of the gentry at large, who, in caſe of invaſion, are aſſembled by a regular ſummons from the king, with conſent of the diet. Every palatinate is divided into diſtricts, over each of which proper officers are appointed; and every perſon poſſeſſing free and noble tenures is bound to military ſervice, either ſingly or at the head of a certain number of his retainers, according to the extent and nature of his poſſeſſions. The troops thus aſſembled are obliged only to ſerve for a limited time, and are not under the neceſſity of marching beyond the limits of their country. They ſubmit to no diſcipline but ſuch as they like themſelves; and are very apt to mutiny if detained more than a fortnight in the place appointed them to meet in, without marching. The mode of levying and maintaining this army is exactly ſimilar to that practiſed under the feudal ſyſtem. At preſent, though it is almoſt totally unfit for the purpoſes of repelling a foreign enemy, it is yet a powerful inſtrument in the hands of domeſtic faction: for the expedition with which it is raiſed under the feudal regulations facilitates the formation of thoſe dangerous confederacies which ſuddenly ſtart up on the conteſted election of a ſovereign, or whenever the nobles are at variance with each other.

POSSE COMITATUS, in law, ſignifies the power of the county, or the aid and aſſiſtance of all the knights, gentlemen, yeomen, labourers, ſervants, apprentices, &c. and all others within the county that are above the age of 15, except women, eccleſiaſtical perſons, and ſuch as are decrepit and infirm. This poſſe comitatus is to be raiſed where a riot is committed, a poſſeſſion kept upon a forcible entry, or any force of reſcue uſed contrary to the king's writ, or in oppoſition to the execution of juſtice; and it is the duty of all ſheriffs to aſſiſt juſtices of the peace in the ſuppreſſion of riots, &c. and to raiſe the poſſe comitatus, or to charge any number of men for that purpoſe.

POSSESSION, in law, is either actual, where a perſon actually enters into lands or tenements deſcended or conveyed to him; or where lands are deſcended to a perſon, and he has not yet entered into them. A long poſſeſſion is much favoured by the law as an argument of right, even though no need can be ſhown, and it is more regarded than an ancient deed without poſſeſſion. If he that is out of poſſeſſion of land bring an action, he muſt prove an undeniable title to it; and when a perſon would recover any thing of another, it is not ſufficient to deſtroy the title of the perſon in poſſeſſion, without he can prove that his own right is better than his. In order to make poſſeſſion lawful upon an entry, the former poſſeſſor and his ſervants are to be removed from off the premiſes entered on: but a perſon by leaſe and releaſe is in poſſeſſion without making any entry upon the lands.

Dæmoniacal Possession (See Dæmon and Dæmoniacs). In the third volume of the Mancheſter Tranſactions, there is a paper on *popular illuſions* or medical demonology by Dr. Ferriar. He informs us, in a note, that, on the 13th of June 1788, George Lukins, of Yatton in Somerſetſhire, was exorciſed in the temple church at Briſtol, and delivered from the poſſeſſion of ſeven devils by the efforts of ſeven clergymen. An account of his deliverance was publiſhed in ſeveral of the public papers, authenticated by the Rev. Mr. Eaſterbrook, vicar of the temple church in Briſtol.—Dr. Ferriar gives us the following particulars, extracted from this account, which we ſhall here inſert.

"Lukins was firſt attacked by a kind of epileptic fit, when he was going about acting Chriſtmas plays, or mummeries: this he aſcribed to a blow given by an inviſible hand. He was afterwards ſeized by fits; during which he declared, with a roaring voice, that he was the devil, and ſung different ſongs in a variety of keys. The fits always began and ended with a ſtrong agitation of the right hand. He frequently uttered dreadful execrations during the fits. The whole duration of his diſorder was eighteen years.

"At length, viz. in June 1788, he declared that he was poſſeſſed by ſeven devils, and could only be freed by the prayers *(in faith)* of ſeven clergymen. Accordingly the requiſite force was ſummoned, and the patient ſung, ſwore, laughed and barked, and treated the company with a ludicrous parody on the *Te Deum*. Theſe aſtoniſhing ſymptoms reſiſted both hymns and prayers till a *ſmall faint voice* admoniſhed the miniſters to adjure. The ſpirits, after ſome murmuring, yielded to the adjuration, and the happy patient returned thanks for his wonderful cure. It is remarkable, that during this ſolemn mockery the fiend ſwore 'by his infernal den' that he would not quit his patient; an oath, I believe, no where to be found but in the Pilgrim's Progreſs, from which Lukins probably got it.

"Very ſoon after the firſt relation of this ſtory was publiſhed, a perſon, well acquainted with Lukins, took the trouble of undeceiving the public with regard to his pretended diſorder, in a plain, ſenſible narrative of his conduct. He aſſerts that Lukins's firſt ſeizure was nothing elſe than a fit of drunkenneſs; that he always foretold his fits, and remained ſenſible during their continuance; that he frequently ſaw Lukins in his fits, 'in every one of which, except in ſinging, he performed not more than moſt active young people can eaſily do;' that he was detected in an impoſture with reſpect to the clenching of his hands; that after money had been collected for him, he got very ſuddenly well: that he never had any fits while he was at St. George's Hoſpital in London, nor when viſitors were excluded from his lodgings by deſire of the author of the Narrative; and that he was particularly careful never to hurt himſelf by his exertions during the paroxyſm.

"Is it for the credit of this philoſophical age, that ſo bungling an impoſture ſhould deceive ſeven clergymen into a public act of exorciſm? This would not have paſſed even on the authors of the *Malleus Maleficarum*; for they required ſigns of ſupernatural agency, ſuch as the ſuſpenſion of the poſſeſſed in the air, without any viſible ſupport, or the uſe of different languages unknown to the demoniac in his natural ſtate."

POSSESSIVE, in grammar, a term applied to pronouns, which denote the enjoyment or poſſeſſion of any thing either in particular or in common: as *meus*, "mine;" and *tuus*, "thine."

POSSIBILITY, in law, is defined to be any thing that is altogether uncertain, or what may or may not be.

Possibility, alſo denotes a non-repugnance to exiſting, in any thing that does not any way exiſt.

POSSIBLE, is ſometimes oppoſed to real exiſtence, and is underſtood of a thing, which, though it actually does not exiſt, yet may exiſt; as a new ſtar.

POSSIDONIA, (anc. geog.) See Poestum.

POST, a word derived from the Latin *poſitus*, "ſet or placed." It is uſed in ſeveral different meanings, but all of them referring either immediately or remotely to this primitive ſenſe of *poſition*. Thus the word Poſt ſignifies, 1. A ſtake or piece of timber ſet upright; 2. A ſtation, particularly a military ſtation; 3. An office or employment; 4. An operation in book-keeping; 5. A conveyance for letters or diſpatches; 6. A particular mode of travelling.

Post, a ſtake or piece of timber ſet upright. Poſts are uſed both in building and in fencing ground. In brick-buildings much of the ſtrength of the fabric depends on the nature of the poſts, as it is through them that the ſeveral parts are ſuſtained and held together. The *corner poſts* are called the *principal poſts*; thoſe formed into breſſummers between principal poſts for ſtrengthening the carcaſe of the houſe are called the *prick poſts*. Poſts which are to be ſet in the ground ought to be well ſeaſoned and coated to preſerve them from rotting; burning the downward end has been recommended as an excellent preſervative, but a coating of pitch or tar, particularly the late invented coal-tar, can be moſt ſafely relied upon. For the various uſes to which poſts may be applied, and the form and ſpecies of them fitteſt to be employed in each caſe, ſee the articles Architecture, Joining, Gardening, House, Fence, &c. In architecture and ſculpture posts is a term uſed to denote certain ornaments formed after the manner of rolls or wreathings.

Post, a ſtation, particularly a military ſtation.—Any place where perſons are ſet or placed upon particular occaſions may be termed a *poſt*; but the word in this view is now chiefly reſtricted to military operations, and means any place or ſituation where ſoldiers are ſtationed. Thus the detachments eſtabliſhed in front of the army are termed the *out-poſts*, the ſtations on the wings of the army are ſaid to be the *poſts of honour*, as being the moſt conſpicuous and moſt expoſed. But in the operations of a campaign, a poſt properly ſignifies any ſpot of ground capable of lodging ſoldiers, or any ſituation, whether fortified or not, where a body of men may make a ſtand and engage the enemy to advantage. The great advantages of good poſts, in carrying on war, as well as the mode of ſecuring them, are only learned by experience. Barbarous nations diſdain the choice of poſts, or at leaſt are contented with ſuch as immediately fall in their way, they truſt ſolely or chiefly to ſtrength and courage: and hence the fate of a kingdom may be decided by the event of a battle. But enlightened and experienced officers make the choice of poſts a principal object of attention. The uſe of them is chiefly felt in a defenſive war againſt an invading enemy; as, by carrying on a war of poſts in a country where this can be done to advantage, the moſt formidable army may be ſo haraſſed and reduced, that all its enterpriſes may be rendered abortive. Indeed in modern times this is ſo well underſtood, that pitched battles have become much more rare than formerly, manœuvring and ſecuring of poſts being conſidered as the moſt eſſential objects in the conduct of a campaign; a change in the art of war much to the advantage of humanity; ſkill, conduct, and prudence, having thus obtained the aſcendency over brutal courage and mere bodily ſtrength. In the choice of a poſt, the general rules to be attended to are, that it be convenient for ſending out parties to reconnoitre, ſurpriſe, or intercept the enemy; that if poſſible it have ſome natural defence, as a wood, a river, or a moraſs, in front or flank, or at leaſt that it be difficult of acceſs and ſuſceptible of ſpeedy fortification; that it be ſo ſituate as to preſerve a communication with the main army, and have covered places in the rear to favour a retreat; that it command a view of all the approaches to it, ſo that the enemy cannot advance unperceived and reſt concealed, while the detachment ſtationed in the poſt are forced to remain under arms; that it be not commanded by any neighbouring heights; and that it be proportioned in extent to the number of men who are to occupy and defend it. It is not to be expected that all theſe advantages will often be found united; but thoſe poſts ought to be ſelected which offer the greateſt number of them.

Post, an office or employment. This uſe of the word is probably derived immediately from the idea of a military ſtation; a poſt being uſed to expreſs ſuch offices or employments as are ſuppoſed either to expoſe the holder to attack and oppoſition, or to require abilities and exertion to fill them. Hence the term is uſed only for *public* offices, and employments under the government; and were ſtrict propriety of ſpeech always attended to, *poſts* would denote thoſe ſtations only in which duty muſt be performed. In common language, however, every *public* office or appointment, even though nominal and ſinecure, goes under the name of a *poſt*.

Post, an operation in book-keeping. Poſting in book-keeping means ſimply the transferring an article to the place in which it ſhould be put, and arranging each under its proper head. It is upon this that the whole theory of book-keeping is founded. The Waſte-book, which is the ground-work of all ſubſequent operations, records every tranſaction exactly in the order in which it occurs. From this the ſeveral articles are poſted, or transferred, into the Journal, which in fact is but a kind of ſupplementary book to the Waſte-book. From the Journal they are poſted anew into the Ledger; in which a ſeparate place is appropriated for each perſon with whom tranſactions are carried on, and frequently for every ſeparate article about which the buſineſs is concerned. The particular mode according to which ſuch transferences are made may vary according to the nature of the trade carried on; the object is the ſame in all, to place every article ſo as that its operations on the general ſtate of the buſineſs may be certainly known and diſtinctly traced. For a full account of the way in which this is done, ſee Book-*Keeping*.

Post, a conveyance for letters or diſpatches. In the early periods of ſociety, communication between the different parts of a country is rare and difficult, individuals at a diſtance having little inclination or opportunity for mutual intercourſe: when ſuch communication is at any time found neceſſary, a ſpecial meſſenger muſt be employed. As order and civilization advance, occaſions of correſpondence multiply. In particular, the ſovereign finds it requiſite frequently to tranſmit orders and laws to every part of the kingdom; and for doing ſo he makes uſe of couriers or meſſengers, to whom he commits the charge of forwarding his diſpatches. But without ſtations in the way, where theſe couriers can be certain of finding refreſhment for themſelves and ſupplies of what may be neceſſary for carrying them forward, the journey, however urgent and important, muſt always be retarded, and in many caſes altogether ſtopped. Experience, therefore, ſoon pointed out the neceſſity of enſuring ſuch accommodations, by erecting upon all the great roads houſes or ſtations at convenient intervals, where the meſſengers might ſtop, as occaſion required, and where too, for the greater convenience, relays of freſh horſes ſhould always be in readineſs, to enable them to purſue their journey with uninterrupted diſpatch. Theſe houſes or ſtations were with great propriety termed *poſts*, and the meſſenger who made uſe of them a *poſt*. Though at firſt, it is probable, the inſtitution was intended ſolely for the ſovereign and the neceſſities of the ſtate; yet by degrees individuals, ſeeing the benefit reſulting from it, made uſe of the opportunity to carry on their own correſpondence; for which they were willing to pay an allowance to the ſovereign. Thus a poſt-office, of ſome kind or other, gradually came to be eſtabliſhed in every civilized country. Without taking notice of the different means of carrying on correſpondence ſaid to have been attempted by pigeons, dogs, and other animals, we can at leaſt trace with certainty the invention of ſomething like regular poſts as far back as the ancient Perſians. Xenophon aſſures us, that they were invented by Cyrus on his Scythian expedition, about 500 years before Chriſt; that the houſes at the ſeveral ſtations were ſumptuouſly built, and large enough to contain a number of men and horſes; and that every courier on his arrival was obliged to communicate his diſpatches to the poſtmaſter, by whom they were immediately forwarded. From the ſhore of the Ægean ſea to Suſa the capital, there were, according to Herodotus, 111 ſtages for poſts, each a day's journey diſtant from the preceding.

In what manner poſts were eſtabliſhed and conducted among the Greeks does not clearly appear; but from the extended commerce carried on, and the frequent communications enjoyed among the different ſtates, there can be no doubt that a regular conveyance, in ſome form or other, was eſtabliſhed.

Though poſts were well known among the Romans, yet it is difficult to trace with certainty the period of their introduction. Some writers carry it back to the times of the republic; poſts and poſt-offices, under the name of *ſtatores* and *ſtationes*, having been then, it is ſaid, eſtabliſhed by the ſenate. Whether this was the caſe or not, Suetonius aſſures us that Auguſtus inſtituted poſts along all the great roads of the empire. At firſt the diſpatches were conveyed from poſt to poſt by young men who ran on foot, and delivered the diſpatches to others at the next ſtage. By and by Auguſtus ſubſtituted, in room of theſe, horſes and chariots, both for the conveyance of diſpatches and the convenience of travelling. His ſucceſſors continued the ſame eſtabliſhment; to the maintenance of which every ſubject of the empire was obliged to contribute. Poſt-horſes are mentioned in the Theodorian code *de curſu publico*; but theſe were only the public horſes appointed to be kept there for the uſe of the public meſſengers, who before this inſtitution ſeized any that came in their way. At each poſt-ſtation, according to Procopius, ten horſes and as many poſtillions were kept, and the uſual rate of their travelling was from five to eight ſtations a-day.

It is to be obſerved, however, that all theſe eſtabliſhments of poſts in ancient times were formed as much, if not more, for travelling ſtations, than for the mere conveyance of letters and diſpatches. This latter object, it is true, was thereby ſecured; but the epiſtolary correſpondence of antiquity was probably at no time ſo extenſive as to require or maintain poſt-offices on the footing of modern poſts, for the mere conveyance of letters. It is in later times only, when the extenſion of commerce and diffuſion of literature gave occaſion to frequent communication, that theſe eſtabliſhments are to be looked for.

The earlieſt inſtitution of *poſts* that occurs in modern hiſtory is about the year 807 by the emperor *Charlemagne*; who, having reduced under his dominion Italy, Germany, and a part of Spain, eſtabliſhed three public poſts at the public expenſe, to carry on the communication with theſe three provinces. The inſtitution of poſts, however, like many other inſtitutions of that emperor, dropped at his death, and for a conſiderable time afterwards no traces of any ſuch eſtabliſhment are to be found. We cannot indeed diſcover them with certainty ſooner than 1464, when that reſtleſs and ſuſpicious prince Louis XI. eſtabliſhed poſts in France, that he might be the ſooner advertiſed of all that paſſed in his own or the neighbouring kingdoms. He employed in this ſervice 230 couriers, who delivered the letters at the different ſtations, and in various towns through which they paſſed in their courſe. Succeeding monarchs created at different times certain offices for the expreſs purpoſe of ſuperintending the poſts; but the frequent changes to which theſe offices were expoſed, prevented for a long time the eſtabliſhment of any regular ſyſtem of poſts in that kingdom; inſomuch that in 1619 the author of the life of the duke d'Epernon ſays, the packet or letter-office was not yet ſet up in France. Former eſtabliſhments, it is probable, were ſolely for the uſe of the court, not for the general good of the nation. From France, the inſtitution gradually ſpread through ſeveral other parts of Europe. In Germany, Lewis Horning aſſures us, they were firſt introduced by count Taxis, who ſettled them at his own expenſe; in acknowledgment for which the emperor Matthias in 1616 gave as a fief the office of poſtmaſter to him and his deſcendants.

In England the eſtabliſhment of poſts in ſome form or other appears as early as the reign of Edward III. but the notices concerning them are ſo vague, that no account can be given of them. In the reign of Edward VI. however, ſome ſpecies of poſts muſt have been ſet up, as an act of parliament paſſed in 1548, fixing the rate of poſt-horſes at one penny *per* mile: the poſt-horſes here referred to were, it is probable, chiefly for travelling, and the carriage of letters or packets only an occaſional ſervice. In 1581, we find in Camden's Annals mention made of a chief poſtmaſter for England being appointed. How his office was managed, does not clearly appear; the limited ſtate of the correſpondence of the country probably rendered it of trifling conſequence. King James I. originally erected a poſt-office under the controul of one Matthew de Queſter or de l'Equeſter, for the conveyance of letters to and from foreign parts; which office was afterwards claimed by lord Stanhope; but was confirmed and continued to William Frizel and Thomas Witherings, by king Charles I. in 1632. Previous to this time it would appear that private perſons were in uſe to convey letters to and from foreign parts; all ſuch interference with the poſtmaſter's office is therefore expreſsly prohibited. King Charles, in 1635, erected a letter-office for England and Scotland, under the direction of the above Thomas Witherings. The rates of poſtage then eſtabliſhed were, two-pence for every ſingle letter for a diſtance under 80 miles; four-pence from 80 to 140 miles; ſix-pence above 140 miles. The allowance to the poſt-maſters on the road for horſes employed in theſe poſts was fixed at two-pence halfpenny *per* mile for every ſingle horſe. All private inland poſts were diſcharged at this time; and in 1637 all private foreign poſts were in like manner prohibited. The poſts thus eſtabliſhed, however, extended only to a few of the principal roads; and the times of tranſmiſſion were not in every caſe ſo certain as they ought to have been.

Witherings was ſuperſeded for abuſes in the execution of his offices in 1640, and they were ſequeſtrated into the hands of Philip Burlamachy, to be exerciſed under the care and overſight of the king's principal ſecretary of ſtate. On the breaking out of the civil war great confuſions and interruptions were neceſſarily occaſioned in the conduct of the letter-office: but it was about that time that the outline of the preſent more extended and regular plan ſeems to have been conceived by Mr. Edmond Prideaux, who was afterwards appointed attorney-general to the commonwealth. He was chairman of a committee in 1642 for conſidering the rate of poſtage to be ſet upon inland letters; and ſome time after was appointed poſtmaſter by an ordinance of both houſes of parliament; in the execution of which office he firſt eſtabliſhed a *weekly* conveyance of letters into *all* parts of the nation. In 1653, this revenue was farmed for 10,000l. for England, Scotland, and Ireland; and after the charge of maintaining poſtmaſters, to the amount of 7000l. *per annum* was ſaved to the public. Prideaux's emoluments being conſiderable, the common council of London endeavoured to erect another poſt-office in oppoſition to his; but they were checked by a reſolution of the houſe of commons, declaring that the office of poſtmaſter is, and ought to be, in the ſole power and diſpoſal of the parliament. This office was farmed by one Maubey in 1654. In 1656 a new and regular general poſt-office was erected by the authority of the protector and his parliament, upon nearly the ſame model that has been ever ſince adopted, with the following rates of poſtage: for 80 miles diſtance, a ſingle letter two-pence; for a greater diſtance, not out of England, three-pence; to Scotland, four-pence. By an act of parliament paſſed ſoon after the reſtoration in 1660, the regulations ſettled in 1656 were re-eſtabliſhed, and a general poſt-office ſimilar to the former, but with ſome improvements, was erected. In 1663 the revenue of the poſt-office was found to produce 21,500l. annually. In 1685 it was made over to the king as a branch of his private income, and was then eſtimated at 65,000l. *per annum.* The year after the revolution the amount of the poſt-office revenue was 90,504l. 10s. 6d At the union the produce of the Engliſh poſt-office was ſtated to be 101,101. In 1711 the former eſtabliſhments of ſeparate poſt-offices for England and Scotland were aboliſhed; and by the ſtat. 9 Anne, c. 10. one general poſt-office, and one poſtmaſter-general, was eſtabliſhed for the whole united kingdom; and this poſtmaſter was empowered to erect chief letter-offices at *Edinburgh*, at *Dublin*, at *New York*, and other proper places in America and the Weſt Indies. The rates of poſtage were alſo increaſed at this time as follows.—In England, for all diſtances under 80 miles 3d.; above 80 miles 4d. From London to Edinburgh 6d. In Scotland, under 50 miles 2d.; from 50 to 80 miles 3d.; above 80 miles 4d. In Ireland, under 40 miles 2d.; above 40 miles 4d. By the above act all perſons, except thoſe employed by the poſtmaſter, were ſtrictly prohibited from conveying letters. That year the groſs amount of the poſt-office was 111,461l. 17s. 10d. The net amount, on a medium, of the three preceding years, was, in the printed report of the commiſſioners, for the equivalent ſtated to be for England, 62,000l. and for Scotland 2000l. In 1754, the groſs revenue of the poſt-office for Great Britain amounted to 210,663l. in 1764 to 281,535l. and in 1774 to 345,321l. The privilege of franking letters had been enjoyed by members of parliament from the firſt erection of the poſt-office; the original deſign of this exemption was, that they might correſpond freely with their conſtituents on the buſineſs of the nation. By degrees the privilege came to be ſhamefully abuſed, and was carried ſo far, that it was not uncommon for the ſervants of members of parliament to procure a number of franks for the purpoſe of ſelling them; an abuſe which was eaſily practiſed, as nothing more was required for a letter's paſſing free than the ſubſcription of a member on the cover. To reſtrain theſe frauds, it was enacted, in 1764, that no letter ſhould paſs free unleſs the whole direction was of the member's writing, and his ſubſcription annexed. Even this was found too great a latitude; and by a new regulation in 1784, no letter was permitted to go free unleſs the date was marked on the cover in the member's own hand-writing, and the letter put into the poſt-office the ſame day. That year the rates of poſtage were raiſed in the following proportions: an addition of 1d. for a ſingle ſtage; 1d. from London to Edinburgh; 1d. for any diſtance under, and 2d. for any diſtance above, 150 miles. An addition to the revenue of 120,000l. was eſtimated to ariſe from theſe regulations and additional rates. In all the ſtatements of duties upon poſtage of letters given in this account, the rates mentioned are thoſe upon ſingle letters, double letters pay double, treble letters treble, an ounce weight quadruple poſtage; all above are charged by the weight in the ſame proportion.

About the year 1784, a great improvement was made in the mode of conveying the mails, upon a plan firſt ſuggeſted in 1782 by Mr. John Palmer. Diligences and ſtage-coaches, he obſerved, were eſtabliſhed to every town of note in the kingdom; and he propoſed that government, inſtead of ſending the mails in the old mode, by a boy on horſeback, and in carts, ſhould contract with the maſters of theſe diligences to carry the mail, along with a guard for its protection. This plan, he ſhowed, could not fail to enſure much more expeditious conveyance, the rate of travelling in diligences being far quicker than the rate of the poſt; and it was eaſy to carry it into execution with little additional expenſe, as the coach-owners would have a ſtrong inducement to contract at a cheap rate for conveying the mail, on account of the additional recommendation to paſſengers their carriages would thereby acquire in point of ſecurity, regularity, and diſpatch.

Though government heartily approved of this plan, and the public at large were ſatisfied of its utility; yet, like all new ſchemes, however beneficial, it met with a ſtrong oppoſition: it was repreſented by a number of the oldeſt and ableſt officers in the poſt-office, not only as impracticable, but dangerous to commerce and the revenue. Notwithſtanding this oppoſition, however, it was at laſt eſtabliſhed, and gradually extended to many different parts of the kingdom; and, upon a fair compariſon, it appeared that the revenue was very conſiderably improved, though Mr. Palmer's numerous reforms, and the great number of new appointments which they rendered neceſſary, greatly increaſed the former expenſe of management. The conveyance of the mails on the new plan was contracted for, after the two firſt years trial, at 20,000l. *per annum* leſs than the ſum firſt eſtimated by Mr. Palmer.

The preſent eſtabliſhment of the general poſt office for Great Britain, conſiſts of a poſtmaſter-general, to the duties of which ſtation there have, for many years paſt, been two perſons appointed under the title of joint poſtmaſters-general; a ſecretary, upwards of 150 aſſiſtants and clerks for the head letter-office in London, under the direction of a ſuperintending preſident of the inland letter department, and a comptroller of the foreign letter-office. Near 600 deputy poſtmaſters, throughout the kingdom, act under one principal and 9 riding ſurveyors. There are alſo diſtinct offices and clerks acting under an accomptant-general and a receiver-general, as well as a ſeparate eſtabliſhment for the penny-poſt, which, ſince the abolition of Mr. Palmer's appointment of ſurveyor and comptroller-general, has been new modelled and greatly improved in all its branches. There is likewiſe a poſtmaſter-general of Scotland with a ſecretary, comptroller, ſurveyors, and a ſeparate eſtabliſhment of all the requiſite officers and clerks at Edinburgh, acting under the orders of the joint poſtmaſters-general in London. The annual expenſe of management is about 150,000l. and the groſs produce exceeds 700,000l. a year.

The firſt accounts we have of the eſtabliſhment of a poſt-office in Scotland reach no further back than 1635, when Charles I. erected one both for Scotland and England. The poſt to Scotland by that appointment was to run night and day, to go from London to Edinburgh and to return in *ſix* days, taking with it all letters intended for any poſt-town in or near the road; the rate of poſtage from London to Edinburgh was 8d. for a ſingle letter. The expedition with which the poſt went from London to Edinburgh at this time, is indeed ſurpriſing, conſidering the nature of the roads; perhaps, however, though the king made the regulation that it ſhould go and return in ſix days, the journey was not always performed in the ſpecified time. During the government of Cromwell, the public poſt conveyed letters to Scotland as well as England; the poſtage from London to Scotland was only 4d. After the Reſtoration, when the poſt-office was erected for England, mention is made in the act of parliament of the conveyance of letters to Scotland; and the poſtage to Berwick is fixed at 3d. For ſome time after, however, we find no eſtabliſhment by act of parliament of an internal poſt in Scotland. In 1662, a poſt between Ireland and Scotland was firſt eſtabliſhed; and the privy council gave Robert Main, who was then poſtmaſter-general for Scotland, an allowance of 200l. Sterling to build a packet-boat for conveying the mail between Portpatrick and Donaghadee: the poſtage to Ireland was 6d. In 1669, a poſt was eſtabliſhed to go between Edinburgh and Aberdeen twice a week, and between Edinburgh and Inverneſs once a week: the rate of poſtage was fixed, for 40 Scots miles 2d. and for every 20 miles further an additional penny. Theſe appear to have been the only *public* poſts in Scotland at that time; but as they could not ſuffice for the correſpondence of the country, there muſt have been more either under the direction of the poſtmaſter, or in the hands of private perſons; probably there might be of both kinds. In 1690, an act for the ſecurity of the common poſt was paſſed, ſubjecting robbers of the mail to capital puniſhment. It was not till 1695 that the eſtabliſhment of the poſt-office in Scotland received the ſanction of parliament; poſts were then appointed for all parts of Scotland; the rates of poſtage were fixed for any place within 50 miles of Edinburgh 2d. between 50 and 100 miles 3d. all places above 100 miles 4d. By the ſame act a weekly packet to Ireland was eſtabliſhed, and 60l. ſterling annually allowed for that ſervice. Though poſts were eſtabliſhed in conſequence of this act, yet ſuch was their mode of travelling, that they hardly deſerved the name. Thus, for inſtance, the perſon who ſet out to carry the mail from Edinburgh to Aberdeen, in place of ſtopping at the firſt intermediate ſtage from Edinburgh, and delivering over the mail to another, to be carried forward, went on with it himſelf the whole journey, reſting two nights by the way, firſt at Dundee, and next at Montroſe.

In this manner the mail was conveyed thrice a week from Edinburgh to Aberdeen; but between moſt parts of Scotland the poſt went only twice, and between ſome only once a week. The poſt-boy generally travelled on foot. Horſes were but little uſed in the ſervice of the poſt-office.

At the Union, the Scots poſt-office was farmed for 1194l.: in 1710, the net amount for Scotland was reckoned to be 2000l. The epiſtolary correſpondence of Scotland muſt have been ſmall indeed, when even the rates of poſtage then eſtabliſhed proved ſo very unproductive. This may perhaps, however, be in part accounted for, by conjecturing, that as private poſts had probably prevailed pretty much before 1695, it was long before theſe were entirely ſuppreſſed, the people ſtill adhering to their old conveyances, and difficulties occurring in ſtrictly enforcing the law; the amount of the poſt-office revenue, therefore, at the two periods above-mentioned probably exhibits a view of only a part of the correſpondence of Scotland.

In 1711, it has been already mentioned, one general poſt-office was eſtabliſhed for the whole united kingdom; but the poſt-maſter-general was authoriſed to erect at Edinburgh a chief letter-office for Scotland.—This was accordingly done, and a poſt-maſter-general for North Britain, with other neceſſary officers, appointed. All the deputy poſt-maſters in Scotland are under his immediate direction, but he himſelf is under the controul of the poſtmaſter-general for Great Britain. From this head letter-office poſts were eſtabliſhed to the different parts of Scotland.

For many years the poſt-boys generally travelled on foot, or if on horſeback, without a change of horſes. It was not till about 1750 that the mail began to be conveyed from ſtage to ſtage by different poſt-boys and freſh horſes to the principal places in Scotland, and by foot runners to the reſt. The communication between London and Edinburgh was at firſt but thrice a week, and ſo ſlow that the mail from London to Edinburgh was upon the road 85 hours, and from Edinburgh to London 131 hours. In 1757, upon a repreſentation from the royal boroughs, regulations were fallen upon, by which the time was ſhortened to 82 hours in the one caſe, and 85 in the other. By the extenſion of Mr. Palmer's plan to Scotland, the time has been ſtill further ſhortened to about 60 hours in each caſe.

The eſtabliſhment of the Scots poſt-office, which has been gradually enlarged as the ſtate of the country required, conſiſts at preſent of a poſtmaſter-general, ſecretary, ſolicitor, and accountant, with a number of other clerks and aſſiſtants for the head office at Edinburgh; under its management are about 180 deputy poſtmaſters for the different poſt-towns through Scotland.

The net produce of the poſt-office for Scotland in 1733 was 5399l. in 1751, 8927l. in 1757, 10,623l. in 1760, 11,942l. in 1776, 31,103l. In 1788 the groſs produce was 55,836l. the expenſe 22,636l. 13s. 6d; in 1793 the groſs amount was about 64,000l. the net produce about 40,000l.

Penny-Post, a poſt eſtabliſhed for the benefit of London and other parts adjacent, whereby any letter or ſmall parcel is ſpeedily and ſafely conveyed to and from all places within the bills of mortality, or within ten miles of the city. It is managed by particular officers, and receiving-houſes are eſtabliſhed in moſt of the principal ſtreets for the more convenient tranſmiſſion of the letters. Some other large towns have inſtituted ſimilar eſtabliſhments.

About 20 years ago a penny poſt was ſet up in Edinburgh by an individual, unconnected with the general poſt-office. It met with but indifferent encouragement for ſome years, doubts being entertained as to its punctuality in delivering the letters; by degrees, however, it ſeemed to be advancing in eſtimation, and was more frequently employed. About a year ago, the general poſt-office, in virtue of the act of parliament prohibiting the conveyance of letters by any but thoſe employed under the poſt maſter-general, took the penny poſt entirely into its own hands; and at preſent letters are tranſmitted from the general poſt-office to the different quarters of Edinburgh and the ſuburbs, three or four times a-day.

Post, a particular mode of travelling. A perſon is ſaid to *travel poſt*, in contradiſtinction to common journey travelling, when, in place of going on during his whole journey in the ſame vehicle, and with the ſame horſes, he ſtops at different ſtages, to provide freſh horſes or carriages for the ſake of greater convenience and expedition. As he thus uſes the ſame mode of travelling that is employed for the common poſt, he is ſaid to travel poſt, or in poſt, *i. e.* in the manner of a poſt.

In tracing the origin of poſts, it has been already remarked, that the more ancient eſtabliſhments of this kind were fully as much for *travelling ſtations* as the conveyance of letters. The relays of horſes provided at theſe public ſtations for the meſſengers of the prince, were occaſionally, by ſpecial licence, allowed to be uſed by other travellers who had ſufficient intereſt at court. Frequent demands of this nature would ſuggeſt the expedient of having in readineſs ſupplies of freſh horſes or carriages over and above what the *public* ſervice required, to be hired out to other travellers on payment of an adequate price. We find, therefore, that in former times the poſtmaſters alone were in uſe to let out horſes for riding poſt, the rates of which were fixed in 1548 by a ſtatute of Edward VI. at one penny *per* mile. In what ſituation the ſtate of the kingdom was with regard to travelling poſt for more than a century after this period, we cannot now certainly diſcover; but in the ſtatute re-eſtabliſhing the poſt-office in 1660, it is enacted, that none but the poſtmaſter, his deputies, or aſſigns, ſhall furniſh poſt-horſes for travellers; with a proviſo, however, that if he have them not ready in half an hour after being demanded, the traveller ſhall be at liberty to provide himſelf elſewhere.

The ſame prohibition is contained in the act eſtabliſhing the Scots poſt-office in 1695, as well as in the ſubſequent act of Queen Anne, erecting the general office for the united kingdom. It is doubtful, however, whether it ever was ſtrictly enforced. By an explanatory act of 26 Geo. II. the prohibition is confined to poſt *horſes* only, and every perſon declared to be at liberty to furniſh *carriages* of every kind for riding poſt. This regulation has, in fact, done away the prohibition, as hardly any perſon now thinks of travelling poſt except in a carriage.

The rate fixed by the act 1695, in Scotland, for a horſe riding poſt, was three-pence *per* Scotch mile. By the act 9. Anne, c. 10. three-pence a mile without, and four-pence a mile with, a guide, was the ſum fixed for each horſe riding poſt. The increaſe of commerce, and neceſſity for a ſpeedy communication between different parts of the kingdom, have brought the mode of travelling poſt ſo much into uſe, that upon every great road in the kingdom poſt-chaiſes are now in readineſs at proper diſtances; and the convenience of poſting is enjoyed in Britain to a degree far ſuperior to what is to be met with in any other country whatever.

Poſting at laſt appeared to the legiſlature a proper object of taxation. In 1779 the firſt act was paſſed, impoſing duties on horſes hired either by themſelves or to run in carriages travelling poſt: the duties were, one penny *per* mile on each horſe if hired by the mile or ſtage, and one ſhilling *per* day if hired by the day. Every perſon letting out ſuch horſes was alſo obliged to take out a licence at five ſhillings *per annum*. Theſe duties were next year repealed, and new duties impoſed, of one penny *per* mile on each horſe hired by the mile or ſtage, and 1s. 6d. on each if hired by the day. A number of additional regulations were at the ſame time enacted for ſecuring theſe duties. An addition of one halfpenny *per* mile, or three-pence *per* day, for each horſe riding poſt, was impoſed in 1785, by Stat. 25 Geo. III. c. 51. The duty is ſecured, by obliging every letter of horſes to deliver to the perſon hiring them a ticket, expreſſing the number of horſes hired, and either the diſtance in miles to be travelled, or that the horſes are hired by the day, as the caſe happens to be. Theſe tickets muſt be delivered to the bar-keeper at the firſt turnpike through which the traveller paſſes; and the turnpike-keeper gives, if demanded, what is termed an *exchange* ticket, to be produced at the next turnpike. The ſtamp-office iſſues to the perſon licenced to let poſt-horſes ſuch a number of theſe tickets as is required, and theſe muſt be regularly accounted for by the perſon to whom they are iſſued. As an effectual check upon his account, the turnpike-keeper is obliged to return back to the ſtamp-office all the tickets he takes up from travellers. Evaſions are by theſe means rendered difficult to be practiſed without running a great riſk of detection. In 1787, for the more effectually levying the poſt-horſe duties, a law was paſſed, authoriſing the commiſſioners of the ſtamp-office to let them to farm by public auction, for a ſum not leſs than the produce in the year ending 1ſt. Auguſt 1786.

In the advertiſement publiſhed by the commiſſioners in conſequence of this law, previous to the receiving propoſals for farming them, the total amount of the duty for Great Britain is ſtated to have been, at the period above referred to, 119,873l. The ſum for which that duty was farmed in 1794 amounted in all to 140,030l. of which the diſtrict of North Britain was 6000l.

Soon after the tax was impoſed, conſiderable difficulties were raiſed about the meaning of the term *poſting*, and what mode of journeying ſhould ſubject travellers to duty. The old law, Stat. 9 Anne, c. 10. explained poſting to be "travelling ſeveral ſtages, and changing horſes;" but the acts impoſing the poſting duties expreſsly declare, that "every horſe hired by the mile or ſtage ſhall be deemed to be hired to travel poſt, although the perſon hiring the ſame doth not go ſeveral ſtages upon a poſt road, or change horſes;" and that "every horſe hired for a day or leſs period of time, is chargeable with the duty of three halfpence *per* mile, if the diſtance be then aſcertained; and if the diſtance be not then aſcertained, with 1s. 6d. each horſe." Horſes hired for any leſs time than two days are by theſe acts to be deemed to be hired for a day. An action was brought in 1788, in the court of exchequer at Edinburgh, to determine whether ſeveral diſputed caſes fell under the meaning of the act, and were liable to duty; when the following deciſions were given:

Saddle-horſes both hired and paid by the mile, and ſaddle-horſes hired originally for an excurſion, but afterwards paid by the mile, were found liable to duty according to the number of miles paid for; carriage-horſes, where the carriage is hired and paid for only at the uſual rate of *outgoing* carriages and no more, whether the perſon hiring it do or do not return in it, were found liable to duty only for the number of miles *out*; but if the carriage be hired and paid for, or actually paid for though not originally hired, at the uſual rate of carriages employed both to carry out and bring back the ſame company, the duty was found to be exigible according to the number of miles both out and home taken together. Hackney-coaches in Edinburgh, hired and paid for leſs than two miles, were found liable to duty for one mile.

No duty was found to be exigible on ſaddle-horſes hired for a mere excurſion, and paid for accordingly, where the diſtance neither is nor can be aſcertained; on hackney-coaches employed in the ſtreets for leſs than a mile, or for an excurſion or round of viſits merely; and on horſes or carriages hired for a journey of three days or more, and paid for accordingly, or paid for at the rate of three days, though the journey ſhould actually be performed in two full travelling days. The general rule of theſe deciſions was, that in every caſe, except unaſcertainable diſtance, or journeys exceeding two days, the mode of travelling fell under the legal definition of poſting. The only point that may ſeem doubtful in the judgments here ſtated, is that where the duty is found chargeable by the number of miles both going and returning. Yet as the law expreſsly declares, that horſes hired by the mile or ſtage are to be deemed *poſting*, and as the number of miles for which they are hired can only be aſcertained by the number paid for, it is clear, that where an addition to the outgoing charge is made on account of bringing back the perſon hiring the carriage, the carriage in that caſe is actually hired and paid for according to the number of miles both out and home, and the duty muſt fall to be rated accordingly. The doubtful points being now ſettled by the above deciſions, the mode of levying the duty in Scotland has been regulated agreeably to them ever ſince the matter was thus determined.

POSTERIOR, a term of relation, implying ſomething behind, or that comes after, another, In which ſenſe it is uſed in oppoſition to *prior* and *anterior*. The back and hips are the poſterior parts of man. Ariſtotle has given prior and poſterior analytics. A date is poſterior to another when it is later or freſher.

POSTERN, in fortification, a ſmall gate, uſually made in the angle of the flank of a baſtion, or in that of the curtain, or near the orillon, deſcending into the ditch; whereby the garriſon can march in and out, unperceived by the enemy, either to relieve the works, or to make private ſallies, &c. The word is alſo uſed in the general for any private or back-door.

POSTHUMOUS, a child born after the death of his father, or taken out of the body of a dead mother: from whence it is frequently applied to the works of an author not publiſhed till after his deceaſe.

POSTIL, a name anciently given to a note in the margin of the Bible, and afterwards to one in any other book poſterior to the text.

POSTING, among merchants, the putting an account forward from one book to another, particularly from the journal or waſte-book to the ledger. See POST and BOOK-KEEPING.

POSTLIMINIUM, among the Romans, the return of one who had gone to ſojourn elſewhere, or had been baniſhed, or taken by an enemy, to his own country or ſtate.

POSTPONING, putting any thing after or behind another with regard to time.

POSTSCRIPT, an article added in a letter or memoir, containing ſomething learnt or recollected after the piece was written.

POSTULATE, in mathematics, &c. is deſcribed to be ſuch an eaſy and ſelf-evident ſuppoſition, as needs no explication or illuſtration to render it intelligible; as that a right line may be drawn from one point to another.

POSTURE, in painting and ſculpture, the ſituation of a figure with regard to the eye, and of the ſeveral principal members thereof with regard to one another, whereby its action is expreſſed. A conſiderable part of the art of a painter conſiſts in adjuſting the poſtures, in giving the moſt agreeable ones to his figures, in accommodating them to the characters of the reſpective figures, and the part each has in the action, and in conducting and in purſuing them throughout.

Poſtures are either natural or artificial. *Natural* poſtures are ſuch as nature ſeems to have had a view to in the mechaniſm of the body, or rather ſuch as the ordinary actions and occaſions of life lead us to exhibit while young, and while the joints muſcles, ligaments, &c. are flexible. *Artificial* poſtures, are thoſe which ſome extraordinary views or ſtudies occaſion us to learn; as thoſe of dancing, fencing, &c. Such alſo are thoſe of our balance and poſture-maſters.

A painter would be ſtrangely puzzled with the figure of Clark (a late famous poſture-maſter in London) in a hiſtory-piece. This man, we are told in the Phil. Tranſ., had ſuch an abſolute command of his muſcles, &c. that he could disjoint almoſt his whole body; ſo that he impoſed on the great ſurgeon Mullens, who looked upon him as in ſuch a miſerable condition, he would not undertake his cure. Though a well-made man, he would appear with all the deformities imaginable; hunch-backed, pot-bellied, ſharp-breaſted, &c. He disjointed his arms, ſhoulders, legs, and thighs; and rendered himſelf ſuch an object of pity, that he has frequently extorted money in quality of a cripple, from the ſame company in which he had the minute before been in quality of a comrade. He would make his hips ſtand a conſiderable way out from his loins, and ſo high as to invade the place of his back. Yet his face was the moſt changeable part about him, and ſhowed more poſtures than all the reſt; inſomuch that it is ſaid he could exhibit all the uncouth odd faces of a Quaker's meeting.

POTAMOGETON, POND-WEED. A genus of the tetragynia order, belonging to the tetrandria claſs of plants; and in the natural method ranking under the 15th order, *Inundatæ*. There is no calyx; but four petals; no ſtyle, and four ſeeds. There are 12 ſpecies, all of them floating vegetables on the ſurfaces of ſtagnant waters, affording an agreeable ſhade to fiſh, and food to cattle.

POTAMON or POTAMO, was a philoſopher of Alexandria. He kept a middle courſe between the ſcepticiſm of the Pyrrhonians and the preſumption of the dogmatiſts; but attached himſelf to none of the ſchools of philoſophy of his time. He was the firſt projector of the Eclectic ſect; for though that mode of philoſophiſing had been pretty common before, he was the firſt that attempted to inſtitute a new ſect on this principle. "Diogenes Laertius relates, that not long before he wrote his Lives of the Philoſophers, an Eclectic ſect, εκλεκτικη τις αἱρεσις, had been introduced by Potamo of Alexandria, who ſelected tenets from every former ſect. He then proceeds to quote a few particulars of his ſyſtem from his Eclectic inſtitutes, reſpecting the principles of reaſoning, and certain general topics of philoſophical inquiry; from which nothing further can be learned, than that Potamo endeavoured to reconcile the precepts of Plato with thoſe of other maſters. As nothing remains concerning this philoſopher beſides the brief account juſt referred to in Laertius, an obſcure paſſage in Suidas, and another ſtill more obſcure in Porphyry; it is probable that this attempt to inſtitute a ſchool upon the Eclectic plan proved unſucceſsful. The time when Potamo flouriſhed is uncertain. Suidas places him under Auguſtus; but it is more probable, from the account of Laertius, that he began his undertaking about the cloſe of the ſecond century." *Enfield's Hiſtory of Philoſophy.*

POTASH, the lixivious aſhes of certain vegetables, uſed in making of glaſs, ſoap, &c. See GLASS, SOAP, &c. The method of making potaſh is directed by Dr. Shaw as follows. Burn a quantity of billet-wood to gray aſhes; and taking ſeveral pounds of theſe aſhes boil them in water, ſo as to make a very ſtrong lixivium, or lye. Let this lye be ſtrained through a coarſe linen cloth, to keep out any black parts of the half-burnt wood that might happen to remain in the aſhes; then evaporate this ſtrained lye in an iron-pan over a quick fire almoſt to dryneſs: then taking out the matter remaining at the bottom, and putting it into an iron crucible, ſet it in a ſtrong fire till the matter is melted, and then immediately pour it out upon an iron-plate, where it ſoon cools, and appears in the form of a ſolid lump of potaſh. Much after this manner is pot-aſh made in the large way of buſineſs, for the ſervice of the ſoap-boiler, glaſs-maker, fuller, &c. but according to the difference of the wood, or combuſtible matter employed, with the manner of turning it, and conducting the proceſs, different kinds of potaſh are prepared. There are certain ſaline plants that yield this potaſh to great advantage, as particularly the plant kali; there are others that afford it in leſs plenty, and of an inferior quality, as bean-ſtalks, &c. but in general all vegetable ſubjects afford it of one kind or other, and may moſt of them be made to yield it tolerably perfect after the manner of the proceſs already laid down, even the loppings, roots, and refuſe parts of ordinary trees, vine clippings, &c. The fixed ſalts of all vegetables excepting the kali and marine plants, when reduced to abſolute purity, or entirely ſeparated from the other principles, appear to be one and the ſame thing: whence it ſhould ſeem, ſays Dr. Shaw, that, by a ſuitable management, good ſaleable potaſh might be made in all places where vegetable matters abound. For if by examining Ruſſia* potaſh, for example, we find that its ſuperior excellence depends upon its being clear of earth, or upon its containing a large proportion of oil, or refined ſalt, theſe advantages may, by properly regulating the operation, be given to Engliſh potaſhes, ſo as perhaps to render the latter as good as the former: but where the potaſh of any remarkable ſaline vegetable is to be imitated, that of the kali for example, the Doctor recommends a prudent ſprinkling of the ſubject with ſalt, or ſea-water, in the burning; and by theſe ways, properly diverſified, any principle that is naturally wanted might be artificially introduced ſo as to perfect the art of potaſh.

About 40 years ago or upwards, Mr. Stephens, encouraged by the Society of Arts, &c. and by a parliamentary grant of 3000l. eſtabliſhed a manufacture of pot-aſh in North America, which produced ſuch as was ſo perfectly good as to anſwer in bleaching and other uſes the purpoſes of *pearl-aſh*; and which at the ſame time afforded a very large produce. But the very great heat which his proceſs required, occaſioned the deſtruction of a very extenſive apparatus; and other circumſtances concurred to diſappoint the hopes and check the ſpirit of the proprietors. The manufacture was, however, afterwards undertaken and proſecuted by others. Mr. Stephens's apparatus was as follows: See plate 20, fig. 1. A is the bed of the kiln, which flies off about four feet by two from the grate, more or leſs according to the ſize; C is the aſh-hole, 2½ or 3 feet deep. Fig. 2. B repreſents quadrangular bars of iron, with their oppoſite angles placed upwards and downwards, not above an inch aſunder. Fig. A, B, and C, are three ſteepers five feet deep, and of any width from four to eight feet ſquare, of the beſt white pine or cypreſs plank, with ſquare joints and ſtrong oak frames, placed each over a receiver, with a cock to let off the lye, and a vent juſt beneath the ſurface of the grating. E repreſents three receivers, ſtanding each under, and projecting out from, its ſteeper. They muſt be made of the beſt ſtuff, carefully put together, and laid in tough clay, well rammed within the ground, their tops being level with the ſurface: they need not be ſo large as the ſteepers by ſix, eight, or twelve inches. Fig. 4. E repreſents a falſe bottom or lattice of boards, eight inches deep and five ſquare, with a hole in the under edge of every partition for the lye to paſs into the ſteeper. Fig. 5. A is the veſſel over the furnace in which the lye and aſhes are mixed; B is a hole or funnel a few inches from the back of the furnace, with an iron ſocket to let the pipe through the hinder part of the arch, to reach down within two inches of the floor of the furnace. C is a caſt iron cauldron for boiling the lye to dryneſs when pearl-aſh is made. D is a veſſel whence the liquor is let into the cauldron as it evaporates. The mortar for building the furnace ſhould be made of loam; the arch ſhould be 18 inches thick, and the floor laid with tiles on a layer of ſand an inch thick, with neat joints.

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[*] According to Sir Peter Warren, the beſt woods for making Ruſſia potaſh are, oak, aſh, poplar, hiccory, elm, hazle, and beech. They muſt be cut in November, December, January, and February, ſplit and ſtacked to dry. After 12 months in warm open weather, it muſt be burnt on a brick hearth by a ſlow fire in a kiln, or cloſe place; the aſhes muſt be ſifted through two ſieves, one finer than the other, and then put up in brick troughs or wooden backs, covered with rain or river water, and muſt remain well marſhed and incorporated five months. Brick furnaces ſhaped like bakers ovens muſt be heated with a ſtrong fire of oak or aſh, burning night and day; the prepared aſhes muſt be gradually thrown on the fire, when they will run into metal like lead: the fire muſt not go out till the furnace is nigh filled with potaſhes. The aſhes muſt then be broken to be taken out, but the larger the pieces the better; they muſt be preſerved from the air in tight caſks, the large pieces by themſelves, and the duſt by itſelf.

Mr. Stephens's proceſs, both with and without the kiln, was as follows. Cut timber, felled at any ſeaſon, into lengths of about eight feet; lay from three to ten of them lengthwiſe in a heap upon dry ground, and fill the vacancies between with ſmaller wood: the ſooner it is burnt after felling, the better. Set fire to it by laying embers on the bottom logs at each end; and for burning the bruſh and lappings, with other ſmaller woods, lay them lengthwiſe on the ground, top to top, lapping over a little, with the butt ends outwards, and as cloſe as a faggot; laying the larger woods on top till the heap is full four feet high; the length of the bruſh ſet againſt each other making the breadth of the heap. As to the choice of the timber, old hollow trees, if not dead, are beſt: pine, cypreſs, and cedar, are to be totally rejected.

As ſoon as the pile is burnt down, rake ſuch aſhes as lie round the outſide a little in towards the middle; add no freſh fuel, nor throw on any brands. Let the aſhes lie without ſtirring till you can juſt bear your hand in them; then carry them to a houſe, or under a ſhed, on a plank floor raiſed a little from the earth and well jointed; there wet them till brought nearly to the conſiſtence of mortar in the firſt mixture of lime and ſand, and ram them in a heap, in which they muſt lie full 20 days, or ſome months if you pleaſe; obſerving to be more ſparing of water in winter, and ramming them cloſer, and ſometimes wetting the top that it may never grow quite dry.

Wood may alſo be burned in a kiln, as fig. 1 and 2; and then it muſt be cut into ſuch lengths as may be moſt convenient for carriage, and beſt ſuit the ſize of the kiln. The mouth of the aſh-hole muſt be cloſe ſtopped by daubing the joints of the lid with loam, or throwing a bank of ſand or earth againſt it: keep the bed of the kiln filled with wood up to the ſurface, but not above it, and let it burn inceſſantly till the aſhes riſe within ſix or eight inches of the grate. Draw them out whilſt red-hot, and in that ſtate ſprinkle them with lye, from four to ſix caracts weight; weigh a ſmall vial which holds about four ounces very exactly; then fill it with water and weigh that alſo: divide the weight of the water into equal parts till you come to $\frac{1}{128}$ of the whole, which is called a *caract*, $\frac{1}{64}$ two caracts, &c. until you have a weight equal to $\frac{1}{4}$ of the whole water, which is called 32 caracts: all which ſmall weights, together with one equal to the phial filled with water, are to be kept for weighing the lye in the ſaid phial till they are made damp; then ram them as before in a heap, but ſeparate from the aſhes made as above. N. B. By kiln-burning a ſtronger lye may be more certainly procured than by the other way, where rain may chance to fall on the aſhes before they can be removed.

The aſhes thus prepared are to be put in vats or ſteepers fig. 3, with a falſe latticed bottom as fig. 4; firſt putting coarſe wheat or rye ſtraw about a foot thick on the lattice or grating; on which put aſhes to within four or five inches of the top, ramming them all the way up, eſpecially at the ſides, with a ſmall light rammer, as tight as you can, without burſting the vat. Form on the top of the ſteeper a hollow baſon in the aſhes four or five inches deep, leaving the aſhes four or five inches thick on the ſides, by raiſing a ſmall bank round the ſides, ſo that the liquor may not overflow the edges of the aſhes at top: keep this baſon conſtantly filled with ſoft water in the ſteeper A, until the aſhes will imbibe no more, which will be in 24 hours or more, according as it is rammed; then turn the cock, and let off what ſhall be ſoaked through into the receiver or lower chamber of the ſteeper, and no more; for if the ſeveral runnings be not kept ſeparate, the lye will not be brought to its due ſtrength. Follow that ſteeper with freſh water on the ſame aſhes for ſeveral other runnings, which will each come off in a few days, till the liquor has neither ſmell nor taſte; then heave out the aſhes, and charge the ſteeper afreſh.

Upon drawing off the firſt running from the ſteeper A, fig. 3. fill the ſteeper B with aſhes as before, and put into its hollow at the top the lye ſo firſt run off, and the ſmaller or half lyes alſo, till full, and draw off as directed for the ſteeper A: if this weighs 18 caracts or more, pump it into the ciſtern F as fit for uſe; if it be ſhort of that, paſs it off as half lye to the ſteeper C, and through freſh aſhes till ſtrong enough. With kiln-aſhes only, from water paſſing through the firſt ſteeper, it will be ſtrong enough for the ciſtern, if the aſhes be well prepared. If your water be hard, let it ſtand two or three days expoſed to the air and ſun in a ſhallow back, and it will be ſoft. When you uſe kiln-aſhes with others, lay them at bottom.

The lye muſt be conveyed from the ciſtern F, as it is wanted to the veſſel A fig. 5; where with every gallon of proof lye mix three ounces of fine, light, wood aſhes: and to the lye that is $\frac{1}{4}$ over-proof put ſix ounces of aſhes; and if $\frac{2}{5}$ over-proof 12 ounces, increaſing or leſſening according to the ſtrength of the lye.

For evaporating the lye and melting the ſalt, heat a furnace till you bring it very near a white heat, of which the ſide doors being red-hot is a mark. This will take 48 hours or more, if the furnace be quite cold; when thorough hot, a little fuel keeps it ſo. Then, through the cock of the veſſel A, paſs the mixture by the funnel B into the furnace, not ſo as to reach much beyond the middle of the floor, before it changes from dark to bright red, letting the heat prevail towards front or back as you ſee neceſſary. When the maſs begins to gather about the flues or in heaps, run in no more till the furnace is cleared by driving the fire backward. You muſt have two funnels, one ſoon choaking: in an hour or leſs will iſſue out a red-hot ſtream of melted ſalt, which is potaſh, to be broke to pieces as ſoon as cold, and packed in tight cloſe caſks, being in no reſpect inferior to the beſt foreign aſh whatever.

The beſt potaſh is made from barilla, and comes from Spain. The plants from which it is procured are found in great plenty about Carthagena, where they are indigenous, and may be collected in a ſwamp called *Almojar* eaſt of that place; the *Sayones* barilla is the beſt. They are found, beſides all along that coaſt, on the borders of the Mediterranean for 60 leagues in length and 8 in breadth. About 150,000 quintals of it are annually exported from Spain. It produces a revenue of 25,500l. a year; each quintal paying a duty of 17 reals: yet Don Bernardo de Ulloa, A. D. 1740, ſays it was farmed at 1822l. 4s. 3d. M. Macdonnell has brought the manufacture of potaſh to its preſent perfection in Spain; but its exportation is materially injured by the heavy tax on it. See Townſhend's *Travels*, vol. iii. p. 131. See alſo BARILLA, KELP, and FUCUS.

In the 70th volume of the Philoſophical Tranſactions we have an account of a method of procuring this ſalt from the putrid water which runs from dunghills. The proceſs is very eaſy, conſiſting only in ſimple evaporation of the fluid, and calcining the impure ſalt till moſt of the foulneſs is burnt out. From 24 wine-pipes full of this muck-water were obtained 9 cwt. 1 qr. 12 lb. of ſaleable pot-aſh, valued at 42s. *per* cwt; the expence of manufacturing them being only valued at 4l. 9s.

The potaſh thus made is of a grayiſh white appearance; deliqueſces a little in moiſt air; but if kept in a dry room, near the fire, acquires a powdery ſurface. It is hard and of a ſpongy texture when broken, with many ſmall cryſtals in its ſubſtance. The colour of its internal parts is duſky and variegated. To the taſte, it is acrid, ſaline, and ſulphureous. It emits no ſmell of volatile alkali, either in a ſolid form, diſſolved, or when added to lime-water; neither does it communicate the ſapphire-colour to a ſolution of blue vitriol. Silver is quickly tinged black by it; a proof that it contains much phlogiſton. Ten grains of this potaſh required 11 drops of the weak ſpirit of vitriol to ſeparate it. The like quantity of ſalt of tartar required 24 drops: a ſtrong efferveſcence occurred in both mixtures; and a ſulphureous vapour exhaled from the former. A tea ſpoonful of the ſyrup of violets diluted with an ounce of water was changed into a bright green colour by five grains of the ſalt of tartar; but ten grains of this potaſh were neceſſary to produce the ſame hue in a ſimilar mixture. Half an ounce of the ſalt diſſolved entirely in half a pint of hot water; but when the liquor was cold, a large purple ſediment ſubſided to the bottom; and it was found that this ſediment amounted to about two-thirds of the whole quantity of aſhes uſed.

Dr. Percival, the author of this paper, concludes with obſerving that this potaſh is a true fixed vegetable alkali, produced by putrefaction; that the quantity of alkali contained in it may be eſtimated at one-third of its weight, whereas the white Muſcovy aſhes are ſaid to yield only one-eighth part; that no quicklime appears to be contained in this potaſh, for a ſolution of it poured from its ſediment remained clear though long expoſed to the air: that it would be worth trying, whether the large purple ſediment, which ſubſides when this potaſh is lixiviated, might not be applied to the manufacture of Pruſſian blue, or uſed in the manner recommended by Macquer for dyeing wool and ſilks; and that this manufacture will furniſh the farmer with top-dreſſing for his garden and land, of great fertilizing powers. See *Phil. Tranſ.* vol. lxx. p. 345.

Theſe are the proceſſes moſt eſſentially different from one another which have appeared concerning the manufacture of this uſeful ſalt. Some indeed have attempted to compoſe it on the ſuppoſition that alkali conſiſted of an earth combined in a peculiar manner with a certain acid. But the little ſucceſs of all theſe attempts ſhows that they have been built on a falſe principle. The only method of producing alkaline ſalts originally is from the aſhes of vegetables; and the vegetable ſubſtances which yield the largeſt quantity of them are tartar and marine plants. From the former the pureſt and ſtrongeſt vegetable alkali is obtained, and from the latter the mineral alkali. From other vegetables, as fern, broom, bean-ſtalks, &c. an alkaline ſalt is produced, but ſo impure, and in ſuch ſmall quantity, that no manufacture of it can be eſtabliſhed in this country with any reaſonable expectations of profit.

Dr. Watſon (the preſent biſhop of Landaff) ſuggeſts, that the inveſtigation of a method of extracting its alkaline part from rock ſalt would be a moſt ſerviceable diſcovery. We have inexhauſtible mines of rock-ſalt in this country, which (he obſerves) the proprietors can afford at ten ſhillings a ton. A ton of rock-ſalt contains about half a ton of mineral alkali, which is for moſt purpoſes far preferable to potaſh. To thoſe who have leiſure to attempt ſuch a diſcovery, he gives the following hint: whether the alkaline part of rock-ſalt may not be obtained by calcining it in conjunction with charcoal in open fire? His reaſon for this conjecture is founded upon the following experiment: upon burning ſea-wreck to a black coal and ſtopping the proceſs at that point, he has obtained great plenty of common ſalt, but no mineral alkali from the black aſhes; though we are certain, that when the black aſhes are thoroughly calcined, or reduced to white aſhes, mineral alkali may be obtained from them. This makes it probable, that the common ſalt contained in the black aſhes of ſea-wreck is decompoſed, and changed into a mineral alkali, during the burning of the black aſhes. There are reaſons to ſuppoſe, that the cinder of pit-coal would anſwer the purpoſe better than charcoal. *Chem. Eſſ.* vol. i. p. 136, &c.

The potaſhes of different countries vary much in quality; and the experiments of Dr. Home, in his treatiſe on Bleaching, ſeem to ſet forth their different properties in the cleareſt point of view. The different kinds tried by him were,

1. *Blue pearl-aſhes.* Theſe appear to be a pure alkaline ſalt, mixed with a ſmall quantity of vitriolated tartar and earth. Half a pound of this, filtered and evaporated, yielded 5½ ounces of pure ſalt.—Here, however, we muſt obſerve, that though the quantity was ſo far diminiſhed by this operation, yet we are not to imagine that the whole of this diminution was owing to impurities; for all ſalts are deſtroyed in ſome meaſure by ſolution in water and exſiccation.

2. *White pearl-aſhes* are nearly of the ſame quality with the former; half a pound of them giving five ounces and ſeven drachms of pure ſalt, with ſome vitriolated tartar and earth.

3. *Ruſſia* or *Muſcovy aſhes* have very much the appearance of ſlacked lime, and are, like it, friable betwixt the fingers. They adhere to the tongue; and their alkaline taſte ſoon goes away, leaving in the mouth a ſtrong taſte of lime. Some ſmall bits of charcoal are obſervable in their compoſition, and they never turn moiſt in the air. Half a pound of the ſalt lixiviated with water and evaporated, gave only 10 drachms 15 grains of very cauſtic ſalt. Theſe conſiſt therefore of a ſmall quantity of alkaline ſalt united with a large quantity of lime.

4. *Caſhub-aſhes* are of the colour of iron ſtone, and extremely hard, with many ſhining particles of charcoal in them: They have a ſaline taſte, with a conſiderable degree of pungency; feel gritty in the mouth when broken in pieces by the teeth; and will diſſolve in water. To extract the pure ſalt, half a pound of the aſhes were boiled in a pint of water; then that water poured off, and half a pint put on the aſhes again; and ſo on, till the aſhes taſted no more ſalt. This boiling took 24 hours, and the laſt water that came off had a ſtrong taſte of ſulphur, and was blackiſh. A piece of ſilver put in the decoction was in a few minutes turned almoſt black; but though the decoction was evaporated conſiderably, it did not turn ſilver black more ſpeedily than before. The whole, when totally evaporated, yielded only 10 drams of a brown ſalt having a ſtrong cauſtic alkaline taſte. Some Caſhub-aſhes powdered, and often waſhed in water ſo that the ſalts were all carried off, were infuſed in water. After ſtanding ſome time, there was a weak lime-water, with ſomething of a ſaline taſte, but no pellicle. Some of this reſiduum was put into a reverberatory furnace for two hours; after which it afforded good lime-water. Caſhub-aſhes then appear to contain an earth half vitrified, ſome lime, alkaline ſalts, and a quantity of ſulphur.

5. *Marcoſt-aſhes* are of a paler colour than the former, with ſome ſmall pieces of charcoal in their compoſition. They have a ſtrong ſaline taſte; and ſo great pungency, that they cannot be held long in the mouth. Half a pound diſſolved in water, filtered and evaporated, yielded 11 drachms one ſcruple and two grains of alkaline reſiduum. The decoction blackened ſilver, but not ſo ſtrongly as the former; and by evaporation it quickly loſt that quality.

Our author next proceeds to conſider the probability of manufacturing theſe aſhes in this country. On which ſubject he has the following obſervations.—"The blue and white pearl-aſhes we have diſcovered to be pure alkaline ſalts, without any conſiderable mixture of heterogeneous bodies. Their purity ſhows the lixive to have been ſtrained through ſome cloſe ſubſtance, ſuch as linen or flannel. The blue aſhes ſhow by their colour that they have ſuſtained the moſt fire. But both of them are ſo much alike, that the one may be ſubſtituted for the other; and therefore we ſhall conſider them in one view.

"Every one knows that alkaline ſalts, ſuch as theſe, are got from all plants except the alkaleſcent, and from all trees except the moſt reſinous, which afford them in very ſmall quantity. Theſe plants or trees, when found, are pulled or felled in the ſpring, dried, and burnt to aſhes. By the affuſion of warm water the ſalts are diſſolved, and, by ſtraining, ſeparated from the earth along with the water. This ſaline liquor which is called a *lixive*, is evaporated over a fire; and what remains is an alkaline ſalt of the ſame kind with the pearl-aſhes.

"I was informed by a ſkilful bleacher in Ireland, that he practiſed a more expeditious way of extracting the ſalts. He bought the aſhes of different vegetables from the commonalty for 9s. a buſhel. From theſe a very ſtrong lye was made, into which dry ſtraw was dipped until it ſucked up all the lye. This ſtraw was afterwards dried and burnt, and gave him ſalts, which he ſhowed me, almoſt as good and pure as the pearl-aſhes. This method I have ſeveral times tried; but could never burn the ſtraw to white aſhes, the ſalts diminiſhing the inflammability of the ſtraw. It is a very expeditious method if it can be practiſed. But I can ſee no occaſion for bringing the lye into a ſolid form, as the ſalts muſt again be diſſolved in water before they can be uſed. The ſtrength of the lye can eaſily be determined by the hydroſtatical balance.

"Though I make no queſtion, that the quantity of ſalt, in plants of the ſame ſpecies, will vary in different ſoils and climates; yet it would be of advantage to have the proportion aſcertained in general. Some trials of this kind I have made.

"Two pounds of fern which had been pulled Auguſt 16. were dried and burnt to white aſhes. Theſe weighed 7 dr. and taſted very ſalt. When lixiviated, ſtrained and evaporated, they gave me 49 gr. of ſalt, about the eighth part of the aſhes. If the fern had been pulled in April, it would have afforded more ſalt. Why then ſhould we not prepare ſalts from this vegetable? There is more of it growing on our hills than would ſerve all our bleachfields. The Iriſh make great uſe of it.

"From 11 oz. of tobacco aſhes, I had 1 oz. of ſalt. Two ounces of peat-aſhes afforded half a drachm of ſalt. Nettles, I am informed, afford much ſalt. Furze and broom, natives of this country are very fit for this purpoſe.

"But the kelp, as it grows in ſuch plenty along our ſhore, and contains more ſalt than any other vegetable I know, would be the moſt proper, were it not for a mixture of ſome ſubſtance that renders it unfit for bleaching, at leaſt of fine cloths, after they have obtained a tolerable degree of whiteneſs. It is obſerved by bleachers, that, in theſe circumſtances, it leaves a great yellowneſs in the linen. As theſe aſhes are much uſed in Ireland, and as it is not uncommon to bleach coarſe cloths with them in Scotland, a diſquiſition into their nature, and ſome attempts to purify them, may not be improper. There are no aſhes ſold ſo cheap as theſe; for the beſt gives but 2l. the 2000 weight *. They may, therefore, allow of more labour to be expended on them, and come cheaper at long-run than the foreign ſalts.

"I dried ſome ſea-ware, and burned it, though I found that laſt operation very difficult. When I had kept it fuſed in the fire for two hours, it weighed three ounces and a half. I poured on the aſhes an Engliſh pint and a half of cold water, that I might have as little of the ſulphur as poſſible. This lye, after it had ſtood for ſome hours, was poured off clear, and had but a ſlight tendency to a green colour. I made a ſecond infuſion with milk-warm water, and poured it off from the ſediment. This had a darker colour than the former; was kept ſeparated from it, and evaporated by itſelf. There was a third infuſion made; but having no ſalt taſte, it was thrown away. The ſecond infuſion ſeemed to contain more ſulphur than the firſt; and a piece of white linen kept in it half an hour, while it was boiling, was tinged yellow, and could not be waſhed white again. The earthy part remaining, weighed, when well dried, 1 oz. 2 dr. The ſaline decoction, evaporated by degrees, and ſet at different times in a cellar to cryſtallize, afforded me 5 dr. 46 gr. The liquor, when entirely evaporated, left 4½ dr. of a yellow ſalt, which appeared to be a ſtrong alkaline. The ſalts which cryſtallized ſeemed to be moſtly ſea-ſalt, with a conſiderable quantity of ſulphur, and ſome alkaline ſalt. There appeared no ſigns of the bittern in the ſalts, as their ſolution did not turn turbid with the oil of tartar. Nor is any of the bittern to be expected in kelp-aſhes, although it probably is to be found in the recent vegetable; becauſe the alkaline ſalts formed by the fire muſt have changed it into a neutral. The lye made warm with water, being evaporated, left 4 drams of a black bitter ſalt, which, from its quantity of ſulphur, appeared unfit for bleaching. Theſe aſhes, then, ſeem to be a compoſition of ſomewhat leſs than the fourth of ſulphur, the ſame quantity of ſea-ſalt, about a fourth of alkaline ſalt, and ſomewhat more than a fourth of earth. The alkaline ſalt contained in kelp-aſhes amounts to one penny a pound. This cheapneſs makes it worth our pains to beſtow ſome labour on them.

"If the bad effects in bleaching with kelp-aſhes ariſe from the ſea-ſalt, as ſome of the moſt knowing bleachers think, they can be freed from it in an eaſy manner. Let a lixive of kelp-aſhes be made with cold water, for that does not extract ſo much of the ſulphur; it muſt ſtand but for a ſhort time, for theſe ſalts diſſolve eaſily; decant it, and evaporate the lye. As the boiling continues, the ſea-ſalt will cryſtallize. When that is all ſeparated, the remaining lye will contain alkaline ſalt with ſome ſulphur. This operation every maſter of a bleachfield may learn and overſee, without taking up much of his time. A ſimilar proceſs is carried on by common ſervants in the alum-works, who have by practice learned it from others.

"I had ſome hopes that the ſulphur might be carried off by long roaſting, ſuch as theſe ſalts undergo before they are fuſed in order to be turned into glaſs; becauſe I had obſerved, that the longer time they were kept in the fire, the freer were they from this ſulphureous part.

"I ordered a quantity of kelp aſhes to be kept in the furnace of a glaſshouſe, where the heat was juſt below the vitrifying point, for 24 hours. During this time they had loſt almoſt four-fifths of their weight. They were now much freer from their ſulphur, and were of a light colour; but much of the alkaline ſalt had been driven off with the oils. If a lye be much impregnated with this ſulphureous matter, it appears to be carried off in a great meaſure by long boiling.

"We come now to explain the method of manufacturing the white Muſcovy aſhes. We have ſhown, by undoubted experiments, that the greateſt part of theſe aſhes conſiſts of lime; and yet we have ſeveral acts of parliament which forbid the uſe of that material under ſevere penalties. The parliament were in the right to diſcharge its uſe, upon the diſadvantageous reports which were made to them. We ſhall immediately ſee how dangerous a material it is when uſed improperly, or without the mixture of alkaline ſalts, which render it ſafe, and more ſoluble in water. But I will venture to ſay, that experiment will not ſupport the prejudice entertained with regard to it, if carried any further.

"Since bleaching, then, cannot be carried on without it (for thoſe aſhes which contain it are quite neceſſary in that operation), and ſince we import them from foreign countries, let theſe prejudices againſt it ceaſe, and let us only conſider how we may render our own lime as ſafe as the foreign. If we can do that, the wiſdom of the legiſlature will be as ready to abrogate theſe acts as they were to make them.

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* "Since this treatiſe was written, however, the price of kelp has been advanced to 7l. or upwards the 2000 weight; ſo that thoſe who would now attempt any thing of this kind, muſt alſo manufacture the kelp themſelves."

“ By my experiments on the white Muſcovy aſhes, I got about the eighth part of alkaline ſalts from them. This made me expect, that, by mixing in the ſame proportion quicklime and alkaline ſalts, I ſhould be able to produce Muſcovy aſhes.

“ To an ounce of quicklime and a drachm of white pearl-aſhes, I added about a gill of water, and boiled them together till the water was all evaporated. The taſte of this ſubſtance was little different from lime. To recover the ſalts again from the lime, I diſſolved it in water, ſtrained off the liquor, and evaporated it. Inſtead of the drachm of ſalts, I had but two grains of a ſubſtance which was more earthy than ſaline.

“ To 3 drachms of quicklime, and as much pot-aſhes, I added a mutchkin of water, and kept it boiling for two hours till it was evaporated. I diſſolved it again in water, which being filtered and evaporated, gave me 1½ drachms of a cauſtic ſalt, that liquefied in the air when it had been but four minutes from the fire. It appears, then, that the alkaline ſalts are deſtroyed by lime, and that a great part of them can never be again recovered. From the remaining lime, after the ſalts were extracted, I got ſtrong lime-water, but without a pellicle. This ſhows, that a quantity of alkaline ſalts, equal to the lime, boiled with it for two hours, are not able to fix all the ſoluble part of the lime.

“ From theſe experiments we may draw ſome corollaries with regard to the preſent ſubject. *1ſt*, That evaporating the water from the lime and ſalts by boiling, is a moſt unfrugal way of preparing theſe white aſhes. *2dly*, That theſe aſhes ought to be kept cloſe ſhut up in caſks; for, if expoſed to the open air, though in a room, the alternate moiſture and drought muſt fix their moſt uſeful parts. This I have found to be fact: for the ſalts that I made became leſs pungent by keeping; and I have obſerved, that the ſurface of the Muſcovy aſhes loſt all pungency by being expoſed to the air, while their internal parts ſtill retained it. *3dly*, That all boiling is prejudicial to theſe Muſcovy aſhes, as it fixes, and that quickly, their moſt ſubtile and probably their moſt ſerviceable parts.

“ Let us now proceed to another method of making theſe white aſhes. I imagined, that if the ſalts were diſſolved in water, and the quicklime ſlacked with that, the maſs would ſoon dry without the aſſiſtance of fire. In this way I added equal parts of both; but the compoſition was ſo ſtrong, that it bliſtered my tongue if it but touched it. When the fourth part was alkaline ſalt, it bliſtered my tongue when kept to it a few ſeconds. I could taſte the ſalts plainly in the compoſition, when they made but the thirty-ſecond part of the whole.

“ I thought, when compoſed with the eighteenth part of ſalt, it had, when freſh made, juſt the taſte and look of the Muſcovy aſhes; nor could any perſon have diſtinguiſhed them. This I once imagined was the proportion; but when I found that the ſaline pungency ſoon turned weaker by keeping, and that this compoſition would not afford the ſame quantity of ſalts that the Muſcovy aſhes did, I ſaw that a much greater quantity of ſalts was neceſſary. The proportion appears to be one of ſalt to four of lime, prepared in this laſt way. Three drachms of aſhes prepared in this way, and kept for a fortnight, gave me but 15 grains of ſalt; which is but the half of what the Muſcovy would have afforded. I find, if the quicklime be firſt quenched, it does not fix the ſalts ſo much; and therefore is better and cheaper. One drachm of potaſhes diſſolved in a little water, and added to 3 drachms of quenched lime, gave me 44 grains of a very cauſtic ſalt. I prefer this method as the beſt.

“ The manufacturers of this ſalt probably pour the lixive upon the lime, as they can know by its ſpecific gravity what quantity of ſalts is in the water, and ſo ſave themſelves the expenſe of procuring the ſalts in a dry form.

“ The manufacture of the Marcoſt and Caſhub aſhes remains yet to be explained. We have diſcovered that both of them contain ſulphur, earth, alkaline ſalts, and lime; and differ in nothing but in the Caſhub's having more ſulphur than the Marcoſt aſhes. We ſhall therefore conſider them together.

“ Whether theſe two ſpecies of aſhes be of any uſe in bleaching, may be, and has already been diſputed. I find they contain no other principles, the ſulphureous part excepted, than the former aſhes combined together. Why then ſhould we expect any other effects from the ſame ingredients in the Marcoſt and Caſhub aſhes, than what we have from either of the pearl and Muſcovy aſhes mixed together? The ſulphureous principle in the former muſt have very bad effects; as I find by experiment, that it leaves a yellowneſs on cloth that is very hard to be waſhed out. It is owing to this ſulphureous principle that linen, after it has been waſhed with ſoap, and is pretty well advanced in whiteneſs, is apt to be diſcoloured by lye which is brought to boil: for, by boiling, the ſulphureous part is extracted from theſe aſhes, and the lye becomes of a deep brown colour. Daily practice, then, ſhows the diſadvantage of this ſulphureous principle. Beſides, as ſulphur unites itſelf quickly and firmly with alkaline ſalts, it muſt weaken or altogether deſtroy a great quantity of theſe in the Marcroft and Caſhub aſhes, and ſo render them of no effect in bleaching. Theſe two reaſons ſeem to me ſufficient to exclude them from the bleachfield; eſpecially as, by increaſing the other materials, we can attain perhaps more ſpeedily the ſame end.

“ However, as cuſtom has introduced them into general practice, we ſhall conſider how they are to be manufactured. Dr. Mitchell has, in a very ingenious and uſeful paper, contained in the Philoſophical Tranſactions for the year 1748, delivered an account tranſmitted to him by Dr. Linnæus of the method of making potaſhes in Sweden. This account was contained in an academical diſſertation of one Lundmark upon this ſubject at Aboe in Sweden. The ſubſtance of this account is, ‘ That birch or alder is burned by a ſlow fire to aſhes, and made into a paſte with water. This paſte is plaſtered over a row of green pine or fir logs. Above that is laid tranſverſely another row of the ſame; and that likewiſe is plaſtered over. In this way they continue building and plaſtering till the pile be of a conſiderable height. This pile is ſet on fire; and whenever the aſhes begin to run, it is overturned, and the melted aſhes are beat with flexible ſticks, ſo that the aſhes incruſt the logs of wood, and become as hard as ſtone.’ This, in the Doctor's opinion, is the method of making the potaſhes that come from Sweden, Ruſſia, and Dantzic: and that there is no other difference betwixt the aſhes made in thoſe different countries, but that the Ruſſian, containing more ſalt, muſt be made into a paſte with a ſtrong lye.

“ There would appear, by my experiments, a greater difference than this betwixt the Swediſh aſhes, if that be the true proceſs, and thoſe I have examined. I had diſcovered the greateſt part of the Muſcovy aſhes to be lime. I ſuſpected it might enter into the compoſition of the Marcoſt and Caſhub; and have accordingly diſcovered it there. Without the ſame grounds, none would ever have ſearched for it. Whence then comes this lime? It muſt either enter into its compoſition, or ariſe from the materials managed according as the proceſs directs.

“ I have tried the birch-aſhes made into a paſte with water. I have tried common charcoal made into a paſte with a third part of potaſhes, and kept them in a ſtrong reverberatory heat for ſome hours, and yet no ſuch cauſtic ſubſtance appeared. I have kept earth and ſalts of kelp-aſhes fuſed together for 24 hours in the furnace of a glaſs-houſe, where the heat was juſt below the degree of vitrification; and yet no remarkable cauſticity appeared afterwards in the concreted maſs. But ſuppoſing that there did, will ever this account for the generation of lime? Theſe chemiſts do not aſſert that it is a calcareous cauſticity. The earth of vegetables kept in fuſion with their ſalts, is ſo far from turning into a quicklime, that the maſs takes the oppoſite courſe, and becomes glaſs. Bodies that, by the laws of nature, are vitreſcible, can never, ſo far as we know, become calcareous. In one or other of theſe two ſubſtances all bodies terminate that are changeable by fire; and vegetables are of the former kind. Here it may be aſked, Why then, ſince they endure ſuch a fire, are they not vitrified? the objection would be juſt, did they contain nothing elſe but what was found in vegetables. But if we once allow that lime is one of the materials, the difficulty is eaſily ſolved: for lime, we know, in proportion as it is mixed, hinders the vitrification of all bodies. In effect, the earthy part in theſe aſhes is almoſt vitrified: and I think that I have carried the vitrification yet further in that part; but I never was able, with the utmoſt heat of a reverberatory furnace, continued for ſix hours, to produce any thing like a thorough vitrification in theſe aſhes. The heat of the fire uſed in the proceſs would ſeem to be very great; and muſt, if it were not very difficult, reduce them to glaſs. The invitreſcible nature of theſe ſalts, ſo far from being an objection, becomes a ſtrong proof of my opinion.

"Theſe ſalts have a remarkable pungency. This we have already ſeen is the natural effect of quicklime on ſalts.

"Theſe ſalts are found to be the fitteſt for making ſoap, and to incorporate ſooneſt and beſt with oils. Salts, we know, of themſelves do not readily unite with oil; but when once mixed with quicklime, they have a greater tendency to union.

"Again, I find that theſe aſhes are more eaſily fluxed than charcoal made into a paſte with the third part ſalt; which is much more than the aſhes contain. Now, it is obſerved that quicklime increaſes the fluxing power of alkaline ſalts; for the common cauſtic made of quicklime and alkaline ſalts is ſooner uſed than the latter alone.

"From theſe reaſons, and the experiments that diſcover lime in theſe aſhes, I am led to think, that it is not generated by the proceſs, but mixed with the aſhes when they are made into a paſte. The following experiment is a convincing proof of what I have been endeavouring to make out.

"I boiled ſome peaſe-ſtraw in a ſtrong lye of pearl-aſhes burned into a black coal, and made it into a paſte with water. Another quantity of ſtraw was boiled in a lye made of one part of quicklime and four parts of pearl ſalts, the lye being poured off turbid from the lime. This ſtraw was likewiſe burned when dry, and made into a paſte. Theſe two ſubſtances were put into ſeparate crucibles, and fluxed in a reverberatory furnace. The latter appeared to reſemble the Marcoſt and Caſhub aſhes more than the former, which ſeemed to want their pungency."

Though the only method of preparing the alkaline ſalt originally is by the combuſtion of vegetables, yet there are ſome neutral ſalts from which if it were poſſible to expel the acid, we ſhould have it in our power to procure the fineſt pearl-aſhes in vaſt quantity. Theſe are vitriolated tartar, nitre, but eſpecially ſea-ſalt, on account of the inexhauſtible quantities of it to be met with in the waters of the ocean. Unhappily, however, there are ſome objections to every one of thoſe. The vitriolated tartar, or any other ſalt in which the vitriolic acid enters, cannot be decompoſed without converting the acid into ſulphur by charcoal-duſt; in which caſe it is as difficult to get free of the ſulphur as of the acid; and if we attempt it by frequent ſolutions in water, we deſtroy the phlogiſton of the ſulphur, and have only vitriolated tartar again inſtead of alkali.

With reſpect to nitre, though its acid may be expelled by fire, yet it is too high-priced, and too much uſed in other manufactures, to be thought of for this purpoſe. A potaſh manufacture from ſea-ſalt has indeed been lately erected in England. The principle on which this was eſtabliſhed is, that the acid of ſea-ſalt may be extracted by means of lime; and accordingly we find that the ſaline effloreſcence, which frequently appears on walls, conſiſts chiefly of the marine alkali deprived of its acid. But this, though delivered on the credit of a very eminent chemiſt, we can affirm from our own obſervation to be a miſtake. Of the many caſes in which we have examined this effloreſcence, only one was found to be alkaline; the others uniformly appeared to be true Glauber's ſalt compoſed of the vitriolic acid and foſſil alkali. Neither did this appear to be formed by any decompoſition of ſalt originally in the plaſter, but to be a real generation of both acid and alkali where none of them exiſted before. See EFFLORESCENCE.

POTATOE, in botany. See SOLANUM. Potatoes, it is generally thought, came originally from North America, where they were not reckoned good for food. They were firſt (we are told) introduced into Ireland in the year 1565, and from thence into England by a veſſel wrecked on the weſtern coaſt, called *North Meols*, in Lancaſhire, a place and ſoil even now famous for producing this vegetable in great perfection. It was 40 years after their introduction, however, before they were much cultivated about London; and then they were conſidered as rarities, without any conception of the utility that might ariſe from bringing them into common uſe. At this time they were diſtinguiſhed from the Spaniſh by the name of *Virginia potatoes*, or *battatas*, which is the Indian name of the Spaniſh ſort. At a meeting of the Royal Society, March 18th, 1662-3, a letter was read from Mr. Buckland, a Somerſet gentleman, recommending the planting of potatoes in all parts of the kingdom to prevent famine. This was referred to a committee; and, in conſequence of their report, Mr. Buckland had the thanks of the ſociety, ſuch members as had lands were intreated to plant them, and Mr. Evelyn was deſired to mention the propoſals at the cloſe of his Sylva.

In Sweden, notwithſtanding the indefatigable induſtry of Linnæus, the culture of potatoes was only introduced in 1764, when a royal edict was publiſhed to encourage their general cultivation. They were known there, however, at an earlier period; for in *the Memoirs of the Royal Academy of Sciences in Sweden*, 1747, M. Charles Skytſe propoſed to diſtil brandy from them, in order to ſave corn, which in that country is very dear. He found by experience, that an acre of land ſet with potatoes will yield a much greater quantity of brandy than when ſown with barley.

The utility of potatoes to the common people is well known, and this utility has brought them into general uſe, and has extended them over every part of this kingdom. To promote this utility, and to make their cultivation more eaſy, a variety of experiments and inquiries have been made. Some of theſe we ſhall now lay before our readers, without repeating, however, what has been ſaid on the ſame ſubject in the article HUSBANDRY. By many people the Iriſh purple potatoe is thought to be the ſweeteſt and beſt; and of theſe the bright and middle-ſized are directed to be ſet whole in February, March, and April, in a fine deep tilth, in any ſoil. During the froſt, the firſt ſetting ſhould be covered with litter or fern. They ſhould be ſet ſix inches deep, and a yard diſtance from each other every way, in a kind of hillocks like a mole-caſt; and they muſt be moulded every month or fortnight, as high as poſſible. By July or Auguſt, under each hillock there will be nearly a buſhel of potatoes. The white kidney potatoe runs all into ſtringy roots in looſe ground, while the pink-coloured will do extremely well in the way we have now directed; and the ſmalleſt of them, though often given to hogs, unleſs they be otherwiſe improper or unhealthy, will be very good ſeed.

The following experiments concerning the culture of potatoes are related in the Georgical Eſſays.

"By all the experiments that have been made, the Howard or large Bedfordſhire potatoe is found to produce the largeſt crop. On that account they are chiefly uſed in feeding of cattle. In two beds, four feet wide, and 200 feet long, I planted in a common field a ſufficient number of ſets of this kind of potatoe, and managed them by a horſe-hoe. The produce was 64 buſhels, each buſhel up-heaped weighing about 70 lb. My cattle eat them boiled with as much eagerneſs as the beſt ſorts, and came on as well with them. I have built a boiling-houſe, &c. on Mr. Young's plan, and during this whole winter have boiled potatoes for my cattle. For the fattening ones, I mix ground oats with them; and for the milk-cows, malt-duſt; and dare venture to affirm, that they are much more profitable than either turnips or cabbages. Once, when my potatoes grew low, I deſiſted giving them to the milking cows. Immediately, though fed with the beſt hay, they fell off amazingly in their milk. I therefore began again; and in a week's time they gave better than one-third more butter. I own this accidental diſcovery gave me much ſatisfaction, as it confirmed my opinion, that potatoes boiled are an excellent winter food for cattle. Their culture is not ſo difficult, at leaſt not ſo precarious, as either turnips or cabbages. Their value is ſuperior, and there is no riſk of their giving a diſagreeable taſte either to butter or milk. Add to this the vaſt increaſe of the Howard potatoe, and its equality with the beſt ſorts when uſed for cattle.

"My gardener cut a large potatoe into nine pieces, which he planted with dung, in a drill, in the garden. By earthing up and laying the ſhoots, he produced 575 * ſizeable potatoes, which weighed eight ſtone eight pound. Another of my ſervants produced, in the field, ſeven ſtone of good potatoes from the ſame number of ſets. Though this experiment cannot always be executed in its full force in an extenſive ſcale, it ought, notwithſtanding, to be imitated as nearly as circumſtances will allow. It ſhows, in the moſt diſtinguiſhing manner, the uſe of clean and careful huſbandry.

"On the 14th of April, I cut a large white potatoe into 17 ſets, which were planted in as many hillocks, at the diſtance of four feet. In the courſe of growing, the plants were earthed up, and on the 14th of October the crop was taken up: The produce, 10 pecks of ſizeable potatoes. At the ſame time that this experiment was made, I had ſeveral hillocks, in which I put three and four ſets of the ſame kind of potatoe. But, upon the moſt careful examination, I could not obſerve that theſe hillocks produced a greater crop than the others planted with a ſingle ſet. Hence it is obvious, that the potatoe ſpreads its roots moſt kindly when leaſt crowded."

Whilſt ſpeaking of the increaſe of potatoes, we cannot help taking notice of a memoir by John Howard, eſq. of Cardington, in Bedfordſhire, on a new kind of potatoe remarkable for its prolificacy. "In the year 1765 (ſays he) being at Clifton, near Briſtol, I was informed a perſon had brought from America a new ſort of potatoe, and with ſome trouble I procured half a dozen roots of it, as the greateſt part of thoſe brought over were already planted. That autumn I planted three of them, and in the following ſpring the other three, in my garden at Cardington in Bedfordſhire; ſetting them in hillocks about ſix feet aſunder. The ſtrength of the ſtems, and largeneſs of the bloſſom and apples, gave the pleaſing proſpect of great increaſe: and accordingly, when I took them up in the autumn 1766, I found they had increaſed far beyond any of the common ſort, which for ſome years I had incouraged our cottagers to cultivate. The produce from each cutting was in weight from 26 to 27 pounds and a half. I ſent for two of the Bedford gardeners, who ſerve the market, to ſee them taken up, and they were ſurpriſed at the great increaſe. I gave ſome of them to theſe gardeners, and others to almoſt all our own cottagers. The increaſe continued to appear the ſame in the ſucceeding year, viz. 1767, as in the laſt: only, as many of the ſingle potatoes had been then found to weigh four or five pounds each, I had now planted moſt of them in drills three feet aſunder, in order to procure a greater number and a leſs ſize. Their produce was now from 22 to 30 pounds from each cutting; and the potatoes were more ſizeable for common uſe. The vegetation was not ſo luxuriant as in thoſe I before planted in hillocks; but the increaſe of theſe was, allowing the cuttings to weigh one ounce, full 400-fold. Having laſt year upwards of a waggon-load of theſe potatoes, I with pleaſure ordered it to be made publicly known, that every perſon who choſe to cultivate them was welcome to have a quantity for planting. In conſequence of this, numbers applied in our own and the adjacent counties. In my plantations, as well as thoſe of other perſons, the increaſe has been ſtill greater this year: for the ſeaſon having proved very favourable, I have had from ſome hillocks 41 pounds and a half, allowing for dirt."

We now continue our extracts from the Georgical Eſſays.

"Take a bunch of the apples of any ſort of potatoe. Hang it up in a warm room during the winter, and in February ſeparate the ſeeds from the pulp, by waſhing the apples in water, and preſſing them with the fingers. Then dry the ſeeds upon paper. In the month of April, ſow theſe ſeeds, in drills, in a bed of earth well dug, and manured with rotten dung. When the plants are about an inch high, draw a little earth up to them with a hoe, in order to lengthen their main roots. When they are about three inches high, dig them up with a ſpade, and ſeparate them carefully from each other, in order for planting out in the following manner. Prepare a piece of freſh ground by trenching it well. Dig up the ſeedling plants as before directed; and plant them out in the ground, thus prepared, in ſuch a manner that there ſhall be 16 inches between each plant. As they advance in growth, let them receive one or two earthings up, in order to lengthen the main root, and encourage the ſhoots under ground. By this management, the potatoes will, in the courſe of one ſeaſon, arrive at the ſize of hen's eggs, and the haulm will be as vigorous as if ſets had been planted. But what proves the luxuriancy in the moſt convincing manner, is, that flowers and apples are produced.

"In Lancaſhire, where the gardeners raiſe potatoes from ſeed, they are always two, and ſometimes three years in bringing them to full ſize. By the above method of tranſplanting, with wide diſtances, many of the potatoes nearly attain their full ſize in one ſeaſon. It is obſervable, that theſe ſeedlings produce potatoes of all the different kinds; and ſometimes new ſorts are procured. We do not find any difference whether the apple comes from one kind or another. It is not ſo when we uſe the ſet, which invariably produces the ſame kind. Potatoes, when propagated from ſets, after a number of years, are found to decreaſe in bearing; for which reaſon they ſhould be brought back every 14 years to their original. From a want of attention to this circumſtance, I have known potatoes ſo run out, that they hardly returned treble ſeed. The farmer

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* Inſtances of the amazing increaſe of potatoes are very numerous, and are almoſt every year detailed in the public papers. In the Gentleman's Magazine for 1757, p. 480, we are told, that from one ſlice of a potatoe, ſet in the ſpring of the ſame year by Mr. Simon M'Hoy, a farmer at Park near Tuam in Ireland, there proceeded no leſs than 84 ſtalks, which produced 965 potatoes.

complains that his land is tired of them; but the true cauſe is the age of the ſets. The increaſe of potatoes raiſed from ſeed is aſtoniſhing. They continue in vigour for about 14 years; after which the produce gradually declines.

"As the culture of potatoes, and particularly of the early ſorts for the table, has of late become an object of very general attention, I hope the following account of a new method of obtaining theſe (without the help of hot-beds) will be acceptable to the public.

"On the 2d of January 1772, I made a hot-bed for the forward ſort of potatoes, and on the 7th put in the ſets, placing a glaſs and frame over them, and taking every precaution to defend them from the froſt. Of theſe ſmall potatoes, or ſets, there remained about 40 in a baſket, which was accidentally hung up in a warm kitchen, and there remained unnoticed till about the 25th of April. I then by accident obſerved the baſket, and perceiving ſomething green on the edge of it, took it down, and, to my great ſurpriſe, found that the potatoes had ſprouted half a yard in length, and that there were a great number of very ſmall potatoes formed on the fibrous roots which had grown out. I took them into my garden, and planted them in a rich ſandy ſoil, without any manure. The roots I put into the ground three inches deep, and laid down the ſtems that had ſprouted, horizontally, and covered them with two inches of ſoil, but left the tops uncovered. Without further attention they grew ſurpriſingly.

"On the 26th of May I took up the roots planted in the hot-bed on the 7th of January. They by no means anſwered my expectations, or paid for the trouble of their culture: but, at the ſame time, I was aſtoniſhed to find the others which were put into the ground ſo late, to have produced larger potatoes than the roots in the hot-bed. I took up all the roots, and picked off the large potatoes from them, which amounted to from 4 to 12 on each root, and then ſet the roots again in the ſame ground. This, indeed, I have ſucceſsfully practiſed for many years, ſometimes even twice, and have had a third good crop at Michaelmas. When this method is tried, the roots muſt be watered on the evenings of hot days.

"In January 1773, in order to make a ſecond trial of this experiment with a large quantity, I placed a great many potatoes of the early ſorts on a thick layer of gravelly ſoil, cloſe to each other, over an oven, ſlated over, but open to the ſouth-weſt, and covered them two inches deep with the ſame earth. At the end of April I took them up, and found the ſtems about a foot long or more. For fear of injuring the fine and delicate fibres of the roots, I took great care in taking them up, and planting them in the ſoil. This I now manured, but in all other reſpects treated them in the manner above deſcribed, many of the fibrous roots having then potatoes formed upon them nearly as large as walnuts. For a week, the plants came on ſurpriſingly, when, by one ſharp night's uncommon froſt, they were nearly deſtroyed. However, notwithſtanding this, freſh ſtems grew up in a few days, and I actually gathered from them, on the 3d of June following, finer potatoes than were ſold at that time at Mancheſter from 1 s. to 1 s 6d. per pound, being the produce of hot-beds. After taking off the larger potatoes, I again planted the roots for a ſecond crop, and in September obtained a very large produce. I weighed the increaſe of many ſeparate roots, which amounted from four pound eight ounces to 14 pound 12 ounces, the potatoes being the largeſt of the forward kinds I ever ſaw.

"Make a compoſt of earth, ſand, and coal aſhes. With this mixture fill a tub about 16 inches deep. Plant this artificial ſoil with ſome ſets of the early round potatoe, and place the tub in a ſtable oppoſite to a window, taking care to water the earth now and then. In all ſeaſons the ſets will ſprout, and give a tolerable increaſe of potatoes. Laſt November I planted ſome ſets in the above manner; and in February following I took up a conſiderable number of young potatoes, clean-ſkinned and well flavoured.

"On the 18th of May 1772, finding ſome beds I had ſown very early with onions to be a miſſing crop, I was induced to make the following experiment. The year before, I had ſet ſome potatoes in another part of my garden in the common way; and as it is impoſſible but ſome will remain in the ground all winter, ſo I found a number of ſprouts about three inches high, which I nipped off cloſe to the ground, and tranſplanted them into the onion-beds, without any further preparation, about a foot and a half aſunder, in the ſame manner that cabbages and cauliflowers are planted. As the ſeaſon became immediately very dry, I was obliged to give my plants a little water for four or five ſucceſſive nights; after which they began to flouriſh, and had the appearance of a promiſing crop during all the ſummer. At the uſual time, in October, I ordered them to be taken up; and for ſize, quantity, and quality, they exceeded all I ever had in the common way. Had the ground been freſh, properly manured and prepared, and the plants put down at a proper diſtance from each other, I am of opinion that the ſucceſs would have been ſtill greater.

"From an accurate experiment made laſt year, I dare venture to recommend baked potatoes as an excellent food for hogs. The pork produced by this food was equal to that from barley and beans: but at preſent I cannot exactly aſcertain the comparative experiment with regard to expenſe; however, I am of opinion, that roaſted potatoes, conſidering the improvement of the hogs, is as cheap a food, if not cheaper, than can be given them. I roaſted my potatoes upon a kiln ſimilar to what is uſed by oatmeal ſhellers for drying their oats. The difference in expenſe between boiling and roaſting the potatoes is prodigious, both with regard to the labour and fuel. A kiln that will coſt 3l. will roaſt potatoes ſufficient for the maintenance of more than 20 hogs; and one man will beſtow all the neceſſary attendance upon them, and do other work beſides. The action of the fire, by diſſipating the crude juices that are contained in raw potatoes, reduces them into a ſtate highly wholeſome and nutritious. Boiling does thus in part, but not ſo effectually. A potatoe roaſted in the manner above deſcribed, partakes much of the nature of a cheſnut, and perhaps is not greatly inferior to it."

To theſe experiments we ſhall add ſome important obſervations of Dr. Anderſon of Cotefield near Leith, who has paid a very particular attention to this as well as other branches of agriculture. Our readers will find the Doctor's remarks and experiments at large in the *Bath Papers*, volume fourth. He firſt conſiders the nature of the ſeeds moſt proper to be planted; and from his experiments he thinks it appears that the produce is not materially affected by planting for ſeed, either whole potatoes or cuttings, or large or ſmall potatoes as ſuch; for it is only incidentally that theſe things can affect the crop. In the fifth volume of the *Bath Papers*, Mr. Wimpey relates an experiment, by which it would appear that there is an advantage in planting cut potatoes. His concluſion is as follows: "The meaſure of all the ground planted, ſays he, was 325 poles; the whole produce 378 buſhels. The meaſure of the ground planted with cut potatoes was 265 poles; the produce 312 buſhels. The ground planted with whole or uncut ſets was 60 poles, and the produce of the ſame 66 buſhels. Now, if 48 buſhels, the whole quantity of ſets uſed, produced 378 buſhels, then 34 buſhels, the quantity cut, ſhould produce 267 buſhels; but they produced 312, which is 45 buſhels more than the proportion. Again, if 48 buſhels produced 378 buſhels, then 14 buſhels ſhould have produced 110 buſhels; but 14 buſhels of uncut produced only 66 buſhels, which is 44 buſhels leſs than the proportion. A preference of 40 *per cent.* in favour of cut potatoes, in compariſon with whole ſets." Mr.

Wimpey corroborates the fact in the ſixth volume of the ſame work, and informs us, moreover, that he uſed to ſupply many of his neighbours with potatoes for planting; ſome of whom deſired to have them all ſmall, as they had found them equally productive with the larger, and ſaved much trouble in cutting. "Others (continues he) preferred the largeſt, who carried their economy much further: they, it ſeems, uſed to pare them, eat the fleſhy part, and plant the rinds only. Upon inquiry, I found it was not an unuſual practice among the cottagers; and I have been credibly informed they get as large crops and as good potatoes in that method of planting as in any other whatever. If this be a fact, it ſeems to appear that the fleſhy part of the bulb is of no uſe in ſupplying nouriſhment to the young fruit after the fibrous roots have put forth and laid hold of the ground. Perhaps an experiment of this ſort may be thought worth making." The weight of the crop, however, Dr. Anderſon aſſerts (and Mr. Wimpey agrees with him, ſee Bath Papers, vol. v. p. 34.), is always in ſome meaſure influenced by the weight of the ſeeds planted: but the weight of produce is not augmented in the *ſame proportion* with the weight of the ſeed planted; the ſmalleſt ſeed yielding the greateſt returns in proportion to the ſeed, but the ſmalleſt in proportion to the extent of the ground. It is in no caſe profitable, however, the Doctor thinks, to plant ſmall potatoes*, or ſmall cuttings, unleſs where it is meant to increaſe as faſt as poſſible a favorite kind; in which caſe it may be ſometimes eligible to plant pieces very ſmall, as in that way the kind will be moſt quickly multiplied. We may alſo remark here, that ſuch as wiſh for a large increaſe ſhould never plant the worſt of the crop; it is, we know, extremely common, and may indeed be an immediate ſaving; but it is unqueſtionably a loſs upon the whole; and perhaps it is one cauſe of the *curl diſeaſe*, which is the ſure indication of a poor dwindling crop, and of which we ſhall ſpeak more at large immediately.

Our author further remarks, that there ſeems to be no reaſon to ſuſpect that eyes taken from any particular part of the bulb are poſſeſſed of a degree of prolificacy greater than thoſe taken from any other part of it, independent of the ſize of the fleſhy part that adheres to the eye. It is however highly probable that a difference in the crop, either with reſpect to the number and ſize, or general weight of the whole, would reſult from planting large cuttings of equal weight, taken from the big end of large potatoes, or from the point, as many eyes would be in the laſt in compariſon of the firſt. This is therefore one of the many preparatory experiments that require to be made. It is poſſible too that even the apples may be an object of value, and may indicate a thriving crop or otherwiſe; but of this there is no certainty, as no ſpecific experiments have yet been made on this ſubject.

With reſpect to the effects of cutting the ſtems of potatoes while growing, the Doctor ſeems to be doubtful. The ſtems of potatoes, if cut while growing, and uſed green, are found to be a wholeſome food for cattle and horſes. But though ſome farmers maintain that the produce in potatoes is not leſſened by having the ſtems cut off while they are in a ſtate of vigorous vegetation; others as poſitively inſiſt that the crop is eſſentially injured by that operation. It is proper that this point ſhould be aſcertained. Probably the crop is hurt if the ſtems are cut over before they have attained a certain point of maturity, though it is poſſible they may be afterwards cut without doing any eſſential injury to it.

We have already mentioned that an experiment was made a good while ago in Sweden, to extract ardent ſpirits from potatoes. Other experiments have been made in this country of a later date, but with little effect. This, however, appears to have proceeded either from ignorance or a want of proper attention to the fermentation and after diſtillation; as appears from Dr. Anderſon's experiment, which ſucceeded extremely well by attending to theſe proceſſes. What he made he aſſerts to have been the fineſt and moſt agreeable vinous ſpirit he ever ſaw, reſembling in taſte very fine brandy, but more mild, and having a certain coolneſs on the ſtomach peculiar to itſelf.

Much may be done in bringing potatoes to perfection by attending to their ſeveral varieties. For this purpoſe ſome particular potatoe muſt be fixed upon as a ſtandard; and when this is done, the inquiry muſt be carried on by attending *firſt*, to their appearances below ground, as, 1. the general form and ſize of the bulbs; 2. their colour; 3. the ſmoothneſs or roughneſs of the ſkin; 4. the conſiſtence, that is, the mealineſs or viſcocity and taſte of the bulb; 5. the colour, length, thickneſs, &c. of the umbilical cord; 6. their tendency to go deep, or to riſe near the ſurface; to ramble wide, or to adhere cloſe to the ſtem; 7. the time when the bulbs knot and ſet; marking, not by the kalendar only, but alſo compared with the advance of the plant above ground; 8. the time when they attain perfect maturity with reſpect to ſize, and alſo that period of their growth at which they loſe the herbaceous, and attain the farinaceous, taſte; 9. their general prolificacy; 10. how long they may be kept, at what ſeaſon they are in greateſt perfection for eating, &c. We muſt *next* attend to the particulars obſervable aboveground; as, 1. the general height, colour, and form of the ſtem; 2. their tendency to puſh out many or few ſtems from a root; 3. whether they carry bloſſom or not; 4. the form, dimenſions, and colour of the leaves; 5. the form, colour, and general habitude of the bloſſom where there is any; 6. the time at which the bloſſom appears; 7. the tendency they have to produce few or many apples; 8. the tendency they have to produce thoſe excreſcences on the ſtalks that reſemble potatoes below ground, which may be called air potatoes; 9. the comparative hardneſs or tenderneſs of the leaves, in reſpect of froſt or other variations of weather that affect them. And *laſtly*, we muſt attend to the particulars that concern the whole plant; as, 1. the ſoil which ſeems beſt to ſuit each kind; 2. the mode of culture that beſt agrees with them; 3. the accidents which are moſt liable to affect them; and in general every particular that could indicate any difference between one kind and another.

Our author next conſiders the circumſtances of raiſing ſeedling potatoes. His mode of raiſing them was ſimilar to that recommended in the *Georgical Eſſays* quoted above; but he differs with reſpect to the utility or ſucceſs of that mode. It has been alleged, he ſays, that potatoes, which have been long propagated by means of bulbs, loſe in time their generative quality, ſo as to become much leſs prolific than at firſt; and it is aſſerted that thoſe bulbs which have been lately obtained from ſeeds are much more prolific, and conſequently much more profitable for being employed as plants than others: but this opinion appears to have been adopted without ſufficient examination: for there appears not the ſmalleſt indication of ſuperior prolificacy in thoſe raiſed from ſeeds, but rather the reverſe. That potatoes do not degenerate in point of prolificacy in conſequence of being long propagated in the uſual way, ſeems to be confirmed by the general experience of all Europe. It is now about a hundred years ſince the potatoe was pretty generally cultivated in Ireland, and it has been very univerſally cultivated in Britain for 50 years paſt; and all that have been reared in it ſince their firſt introduction two hundred years ago, a very few of late only excepted, have been propagated from bulbs only; ſo that if they had declined in point of prolificacy, the degeneracy ſhould in this time have been very apparent. Nothing of that kind however was ever remarked, nor any inſinuation of that ſort thrown out, till the diſcovery of rearing potatoes from ſeed was made, when it was for the firſt time heard of. There are many perſons now living who have been in the conſtant practice of rearing potatoes for 30 or 40 years; and notwithſtanding the general tendency that mankind have to diſpraiſe the preſent when compared to paſt times, yet none of them have given the ſmalleſt hint of degeneracy in this reſpect. And perhaps it will be found that this is merely a groundleſs notion, that has originated from the partial fondneſs of thoſe who firſt propagated this plant from ſeed, in favour of their new diſcovery. It has been further ſaid, that by raiſing potatoes from ſeed, many new and valuable kinds may be obtained; and it is alſo aſſerted in the *Georgical Eſſays*. Indeed an opinion of obtaining new varieties of plants by propagating them from ſeed univerſally prevails among naturaliſts. But Dr. Anderſon, in his firſt paper, doubts whether this be fact, and whether, when any of theſe occur, they have not been the effect of accidental poſition or other cauſes. We may certainly (ſays he) aſſert on the whole, that if the practice of rearing potatoes from ſeeds ſhall ever be productive of any advantages to ſociety, they have not yet been diſcovered. Since he wrote that treatiſe, which appears in the Bath Papers, vol. iv. (and of which we are now giving a ſhort account), however, he has had occaſion to alter his opinion, which he does with great candour in vol. v. The experiment which induced him to alter his opinion, and which appears to be deciſive, was made with the ſeed of a potatoe procured from Ireland of a very peculiar kind. Its colour was a dirty dark purple, its ſhape a round irregular bulb, and its ſtem tall and upright. The ſeeds procured from this potatoe were ſown by themſelves, and the ſeedlings when of a proper ſize were tranſplanted. From the appearance of the ſtems he ſoon diſcovered that they were not all of one ſort, and on taking them up the variety was almoſt infinite; and ſuch as could not be accounted for on the principles of a mongrel adulteration. The diverſities reſpected colour, ſhape, &c. ſome of which he enumerates. See *Bath Papers*, vol. v. p. 127.; ſee alſo p. 35. where Mr. Wimpey controverts the Doctor's former opinion.

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* In oppoſition to this, it is the opinion of even practical men, that the ſmall potatoes are to be preferred. "I have been informed (ſays Mr. Hollins) by a native of America, that what we call the long red American potatoe, grows in that rich and newly-cleared ſoil to a very large ſize; but that the potatoes proceeding from the roots were never uſed as ſeed; for there ſprung from the ſtalk, very near the ſurface of the ground, ſmall potatoes as they called them; but he ſaid, they were about the ſize of thoſe raiſed in England, and thoſe were always planted. I hope the Society will forgive my mentioning this, as it confirms what I have already ſaid, "that ſmall potatoes are beſt for ſeed." *London Society of Arts*, vol. xi. p. 82.

Reſpecting the cauſes and prevention of the *curled diſeaſe* in potatoes there has been a variety of opinions, which we have detailed under the article HUSBANDRY. Dr. Anderſon confeſſes that he can ſay but little *poſitive* as to the cauſe of this diſorder, but he thinks a good deal may be ſaid on the *negative* ſide of the queſtion. It was little known till lately[*], and in the northern parts of this iſland it was abſolutely unknown but a very few years ago; and even now in the more remote corners it is ſtill leſs frequent than in the more ſouthern and more commercial diſtricts of the iſland. It has been ſuppoſed that nature, fated as it were by having long produced this plant in a climate not deemed congenial to it, had become ſo far exhauſted as to occaſion this diſeaſe. But in this caſe, the more northern parts, where the climate is moſt unfavourable, ſhould have been ſooneſt affected. It has been alſo thought that potatoes, whoſe bulbs are froſt-bitten before they are houſed, occaſion this diſeaſe in the plants they produce. But the fact is, that they are leaſt liable to the diſeaſe in thoſe diſtricts where they are moſt expoſed to froſt. A potatoe can never indeed be benefited by froſt: but it is not at all probable that the being touched by it occaſions the curl. The taking up potatoes before they arrive at maturity has been thought to occaſion the diſeaſe; but in places where they muſt be taken up ſo, the diſeaſe is ſcarcely known. It has alſo been thought that potatoes obtained from *ſeed* are entirely free from it. But Dr. Anderſon gives a proof of the contrary; for one half of the plants of a large field planted from potatoes the third year from the ſeed were curled; while another field adjoining raiſed from potatoes that never were, that he knows, produced from ſeed in this country, had ſcarcely one curled plant in the whole. The diſeaſe has been ſuppoſed by others to ariſe from the ſoil or ſeaſon. But that this is not the caſe, appears from the circumſtance of a ſingle field which Dr. Anderſon planted with potatoes of the very ſame ſort, but obtained from different perſons. The ridges were intermixed, and the one was very much curled, and the other perfectly free. The diſeaſe, therefore, appears to ariſe from infected ſeed: it is however poſſible that it may be communicated by juxtapoſition; and if ſo, the diſeaſe might be in a great meaſure if not entirely avoided, by pulling out thoſe that ſhowed the leaſt ſymptom of it, on their firſt appearing above ground.

In the Tranſactions of the London Society for Encouragement of Arts, &c. we find a good deal about the curl diſeaſe. Many of the writers agree in opinion with Dr. Anderſon in many reſpects; and particularly, that though the diſeaſe may be prevented, we do not yet know enough of its nature to be able to cure it. See their vol. viii. p. 18, &c. ix. p. 52, &c. and x. p. 75. In this laſt volume we are told that the principal cauſes of the curl are three: 1. From their being forced by cultivation to overgrow their power for vegetation; 2. From their vegetative power being dried up in ebb ſoil by the ſcorching heat of the ſun; and, 3. From their being expoſed too long after they are cut in ſets before they are planted.

It is generally and very naturally believed, that a dry ſoil or a dry ſeaſon neceſſarily produces the drieſt potatoes. But there is good reaſon to doubt the truth of the opinion. The year 1775 was the drieſt and warmeſt ſeaſon that has been known in Scotland within the memory of man, yet the potatoes of that year's crop were watery almoſt to a proverb: on the other hand, the potatoes of crop 1777, although it was a remarkably rainy ſeaſon, were as dry and meally at leaſt as is common, and much more ſo than in the year 1775. It deſerves alſo to be remarked, that the crop of 1775 was almoſt double in quantity to that of 1777. Hence a dry ſeaſon would ſeem to augment the produce, though it does not for certain in all caſes improve the quality, of this crop: nor does a dry ſoil neceſſarily inſure meally potatoes; for our author ſays he has often ſeen potatoes of the ſame kind, and of the ſame year's produce, reared in two different places; the one of them in a naturally damp ſoil, which turned out to be much freer and more meally than the others which were reared on a drier and ſharper ſoil. He confeſſes, that he has alſo often ſeen it turn out in fact, that potatoes raiſed in thoſe diſtricts where the ſoil is hot and ſandy, are uſually more free and tender than thoſe raiſed in countries where the ſoil is cold and damp. Our author tries to account for theſe contradictory phenomena by conjecturing the probable cauſe of the waterineſs or dryneſs of a crop. He aſks, Whether in this reſpect the crop is anywiſe affected by the degree of ripeneſs that the plants employed for ſeed may have attained in the preceding ſeaſon? That this is the caſe he thinks highly probable. Potatoes which, on account of the richneſs or other peculiarity of the soil, continue in a ſtate of vegetation highly luxuriant till they are nipped by froſt, or checked in their growth by other inclemencies of the ſeaſon, have much leſs chance of being dry and meally than others of the ſame ſort which have attained their full growth before the coldneſs or inclemency of the weather checked them. But our author's queſtion does not relate to this, but to the effect theſe unripe potatoes, uſed as ſeed, would have on the ſucceeding crop; a circumſtance which experience alone can determine. "But even if it ſhould be found (continues our author) that the maturity of the ſeeds affected the quality of the potatoes, it would not follow invariably that the ſeeds produced on early dry ſoils would be better than thoſe from later ſoils; becauſe it might ſometimes happen from local poſition, and other accidental circumſtances, that the growth of the potatoes in the dry early ſoil might be checked by froſts many weeks before thoſe on the other ſoil were affected, in conſequence of which the plants in the cold ſoil might attain to more perfect maturity than thoſe on the drier one. I mention this peculiarity merely to ſhow how cautious the farmer ought to be in adopting general concluſions without carefully attending to all the collateral circumſtances that may affect his experiment. I ſhall only further add on this head, that I had occaſion to know well a dry warm ſpot of ground on which the ſtems of the potatoes of crop 1776 were froſt-bitten at leaſt *ſix weeks* before thoſe on another ſpot at ſome miles diſtance from it, where the ſoil was naturally more cold and damp, were in the ſmalleſt degree affected by it. It likewiſe ſo happened, that the potatoes raiſed on the firſt-mentioned ſpot in the year 1777 (their own froſt-bitten [*] ſeed was employed) had ſuch a peculiar acrid and bitteriſh taſte as to be hardly at all eatable, while thoſe in the colder place of that crop had nothing of that unuſual taſte. Whether this diverſity was occaſioned by the circumſtance here alluded to, I do not take it on me to ſay. In matters of ſuch nice diſquiſition as the preſent, many facts obtained by very accurate obſervation are neceſſary before any concluſion can be relied on."

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[*] In the eighth volume of the Tranſactions of the London Society for Encouragement of Arts &c. p. 43. we are told that the curl firſt appeared in 1764, in the very diſtrict in Lancaſhire where they were firſt cultivated.

Potatoes, when planted in water, ſhoot out a great number of fine white roots like threads into the water; but on none of them is there to be found the leaſt appearance of a bulb; while on the other hand the potatoes in that caſe always grow on the top. Potatoes are found to be extremely uſeful in bringing exhauſted land into heart again. See HUSBANDRY. The biſhop of Killaloe in Ireland directs the uſe of them for this purpoſe in a letter in the *Bath Papers*, vol. 4. p. 232, and confirms its utility in this reſpect by experiments of his own. In the 10th vol. of the *Tranſactions of the London Society for Encouragement of Arts*, &c. p. 34, there is alſo a moſt deciſive proof of this utility.

We have been induced, from the extenſive utility of this root, to extend our obſervations on the ſubject to a greater length than we ſhould otherwiſe have done. Such of our readers as wiſh for further information, will of courſe conſult the books from which we have made up the preſent article, as well as other books on Agriculture; in which they will find the obſervations and experiments which we have mentioned at much greater length than we could poſſibly give them. In the ſixth volume of the *Bath Society Papers* there is an excellent paper on the culture of potatoes and feeding hogs with them during ſeven years by John Billingſley, eſq. of which our limits do not permit us to take particular notice. There are alſo a variety of other papers in the ſeveral volumes of that work, as well as in the Tranſactions of the London Society, which we have already ſeveral times mentioned; which will deſerve the particular attention of ſuch as wiſh well to the poor, or have a deſire ſtill further to extend the utility of this moſt valuable root. Cheap preparations are made, by means of potatoes, for the poor: we ſhall finiſh the preſent article with a receipt to make a potatoe herrico, which may be equally uſeful to thoſe whoſe circumſtances are not ſuch as to make them regardleſs of economy. We take it from the Gentleman's Magazine, and give it in the words of a perſon who had tried the experiment.

Scrape the ſkin clean off four pounds of good raw potatoes, then waſh them clean in fair water: take two pounds of beef, one of mutton, and one of pork; or as you like beſt, four pounds of any of theſe meats; cut them into pieces of three or four ounces each, ſeaſon them very well with pepper and ſalt, and a good onion chopped very ſmall: have ready a ſtrong wide-mouthed ſtone jar, ſuch as hares are uſually jugged in; ſlice thin a layer of the potatoes into the jar, then a layer of the ſeaſoned meat over them, and ſo alternately layers of potatoes and meat; let your uppermoſt layer be potatoes, ſo that your jar be about three quarters full, but put no water into your jar; then cloſe or ſtop the mouth of it with a large well-fitted piece of cork, covering the ſame with a ſtrong piece of canvas, and tyeing it down with pack-thread, ſo as only a little of the ſteam may eſcape in the ſtewing; for a little ſhould conſtantly evaporate from the ſide of the cork, to ſave the jar from burſting. Then place your jar upright in a kettle of cold water on the fire, ſo as the mouth of the jar may be always two inches above the water in the kettle when boiling. The herrico in the jar will begin to boil ſome minutes ſooner than the water in the kettle, and that for obvious reaſons. In about an hour after the water in the kettle begins to boil, your herrico will be fully ſtewed. Then take out and open the jar, pour out the herrico into a deep diſh, and ſerve it up.

This excellent, wholeſome, and economical diſh ſupplies an agreeable dinner twice a week to a family conſiſting of three grown people, and three children under fourteen years of age, where neither health nor good ſtomachs are wanting, thanks to God: and, in point of economy we muſt obſerve, that here is the whole article of butter ſaved, as alſo the whole article of bread, or nearly ſo; nor does there require ſo large or ſo continued a fire, nor ſo much time or trouble as is neceſſary for the dreſſing of many other diſhes that by no means deſerve the preference to this excellent herrico.

We have alſo (by way of change) made it with powdered beef, ſometimes with powdered pork, ſometimes with half freſh beef or mutton and half pickled pork, and found it good in all theſe ways, particularly with three pounds of freſh beef and one of pickled pork. We have left off ſending pies and ſtews to the bakers. We ſometimes (in a large kettle) boil a ſmall piece of powdered beef along-ſide of the jar by continuing the boiling an hour and a half longer, and this ſerves us to eat cold the next day with hot garden-ſtuff or a pudding.

POTATOE-*Bread*. See BREAD *of Potatoes*.

Spaniſh POTATOE. See CONVOLVULUS.

POTENT, or POTENCE, in heraldry, the term for a kind of croſs, whoſe ends all terminate like the head of a crutch. It is otherwiſe called the *Jeruſalem croſs*, and is repreſented in the Plate annexed to the article HERALDRY.

POTENTIA (POWER), that whereby a thing is capable either of acting or being acted upon.

POTENTIAL, in the ſchools, is uſed to denote and diſtinguiſh a kind of qualities, which are ſuppoſed to exiſt in the body *in potentia* only; by which they are capable in ſome meaſure of affecting and impreſſing on us the ideas of ſuch qualities, though not actually inherent in themſelves; in which ſenſe we ſay potential heat, potential cold, &c.

POTENTIAL *Cautery*, in medicine, denotes the conſuming, or reducing to an eſchar, any part of the human body by a cauſtic or metallic ſalt, &c. inſtead of a red-hot iron, which laſt is called the *actual cautery*.

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[*] Obſerve, the term *froſt-bitten* is here applied to the ſtems only, and not to the bulbs. The ſtems were ſo much hurt by the froſt as to turn black and decay, but the bulbs were taken up before the froſt had been ſufficiently intenſe to hurt them.

Potential, in grammar, an epithet applied to one of the moods of verbs. The potential is the ſame in form with the ſubjunctive, and is, according to Ruddiman, implied in that mood, for which reaſon that grammarian rejects it; but others will have it to differ from the ſubjunctive in this, that it always implies in it either *poſſum*, *volo*, or *debeo*. It is ſometimes called the *permiſſive mood*, becauſe it often implies a permiſſion or conceſſion to do a thing. See Grammar.

POTENTILLA, silver-weed, *wild tanſey*, or *cinquefoil*: A genus of the pentagynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 35th order, *Senticoſæ*. The calyx is decemfid; there are five petals; the ſeeds roundiſh, naked, and affixed to a ſmall dry receptacle. The ſpecies are, 1. The *fruticoſa*, or ſhrubby potentilla, commonly called *ſhrub-cinquefoil*. This riſes with a ſhort ſhrubby ſtem, dividing into a branchy full head, three or four feet high; cloſely garniſhed with pinnated leaves of five oblong, narrow, acute-pointed, folioles, pale-green above, and whitiſh underneath; and the branches terminated by cluſters of large, ſpreading, yellow flowers. This is a beautiful deciduous flowering ſhrub, worthy a place in every curious collection. It grows wild in Yorkſhire and other northern parts of England, &c. but has been long cultivated in gardens as an ornamental ſhrub. 2. The *reptans*, or creeping common five-leaved potentilla, or five-leaved graſs, hath a thick fibry root, ſlender trailing repent ſtalks, digitated five-lobed petiolated leaves, and yellow flowers ſingly. 3. The *rupeſtris*, or mountain upright cinquefoil, hath upright ſtalks, eight or nine inches high; pinnated five and three-lobed alternate leaves, having oval crenated lobes, and the ſtalks terminated by ſmall white flowers. 4. The *recta*, or erect ſeven lobed yellow cinquefoil, hath erect ſtalks, ſeven-lobed leaves; having three lobes ſpear-ſhaped and ſerrated, green and hairy on both ſides, and the ſtalks terminated by corymboſe cluſters of yellow flowers. 5. The *fragaroides*, or ſtrawberry-like trailing potentilla, hath a ſomewhat tuberous root, furniſhed with many long fibres, long trailing ſhoots, rooting at the joints; pinnated, moſtly three-lobed leaves, having oval lobes, with the extreme lobe the largeſt, and cluſters of ſmall white flowers. This ſpecies bears a great reſemblance to the ſmall ſterile ſtrawberry plants. 6. The *argentea*, ſilvery upright potentilla, hath upright ſtalks, branching a foot high; and five-lobed leaves, having the lobes wedge-ſhaped, cut on the edges, hoary and white underneath, and the branches terminated by ſmall yellow flowers.

All theſe plants flower in June and July; the flowers are compoſed each of five roundiſh petals, and about 20 ſtamina. They are all very hardy, and may be employed in the different compartments of the pleaſure ground. Their propagation is very eaſy. The ſhrubby potentilla may be propagated abundantly by ſuckers, layers, and cuttings; all of which will readily grow, and make plants in one year, which after having two or three year's growth in the nurſery will be fit for any of the ſhrubbery compartments. All the herbaceous kinds may be propagated by parting the roots in autumn or ſpring, or by ſeed in any of thoſe ſeaſons.

POTERIUM, garden burnet: A genus of the polyandria order, belonging to the monœcia claſs of plants; and in the natural method ranking under the 54th order, *Miſcellaneæ*. The male calyx is tetraphyllous; the corolla quadripartite; and there are from 30 to 40 ſtamina. The female calyx is tetraphyllous; the corolla quadripartite; there are two piſtils; the berry is formed of the indurated tube of the corolla. The ſpecies are, 1. The *ſanguiſorba*, or common garden burnet, hath fibry perennial roots, crowned by a large tuft of pinnated leaves, or ſix or ſeven pair of ſawed lobes, terminated by an odd one; upright angular ſtalks, dividing, and branching a foot and a half high, terminated by oblong ſpikes of purpliſh red flowers. This ſpecies grows wild in England, in chalky ſoils; but has been long cultivated as a choice ſalad-herb for winter and ſpring uſe, it being of a warm nature; the young leaves are the uſeful parts. It is perennial in root, and retains its radical leaves all the year, but the ſtalks are annual. 2. The *hybridum*, hybrid agrimony-leaved Montpelier burnet, riſes with upright, taper, cloſely gathered, ſtalks two feet high; pinnated odoriferous leaves of three or four pair of ſawed lobes, terminated by an odd one; and the ſtalks terminated by long footſtalks dividing into ſmaller, each ſupporting a ſmall roundiſh ſpike of flowers. This ſpecies often proves biennial; but, by cutting down ſome of the ſtalks before they flower, it will cauſe it to multiply at bottom, and become abiding. 3. *Poterium ſpinoſum*, ſhrubby ſpinous burnet of Crete, hath a ſhrubby ſtem and branches, riſing a yard high, armed with ſpines; ſmall pinnated evergreen leaves, of ſix or ſeven pair of lobes, terminated by an odd one, and the branches terminated by ſmall heads of greeniſh flowers.

All theſe ſpecies flower in June and July, ſucceeded by ripe ſeeds in Autumn. They are all naturally perennial; but the two herbaceous ones are abiding in root only; the other in root, ſtem, and branches: the two former are hardy, and the third requires ſhelter in winter. The firſt ſort merits culture in every kitchen-garden for winter and ſpring ſalads. Some plants, both of the firſt and ſecond ſorts, may be introduced in the herbaceous collection in the pleaſure garden for variety. The third ſort muſt be kept always in pots, to have ſhelter in winter. They are all eaſily propagated;—the firſt ſort by ſeed and by parting the roots. The ſecond ſort may alſo be increaſed by ſeed and ſlips off the root, as the former ſort. And the propagation of the third is by ſlips or cuttings of the branches in ſpring and ſummer, planted in pots, and placed under glaſſes, giving ſhade and water; or might be forwarded more by plunging them in a hot-bed.

Burnet is of a cordial nature; in ſummer, the leaves are uſed for cool tankards, to give the wine an agreeable flavour. The powder of the root of the firſt ſpecies is commended againſt ſpitting of blood, bleeding at the noſe, dyſenteries, and diſeaſes attended with violent ſecretions. In winter and ſpring, the young tender leaves are uſed in ſalads. Its uſes as food for cattle are well known.

POTHOS, in botany; a genus of the polyandria order, belonging to the gynandria claſs of plants. The ſpatha or ſheath is a ſimple ſpadix covered; there is no calyx, but four petals, and as many ſtamina; the berries diſpermous.

POTION, a liquid medicine, conſiſting of as much as can be drunk at one draught.

POTIPHAR, or Putiphar, an officer of the court of Pharaoh king of Egypt, and general of his troops, according to our tranſlation, Le Clerc, and the verſion of the Vulgate; but according to the Hebrew and Septuagint, the chief of his butchers or cooks. The Hebrew text, the Septuagint, and Vulgate, call him Eunuch. But it is probable it in this place means only an officer of the king's court, for he was certainly married and had children. We have no other accounts of him than what appear in ſcripture; and that account is too generally known to be enlarged on in this place. See Geneſis xxxviii. xxxix. &c.

POTOSI, a city of Peru in South America, ſituated at the bottom of a mountain of that name, in which is the richeſt ſilver mine ever diſcovered. To give an idea of its richneſs, we ſhall mention its produce at different times. Excluſive of what was not regiſtered, ſays Abbé Raynal, and was ſmuggled away, the fifth part belonging to the government, from 1545 to 1564, amounted to 36,450,000 livres (151,875 l.) *per annum*. But this abundance of metals ſoon decreaſed. From

1564 to 1585, the annual fifth-part amounted to no more than 15,187,488 livres 4 ſols (632,812 l. 1s.). From 1585 to 1624, it amounted to 12,149,994 livres 12 ſols (506,249 l. 15s. 6d.). From 1624 to 1633, to 6,074,997 livres 6 ſols (253,124 l. 17s. 9d.). From this laſt period, the produce of theſe mines has ſo evidently decreaſed, that in 1763 the fifth-part, belonging to the king, did not exceed 1,364,682 livres 12 ſols (56,861 l. 15s. 9d.). Situated in W. lon. 67. S. lat. 22. See the article Peru.

POTSDAM, or Postdam, a town of Germany, in the circle of Upper Saxony, with a palace belonging to the king of Pruſſia. It is ſeated in an iſland ten miles in circumference, formed by the rivers Sprae and Havel. The palace is very curious, and finely built upon a delightful ſpot 12 miles weſt of Berlin. E. lon. 13. 42. N. lat. 52. 34. Reiſbeck in his travels informs us, that the houſes in Potſdam are ſtill finer than thoſe of Berlin; but like them they are inhabited only by perſons of the lower and middling ranks.

POTT (Percival), was born in London in 1713. He received the firſt rudiments of his education at a private ſchool at Darne in Kent; and became an apprentice to Mr. Nourſe, one of the ſurgeons of St. Bartholomew's hoſpital; of which hoſpital, in 1744-5, he was elected an aſſiſtant ſurgeon, and in 1749 appointed one of the principal ſurgeons. In 1746, he married the daughter of Robert Cruttenden, eſq. His firſt publication is ſaid to have been planned in 1756, during his confinement in conſequence of a compound fracture of the leg: from that time his pen was ſeldom long unemployed. His practice and his reputation were now rapidly increaſing; in 1764 he was elected a fellow of the Royal Society; and afterward was complimented with honorary diplomas from the Royal Colleges of Surgeons at Edinburgh and in Ireland. In 1787 he reſigned the office of ſurgeon to St. Bartholomew's hoſpital, "after having ſerved it (as he uſed to ſay), man and boy, half a century;" and on the 22d of December 1788, after an illneſs of eight days, he expired.

"The labours of the greateſt part of his life (ſays Mr. Earle, who publiſhed his Chirurgical works), were without relaxation; an increaſing family required his utmoſt exertion: of late years he had a villa at Neaſden; and in the autumn uſually paſſed a month at Bath, or at the ſea-ſide. Thus, though he gathered, as he expreſſed it, ſome of the fruit of the garden which he had planted as he went along, and always lived in a generous and hoſpitable manner, at the ſame time beſtowing on four ſons and four daughters a liberal and neceſſarily expenſive education, and applying large ſums to their eſtabliſhment during his lifetime, he left an ample proviſion for them at his deceaſe. Among his papers was found, what he had often mentioned, a ſmall box, containing a few pieces of money, being the whole which he ever received from the wreck of his father's fortune. With this was depoſited an exact account of every individual fee which a long life of buſineſs had produced—abundant evidence of well-ſpent time, and the induſtrious application of abilities, to which the *res anguſta domi*, at the commencement, probably acted more powerfully as an incentive than as an obſtacle."

POTTER (Christopher), a learned Engliſh divine, was born in 1591, and bred at Oxford. In 1633, he publiſhed his "Anſwer to a late Popiſh Plot," entitled *Charity miſtaken*, which he wrote by ſpecial order of king Charles I. whoſe chaplain he was. In 1634 he was promoted to the deanery of Worceſter; and in 1640 was conſtituted vice-chancellor of the univerſity of Oxford, in the execution of which office he met with ſome trouble from the members of the long parliament. Upon the breaking out of the civil wars he ſent all his plate to the king, declaring, "that he would rather, like Diogenes, drink in the hollow of his hand, than that his majeſty ſhould want;" and he afterwards ſuffered much for the royal cauſe. In conſideration of this he was nominated to the deanery of Durham in 1646, but was prevented from being inſtalled by his death, which happened about two months after. He was a perſon learned and religious, exemplary in his converſation, courteous in his carriage, of a ſweet and obliging nature, and of a comely preſence. He was remarkable in his charity to the poor.

Potter (Dr. John), archbiſhop of Canterbury, was the ſon of a linen-draper at Wakefield in Yorkſhire, where he was born about the year 1674. He ſtudied at Univerſity college, Oxford; and at 19 publiſhed *Variantes lectiones & notæ ad Plutarchi librum de audiendis poetis; & ad Baſilii magni orationem ad juvenes, quomodo cum fructu legere poſſint Græcorum libros*, 8vo. 1693. In 1697 came out his edition of *Lycophron*, in folio; which is reckoned the beſt of that obſcure writer: ſoon after he publiſhed his *Antiquities of Greece*, 2 vols. 8vo. Theſe works eſtabliſhed his literary reputation, and engaged him in a correſpondence with Grævius and other learned foreigners. In 1706, he was made chaplain to the queen; in 1715, biſhop of Oxford; and in 1737, he ſucceeded archbiſhop Wake in the ſee of Canterbury; which high ſtation he ſupported with much dignity until his death in 1747. He was a learned and exemplary churchman; but not of an amiable diſpoſition, being but too ſtrongly tinctured with the pride of office; nor is it to his credit that he diſinherited his ſon for marrying below his rank in life. His Theological works, containing ſermons, charges, diſcourſes on church-government, and divinity lectures," were printed at Oxford, in 3 vols. 8vo, 1753.

POTTERY, the manufacture of earthen-ware, or the art of making earthen veſſels. See Delft-*Ware*, Stone-*Ware*, and Porcelain, &c. The wheel and lathe are the chief and almoſt the only inſtruments in pottery: the firſt for large works, and the laſt for ſmall. The potter's wheel conſiſts principally in the nut, which is a beam or axis, whoſe foot or pivot plays perpendicularly on a free-ſtone ſole or bottom. From the four corners of this beam, which does not exceed two feet in height, ariſe four iron bars, called the *ſpokes of the wheel*; which forming diagonal lines with the beam, deſcend, and are faſtened at bottom to the edges of a ſtrong wooden circle, four feet in diameter, perfectly like the felloe of a coach-wheel, except that it has neither axis nor radii, and is only joined to the beam, which ſerves it as an axis by the iron bars. The top of the nut is flat, of a circular figure, and a foot in diameter: and on this is laid the clay which is to be turned and faſhioned. The wheel thus diſpoſed is encompaſſed with four ſides of four different pieces of wood faſtened on a wooden frame; the hind-piece, which is that on which the workman ſits, is made a little inclining towards the wheel; on the fore-piece is placed the prepared earth; on the ſide-pieces he reſts his feet, and theſe are made inclining to give him more or leſs room. Having prepared the earth, the potter lays a round piece of it on the circular head of the nut, and ſitting down turns the wheel with his feet till it has got the proper velocity; then, wetting his hands with water, he preſſes his fiſt or his fingers-ends into the middle of the lump, and thus forms the cavity of the veſſel, continuing to widen it from the middle; and thus turning the inſide into form with one hand, while he proportions the outſide with the other, the wheel conſtantly turning all the while, and he wetting his hands from time to time. When the veſſel is too thick, he uſes a flat piece of iron, ſomewhat ſharp on the edge, to pare off what is redundant; and when it is finiſhed, it is taken off from the circular head by a wire paſſed under the veſſel.

The potter's lathe is alſo a kind of wheel, but more ſimple and ſlight than the former: its three chief members are an iron beam or axis three feet and a half high, and two feet and a half in diameter, placed horizontally at the top of the beam, and ſerving to form the veſſel upon: and another larger wooden wheel, all of a piece, three inches thick, and two or three feet broad, faſtened to the ſame beam at the bottom, and parallel to the horizon. The beam or axis turns by a pivot at the bottom in an iron ſtand. The workman gives the motion to the lathe with his feet, by puſhing the great wheel alternately with each foot, ſtill giving it a greater or leſſer degree of motion as his work requires. They work with the lathe with the ſame inſtruments, and after the ſame manner as with the wheel. The mouldings are formed by holding a piece of wood or iron cut in the form of the moulding to the veſſel, while the wheel is turning round; but the feet and handles are made by themſelves and ſet on with the hand; and if there be any ſculpture in the work, it is uſually done in wooden moulds, and ſtuck on piece by piece on the outſide of the veſſel. For the glazing of the work, ſee GLAZING.

POTTLE, an Engliſh meaſure containing two quarts. In London it denotes a little taper-ſhaped baſket for ſtrawberries and other delicate fruits, but of no preciſe dimenſions.

POVERTY ſignifies indigence or want of riches, and has been the lot of a large portion of men in every age. Whether on the whole, it has been productive of good or bad conſequences, has been diſputed. In a moral view, perhaps it has been, on the whole, uſeful, as adverſity is in general more conducive to virtue than proſperity, which too often leads to luxury and vice.—Sometimes, however, poverty has had a baneful effect upon the mind, and has prompted men to commit very inhuman actions; but this in civilized communities very ſeldom occurs. In a political view, poverty is thought by ſome to be hurtful: Raynal thinks it is a check to population (ſee his Hiſtory, vol. vi. p. 471.); and Dr. Smith ſo far agrees with him; for, though he aſſerts, and indeed proves, that poverty is no check to the production of children, he allows it to be very unfavourable to raiſing them. See *Smith's Wealth of Nations*, vol. i. p. 119, &c. See alſo POOR.

POULADUFF, two remarkable great holes in the ground, about a mile weſt of Roſs, in the county of Cork, and province of Munſter, in Ireland, 80 yards deep, in which the ſea flows by ſubterraneous paſſages. They are called Eaſt and Weſt *Pouladuff*; one is on the lands of Downeen, and the other on Tralong.

POULTICE, a ſort of medicine, called alſo a *cataplaſm*. See CATAPLASMA.

POULTRY, all kind of domeſtic birds brought up in yards, as cocks, hens, capons, ducks, turkeys, &c. Moſt, if not all, of the domeſtic birds of the poultry kind that we maintain in our yards are of foreign extraction: but there are others to be ranked in this claſs that are as yet in a ſtate of nature, and perhaps only wait till they become ſufficiently ſcarce to be taken under the care of man to multiply their propagation. It will appear remarkable enough, if we conſider how much the tame poultry which we have imported from diſtant climates has increaſed, and how much thoſe wild birds of the poultry kind that have never yet been taken into keeping have been diminiſhed and deſtroyed. They are all thinned; and many of the ſpecies, eſpecially in the more cultivated and populous parts of the kingdom, are utterly unſeen.

Under birds of the poultry kind may be ranked all thoſe that have white fleſh, and, comparatively to their heads and limbs, have bulky bodies. They are furniſhed with ſhort ſtrong bills for picking up grain, which is their chief and often their only ſuſtenance. Their wings are ſhort and concave; for which reaſon they are not able to fly far. They lay a great many eggs; and, as they lead their young abroad, the very day they are hatched, in queſt of food, which they are ſhown by the mother, and which they pick up for themſelves, they generally make their neſts on the ground. The toes of all theſe are united by a membrane as far as the firſt articulation, and are then divided.

Under this claſs we may therefore render the common cock, the peacock, the turkey, the pintada or Guinea-hen, the pheaſant, the buſtard, the grous, the partridge and the quail. They all bear a ſtrong ſimilitude to each other, being equally granivorous, fleſhy, and delicate to the palate. They are among birds what beaſts of paſture are among quadrupeds, peaceable tenants of the field, and ſhunning the thicker parts of the foreſt, that abound with numerous animals who carry on unceaſing hoſtilities againſt them.

As nature has formed the rapacious claſs for war, ſo ſhe ſeems equally to have fitted theſe for peace, reſt, and ſociety. Their wings are but ſhort, ſo that they are ill-formed for wandering from one region to another: their bills are alſo ſhort, and incapable of annoying their oppoſers: their legs are ſtrong indeed; but their toes are made for ſcratching up their food, and not for holding or tearing it. Theſe are ſufficient indications of their harmleſs nature; while their bodies, which are fat and fleſhy, render them unwieldy travellers, and incapable of ſtraying far from each other.

Accordingly, we find them chiefly in ſociety: they live together: and though they may have their diſputes, like all other animals, upon ſome occaſions; yet, when kept in the ſame diſtrict, or fed in the ſame yard, they learn the arts of ſubordination; and, in proportion as each knows his ſtrength, he ſeldom tries a ſecond time the combat where he has once been worſted.

In this manner, all of this kind ſeem to lead an indolent voluptuous life. As they are furniſhed internally with a very ſtrong ſtomach, commonly called a *gizzard*, ſo their voraciouſneſs ſcarce knows any bounds. If kept in cloſe captivity, and ſeparated from all their former companions, they have ſtill the pleaſure of eating left; and they ſoon grow fat and unwieldy in their priſon. To ſay this more ſimply, many of the wilder ſpecies of birds, when cooped or caged, pine away, grow gloomy, and ſome refuſe all ſuſtenance whatever; none except thoſe of the poultry kind grow fat, who ſeem to loſe all remembrance of their former liberty, ſatisfied with indolence and plenty.

POUNCE, gum ſandarach pounded and ſifted very fine, to rub on paper, in order to preſerve it from ſinking, and to make it more fit to write upon.

POUNCE, is alſo a little heap of charcoal duſt, incloſed in a piece of muſlin or ſome other open ſtuff, to be paſſed over holes pricked in a work, in order to mark the lines or deſigns thereof on paper, ſilk, &c. placed underneath; which are to be afterwards finiſhed with a pen and ink, a needle, or the like. This kind of pounce is much uſed by embroiderers, to transfer their patterns upon ſtuffs; by lace-makers, and ſometimes alſo by engravers.

POUNCES, in falconry, the talons or claws of a bird of prey.

POUND, a ſtandard weight; for the proportion and ſubdiviſions, of which, ſee the article WEIGHT.

POUND alſo denotes a money of account; ſo called, becauſe the ancient pound of ſilver weighed a pound troy.

POUND, among lawyers, denotes a place of ſtrength, in which to keep cattle that are diſtrained, or put in for treſpaſs, until they are replevied or redeemed.

POUNDAGE, a ſubſidy of 12d. in the pound, granted to the crown on all goods and merchandizes exported or imported; and if by aliens, one penny more.

POURPRESTURE, in law, is a wrongful incloſure, or incroachment upon another perſon's property.

POURSUIVANT, or PURSUIVANT, in heraldry, the loweſt order of officers at arms.—They are properly attendants on the heralds when they marſhal public ceremonies. Of theſe in England there were formerly many; but at preſent there are only four, viz. blue-mantle, rouge-croſs, rouge-dragon, and port-cullice. In Scotland there is only one king at arms, who is ſtyled *Lyon*, and has under him no leſs than ſix heralds, as many purſuivants, and a great many meſſengers at arms.

POURVEYANCE, or Purveyance, in law, the providing corn, fuel, victuals, &c. for the king's houſehold; and hence the officer who did ſo was termed *pourveyor*. As ſeveral offences were committed by theſe officers, it was enacted by ſtat. 12. Car. II. that no perſon under colour of pourveyance, ſhall take any timber, cattle, corn, &c. from any ſubject without his free conſent, or without a juſt appraiſement, and paying for the ſame.

POUSSIN (Nicholas), an eminent French painter, born in 1594, at Andel, a little city in Normandy, where his father was of noble extraction, but born to a ſmall eſtate. He was inſtructed for a few months by one Ferdinand Elle, a portrait-painter, and afterwards ſpent a month with L'Allemant; but finding theſe artiſts not likely to improve him ſuitably to his deſires, he firſt ſtudied the paintings of the beſt maſters, and then haſtened to finiſh a few pieces he was engaged in, and travelled to Italy. Here he devoted almoſt his whole attention to the ſtudy of antique ſtatues and bas reliefs; which was probably the cauſe of his want of knowledge in, and taſte for, the art of colouring. Being invited back to Paris by Louis XIII. who aſſigned him a penſion with lodgings in the Thuilleries, he painted for prince Juſtiniani a hiſtorical picture repreſenting Herod's cruelty; an admirable compoſition, in which he gave ſuch expreſſion to every character, as could not fail to ſtrike the beholder with terror and pity: he then laboured for ſeveral years on the celebrated pictures of the ſeven ſacraments of the Romiſh church. But none of Pouſſin's deſigns have been more generally admired than that of the death of Germanicus; which would have gained him immortal honour if he had never painted another picture. He began the labours of Hercules in the gallery of the Louvre; but the faction of Vouet's ſchool railing at him and his performances, put him ſo out of humour with his own country, that he returned to Rome where he died in 1665. He never went beyond eaſel-pieces, for which he had a perpetual demand; and his method was to fix the price he expected on the back of the canvas, which was readily paid.

Poussin (Gaſpar). This painter, whoſe real name was *Dughet*, was born at Paris in 1600; and was induced to travel to Rome, not only from a love to the art of painting, but alſo to viſit his ſiſter, who was married to Nicholas Pouſſin. Sandrart ſays that Gaſpar was employed at firſt only to prepare the pallet, pencils, and colours, for Nicholas; but by the precepts and example of that excellent maſter, gradually roſe to the higheſt reputation, and is undoubtedly one of the beſt landſcape-painters that ever appeared. It is generally thought that no painter ever ſtudied nature to better purpoſe, or repreſented the effects of land-ſtorms more happily, than Gaſpar; all his trees ſhow a natural degree of agitation, every leaf being in motion; his ſcenes are all beautifully choſen, as are the ſites of his buildings. He deſigned human figures but very indifferently; for which reaſon he frequently prevailed on Nicholas to paint them for him; and they were always introduced with the utmoſt propriety. While he continued at Rome he dropped his own name, and aſſumed that of his brother-in law and benefactor, by which only he is at preſent known. He died in 1662.

POWDER, in pharmacy, a dry medicine well broken, either in a mortar, by grinding, or by ſome chemical operation.

Gun-Powder. See Gunpowder. See alſo Obſervations on Gunpowder in the Iriſh Tranſactions 1788, p. 97. claſs *Science*, by Mr. Napier. The expanſive force of gunpowder has been wonderfully exemplified by count Rumford. See his paper on that ſubject in the Phil. Tranſ. for 1796.

Powder-*Cheſts*, certain ſmall boxes charged with powder and a quantity of old nails or ſplinters of iron, and faſtened occaſionally on the deck and ſides of a ſhip, in order to be diſcharged on an enemy who attempts to ſeize her by boarding. Theſe caſes are uſually from 12 to 18 inches in length, and about eight or ten in breadth, having their outer or upper part terminating in an edge. They are nailed to ſeveral places of the quarter-deck and bulk-head of the waiſt, having a train of powder, which communicates with the inner apartments of the ſhip, ſo as to be fired at pleaſure to annoy the enemy. They are particularly uſed in merchant-ſhips which are furniſhed with cloſe-quarters to oppoſe the boarders.

Powder-*Magazine*, a bomb-proof arched building, to contain powder in fortified places.

Powder *for the Hair*. The beſt ſort is ſtarch well pounded and ſifted, and generally prepared with ſome perfume.

James's Powder. See James's *Powder*. In the Philoſophical Tranſactions for 1791, p. 317, there is a paper by Dr. Pearſon, containing experiments and obſervations on James's powder. Dr. Pearſon ſays, it was originally a patent medicine; but it is well known that it cannot be prepared by following the directions of the ſpecification in the court of chancery. His obſervations and experiments, therefore, he thinks, may explain the nature and manner of preparing this medicine, and perhaps may extend the hiſtory of antimony. The reſult of the whole, in Dr. Pearſon's own words, is as follows: 1. James's powder conſiſts of phoſphoric acid, lime, and antimonial calx; with a minute quantity of calx of iron, which is conſidered to be an accidental ſubſtance. 2. Either theſe three eſſential ingredients are united with each other, forming a triple compound, or phoſphorated lime is combined with the antimonial calx, compoſing a double compound in the proportion of about 57 parts of calx and 43 parts of phoſphorated lime. 3. This antimonial calx is different from any other known calx of antimony in ſeveral of its chemical qualities. About three-fourths of it are ſoluble in marine acid, and afford Algaroth powder; and the remainder is not ſoluble in this menſtruum, and is apparently vitrified. It alſo appears that, by calcining together bone-aſhes, that is, phoſphorated lime, and antimony in a certain proportion, and afterwards expoſing the mixture to a white heat, a compound was formed, conſiſting of antimonial calx and phoſphorated lime in the ſame proportion, and poſſeſſing the ſame kind of chemical properties as James's powder.

POWDIKE, in the fens of Norfolk and Ely. By ſtat. 22 Hen. VIII. c. 11. perverſely to cut down and deſtroy the powdike in the fens of Norfolk and Ely is felony. See *Blackſtone's Commentaries*, vol. iv. p. 243.

POWER, has been defined the faculty of doing or ſuffering any thing. Power, therefore, is two fold, viz. conſidered as able to make, or able to receive any change; the former whereof may be called *active*, and the latter *paſſive, power*: but this diſtinction is improper. See Metaphysics.

Power, in mechanics, denotes any force, whether of a man, a horſe, a ſpring, the wind, water, &c. which, being applied to a machine, tends to produce motion.

Power, in law, ſignifies in general a particular authority granted by any perſon to another to repreſent him, or to act in his ſtead.

POWERS, in arithmetic and algebra, are nothing but the products ariſing from the continual multiplications of a number or quantity into itſelf. See Algebra and Arithmetic.

POX, *French Pox*, or *Lues Venerea*. See Medicine.

Small-Pox. See Inoculation, and Medicine.

POYNING'S law, an act of parliament made in Ireland under Henry VII. whereby all the ſtatutes of force in England were made of force in Ireland; which before that time they were not.—Nor are any now in force there made in England ſince that time. The law took its name from Sir Edward Poyning, lord-lieutenant of that kingdom at the time of its making.

POZZOLANA. See Puzzolana.

PRACTICE, in arithmetic. See Arithmetic.

Gun-Practice, in military education. In the ſpring, as ſoon as the weather permits, the exerciſe of the great guns begins, with an intention to ſhow the gentlemen cadets at the royal military academy at Woolwich, and private men, the manner of laying, loading, pointing, and firing the guns. Sometimes inſtruments are uſed to find the centre line, or two points, one at the breech, the other at the muzzle, which are marked with chalk, and whereby the piece is directed to the target: then a quadrant is put into the mouth to give the gun the required elevation, which at firſt is gueſſed at, according to the diſtance the target is from the piece. When the piece has been fired, it is ſponged to clear it from any duſt or ſparks of fire that might remain in the bore, and loaded: then the centre line is found as before; and if the ſhot went too high or too low, to the right or to the left, the elevation and trail are altered accordingly. This practice continues morning and evening for about ſix weeks, more or leſs according as there are a greater or leſs number of recruits. In the mean time others are ſhown the motions of quick-firing with field-pieces.

Mortar-Practice, generally thus. A line of 1500 or 2000 yards is meaſured in an open ſpot of ground from the place where the mortars ſtand, and a flag fixed at about 300 or 500 yards: this being done, the ground where the mortars are to be placed is prepared and levelled with ſand, ſo that they may lie at an elevation of 45 degrees; then they are loaded with a ſmall quantity of powder at firſt, which is increaſed afterwards by an ounce every time, till they are loaded with a full charge; the times of the flights of the ſhells are obſerved, to determine the length of the fuzes. The intention of this practice is, when a mortar battery is raiſed in a ſiege, to know what quantity of powder is required to throw the ſhells into the works at a given diſtance, and to cut the fuzes of a juſt length, that the ſhell may burſt as ſoon as it touches the ground.

PRÆMUNIRE, in law, is taken either for a writ ſo called, or for the offence whereon the writ is granted; the one may be underſtood by the other.—The church of Rome, under pretence of her ſupremacy and the dignity of St. Peter's chair, took on her to beſtow moſt of the eccleſiaſtical livings of any worth in England, by mandates, before they were void; pretending therein great care to ſee the church provided with a ſucceſſor before it needed. Whence theſe mandates or bulls were called *gratiæ expectativæ*, or *proviſiones*; whereof ſee a learned diſcourſe in *Duarenus de beneficiis*, lib. 3. cap. 1. Theſe proviſions were ſo common, that at laſt Edward I. not digeſting ſo intolerable an encroachment, in the 35th year of his reign made a ſtatute againſt papal proviſions, which, according to Sir Edward Coke, is the foundation of all the ſubſequent ſtatutes of præmunire: which is ranked as an offence immediately againſt the king, becauſe every encouragement of the papal power is a diminution of the authority of the crown.

In the weak reign of Edward II. the pope again endeavoured to encroach, but the parliament manfully withſtood him; and it was one of the articles charged againſt that unhappy prince, that he had given allowance to the bulls of the ſee of Rome. But Edward III. was of a temper extremely different; and, to remedy theſe inconveniences, firſt by gentle means, he and his nobility wrote an expoſtulation to the pope: but receiving a menacing and contemptuous anſwer, withal acquainting him, that the emperor (who a few years before at the diet of Nuremberg, A. D. 1323, had eſtabliſhed a law againſt proviſions), and alſo the king of France, had lately ſubmitted to the holy ſee; the king replied, that if both the emperor and the French king ſhould take the pope's part, he was ready to give battle to them both, in defence of the liberties of the crown. Hereupon more ſharp and penal laws were deviſed againſt proviſors, which enact ſeverally, that the court of Rome ſhall preſent or collate to no biſhopric or living in England; and that whoever diſturbs any patron in the preſentation to a living by virtue of a papal proviſion, ſuch proviſor ſhall pay fine and ranſom to the king at his will, and be impriſoned till he renounces ſuch proviſion; and the ſame puniſhment is inflicted on ſuch as cite the king, or any of his ſubjects, to anſwer in the court of Rome. And when the holy ſee reſented theſe proceedings, and pope Urban V. attempted to revive the vaſſalage and annual-rent to which king John had ſubjected his kingdom, it was unanimouſly agreed by all the eſtates of the realm in parliament aſſembled, 40 Edw. III. that king John's donation was null and void, being without the concurrence of parliament, and contrary to his coronation-oath; and all the temporary nobility and commons engaged, that if the pope ſhould endeavour by proceſs or otherwiſe to maintain theſe uſurpations, they would reſiſt and withſtand him with all their power.

In the reign of Richard II. it was found neceſſary to ſharpen and ſtrengthen theſe laws, and therefore it was enacted by ſtatutes 3 Ric. II. c. 3. and 7. Ric. II. c. 12. firſt, that no alien ſhall be capable of letting his benefice to farm; in order to compel ſuch as had crept in, at leaſt to reſide on their preferments: and afterwards, that no alien ſhould be capable to be preſented to any eccleſiaſtical preferment, under the penalty of the ſtatutes of proviſors. By the ſtatute 12 Rich. II. c. 15. all liegemen of the king accepting of a living by any foreign proviſion, are put out of the king's protection, and the benefice made void. To which the ſtatute 13 Rich. II. ſtat. 2. c. 2. adds baniſhment and forfeiture of lands and goods: and by c. 3. of the ſame ſtatute, any perſon bringing over any citation or excommunication from beyond ſea, on account of the execution of the foregoing ſtatutes of proviſors, ſhall be impriſoned; forfeit his goods and lands, and moreover ſuffer pain of life and member.

In the writ for the execution of all theſe ſtatutes, the words *præmunire facias* being uſed to command a citation of the party, have denominated in common ſpeech, not only the writ, but the offence itſelf of maintaining the papal power, by the name of *præmunire*. And, accordingly, the next ſtatute we ſhall mention, which is generally referred to by all ſubſequent ſtatutes, is uſually called the *ſtatute of præmunire*. It is the ſtatute 16 Rich. II. c. 5. which enacts, that whoever procures at Rome, or elſewhere, any tranſlations, proceſſes, excommunications, bulls, inſtruments, or other things which touch the king, againſt him, his crown, and realm, and all perſons aiding and aſſiſting therein, ſhall be put out of the king's protection, their lands and goods forfeited to the king's uſe, and they ſhall be attached by their bodies to anſwer to the king and his council; or proceſs of *præmunire facias* ſhall be made out againſt them as in other caſes of proviſors.

By the ſtatute 2 Henry IV. c. 3. all perſons who accept any proviſion from the pope, to be exempt from canonical obedience to their proper ordinary, are alſo ſubjected to the penalties of præmunire. And this is the laſt of our ancient ſtatutes touching this offence; the uſurped civil power of the biſhop of Rome being pretty well broken down by theſe ſtatutes, as his uſurped religious power was in about a century afterwards: the ſpirit of the nation being ſo much raiſed againſt foreigners, that about this time, in the reign of Henry V. the alien priories, or abbeys for foreign monks, were ſuppreſſed, and their lands given to the crown. And no further attempts were afterwards made in ſupport of theſe foreign juriſdictions.

This, then, is the original meaning of the offence which we call *præmunire*; viz. introducing a foreign power into this land, and creating *imperium in imperio*, by paying that obedience to papal proceſs which conſtitutionally belonged to the king alone, long before the Reformation in the reign of Henry VIII. at which time the penalties of præmunire were indeed extended to more papal abuſes than before; as the kingdom then entirely renounced the authority of the ſee of Rome, though not at all the corrupted doctrines of the Roman church. And therefore, by the ſeveral ſtatutes of 24 Henry VIII. c. 12. and 25 Henry VIII. c. 19. and 21. to appeal to Rome from any of the king's courts, which (though illegal before) had at times been connived at; to ſue to Rome for any licence or diſpenſation, or to obey any proceſs from thence, are made liable to the pains of præmunire. And, in order to reſtore to the king in effect the nomination of vacant biſhoprics, and yet keep up the eſtabliſhed forms, it is enacted by ſtatute 25 Henry VIII. c. 20. that if the dean and chapter refuſe to elect the perſon named by the king, or any archbiſhop or biſhop to confirm or conſecrate him, they ſhall fall within the penalties of the ſtatutes of præmunire. Alſo by ſtatute 5 Eliz. c. 1. to refuſe the oath of ſupremacy will incur the pains of præmunire; and to defend the pope's juriſdiction in this realm, is a præmunire for the firſt offence, and high-treaſon for the ſecond. So, too, by ſtatute 13 Eliz. c. 2. to import any *agnus Dei*, croſſes, beads, or other ſuperſtitious things pretended to be hallowed by the biſhop of Rome, and tender the ſame to be uſed; or to receive the ſame with ſuch intent, and not diſcover the offender; or if a juſtice of the peace, knowing thereof, ſhall not within 14 days declare it to a privy-counſellor, they all incur a præmunire. But importing or ſelling maſs-books, or other Popiſh books, is by ſtatute 3 Jac. I. c. 5. § 25. only liable to a penalty of 40s. Laſtly, to contribute to the maintenance of a Jeſuit's college, or any Popiſh ſeminary whatever beyond ſea, or any perſon in the ſame, or to contribute to the maintenance of any Jeſuit or Popiſh prieſt in England, is by ſtatute 27 Eliz. c. 2. made liable to the penalties of præmunire.

Thus far the penalties of præmunire ſeem to have kept within the proper bounds of their original inſtitution, the depreſſing the power of the pope: but they being pains of no conſiderable conſequence, it has been thought fit to apply the ſame to other heinous offences; ſome of which bear more, and ſome leſs, relation to this original offence, and ſome no relation at all.

Thus, 1. By the ſtatute 1 and 2 Ph. and Mar. c. 8. to moleſt the poſſeſſors of abbey-lands granted by parliament to Hen. VIII. and Edward VI. is a præmunire. 2. So likewiſe is the offence of acting as a broker or agent in any uſurious contract where above 10 *per cent.* intereſt is taken, by ſtatute 13 Eliz. c. 10. 3. To obtain any ſtay of proceedings, other than by arreſt of judgment or writ of error, in any ſuit for a monopoly, is likewiſe a præmunire, by ſtat. 21 Jac. I. c. 3. 4. To obtain an excluſive patent for the ſole making or importation of gunpowder or arms, or to hinder others from importing them, is alſo a præmunire by two ſtatutes; the one 16 Car. I. c. 21. the other 1 Jac. II. c. 8. 5. On the abolition, by ſtat. 12. Car. II. c. 24. of purveyance, and the prerogative of pre-emption, or taking any victual, beaſts, or goods for the king's uſe, at a ſtated price, without conſent of the proprietor, the exertion of any ſuch power for the future was declared to incur the penalties of præmunire. 6. To aſſert, maliciouſly and adviſedly, by ſpeaking or writing, that both or either houſe of parliament have a legiſlative authority without the king, is declared a præmunire by ſtatute 13 Car. II. c. 1. 7. By the *habeas corpus* act alſo, 31 Car. II. c. 2. it is a præmunire, and incapable of the king's pardon, beſides other heavy penalties, to ſend any ſubject of this realm a priſoner into parts beyond the ſeas. 8. By the ſtatute 1 W. & M. ſt. 1. c. 8. perſons of 18 years of age refuſing to take the new oaths of allegiance as well as ſupremacy, upon tender by the proper magiſtrate, are ſubject to the penalties of præmunire; and by ſtatutes 7 & 8 W. III. c. 24. ſerjeants, counſellors, proctors, attorneys, and all officers of courts, practiſing without having taken the oaths of allegiance and ſupremacy, and ſubſcribed the declaration againſt popery, are guilty of a præmunire whether the oaths be tendered or not. 9. By the ſtatute 6 Ann. c. 7. to aſſert maliciouſly and directly, by preaching, teaching, or adviſed ſpeaking, that the then pretended prince of Wales, or any perſon other than according to the acts of ſettlement and union, hath any right to the throne of theſe kingdoms, or that the king and parliament cannot make laws to limit the deſcent of the crown; ſuch preaching, teaching, or adviſed ſpeaking, is a præmunire: as writing, printing, or publiſhing the ſame doctrines amounted, we may remember, to high treaſon. 10. By ſtatute 6 Ann. c. 23. if the aſſembly of peers of Scotland, convened to elect their 16 repreſentatives in the Britiſh parliament, ſhall preſume to treat of any other matter ſave only the election, they incur the penalties of a præmunire. 11. The ſtat. 6 Geo. I. c. 18. (enacted in the year after the infamous South Sea project had beggared half the nation) makes all unwarrantable undertakings by unlawful ſubſcriptions, then commonly known by the name of *bubbles*, ſubject to the penalties of a præmunire. 12. The ſtat. 12 Geo. III. c. 11. ſubjects to the penalties of the ſtatute of præmunire all ſuch as knowingly and wilfully ſolemnize, aſſiſt, or are preſent at, any forbidden marriage of ſuch of the deſcendants of the body of king Geo. II. as are by that act prohibited to contract matrimony without the conſent of the crown.

Having thus inquired into the nature and ſeveral ſpecies of præmunire, its puniſhment may be gathered from the foregoing ſtatutes, which are thus ſhortly ſummed up by Sir Edward Coke: "That, from the conviction, the defendant ſhall be out of the king's protection, and his lands and tenements, goods and chattels, forfeited to the king; and that his body ſhall remain in priſon at the king's pleaſure, or (as other authorities have it) during life; both which amount to the ſame thing, as the king by his prerogative may any time remit the whole, or any part of the puniſhment, except in the caſe of tranſgreſſing the ſtatute of *habeas corpus*. Theſe forfeitures here inflicted do not (by the way) bring this offence within our former definition of FELONY; being inflicted by particular ſtatutes, and not by the common law." But ſo odious, Sir Edward Coke adds, was this offence of præmunire, that a man that was attainted of the ſame, might have been ſlain by any other man without danger of law; becauſe it was provided by law, that any man might do to him as to the king's enemy; and any man may lawfully kill an enemy. However, the poſition itſelf, that it is at any time lawful to kill an enemy, is by no means tenable: it is only lawful, by the law of nature and nations, to kill him in the heat of battle, or for neceſſary ſelf defence. And to obviate ſuch ſavage and miſtaken notions, the ſtatute 5 Eliz. c. 1. provides, that it ſhall not be lawful to kill any perſon attained in a præmunire, any law, ſtatute, opinion, or expoſition of law to the contrary notwithſtanding. But ſtill ſuch delinquent, though protected as a part of the public from public wrongs, can bring no action for any private injury, how atrocious ſoever; being ſo far out of the protection of the law, that it will not guard his civil rights, nor remedy any grievance which he as an individual may ſuffer. And no man, knowing him to be guilty, can with ſafety give him comfort, aid, or relief.

PRÆNESTE (anc. geog.), a town of Latium, to the ſouth-eaſt of Rome, towards the territory of the Æqui; a place of great ſtrength; famous for the temple and oracle of Fortune, called *Sortes Prænestinæ* (Strabo); which Tiberius wanted to deſtroy, but was deterred by the awful majeſty of the place. From a colony it was raiſed to a municipium by Tiberius (Inſcriptions, Florus, A. Gellius), on the conſideration of his recovery from a dangerous illneſs near this place. Thither the Roman emperors uſually retired, on account of the agreeableneſs of the ſituation (Suetonius). It was a very ancient city, with a territory of large extent (Livy). The temple of Fortune was built in the moſt ſumptuous manner by Sylla, and the pavement was Moſaic work (Pliny). Concerning the Sortes, there is a remarkable paſſage in Cicero; who ſays that it was all a mere contrivance, in order to deceive, either for the purpoſes of gain or ſuperſtition. The town that has ſucceeded it ſtands low in a valley, and is called *Paleſtrina*, in the Campania of Rome. E. lon. 13. 30. N. lat. 42. 0.

PRÆSIDIUM (Notitia), a town of the Carnavii in Britain. Now thought to be Warwick (Camden). Another of Corſica (Antonine), 30 miles to the ſouth of Aleria. A third *Præſidium* ſurnamed *Julium*, in Bætica (Pliny).

PRÆTORIA AUGUSTA (Ptolemy), a town of Dacia. Now called *Braſſow* by the natives, and *Cronſtat* by the Germans (Baudrand): a town in Tranſylvania. E. lon. 25°. N. lat. 47°. Another of the Salaſſii, near the two gates or defiles of the Alps, the Grajæ and Penninæ (Pliny); a Roman colony, ſettled by Auguſtus after the defeat of the Salaſſii by Terentius Varro, on the ſpot where he encamped (Strabo, Dio Caſſius, Ptolemy), ſituated on the river Duria Major. The town is now called *Aoſta* or *Aouſt*, in Piedmont. E. lon. 7. 14. N. lat. 45. 19.

PRÆTORIUM (Antonine, Notitia Imperii), a town of the Brigantes. Now *Paterington* (Camden), near the mouth of the Humber in Yorkſhire, *Coventry* (Talbot).

PRAGMATIC SANCTION, in the civil law, is defined by Hottoman to be a reſcript or anſwer of the ſovereign, delivered by advice of his council, to ſome college, order, or body of people, upon conſulting him on ſome caſe of their community. The like anſwer given to any particular perſon is called ſimply *reſcript*. The term *pragmatic ſanction* is chiefly applied to a ſettlement of Charles VI. emperor of Germany, who, in the year 1722, having no ſons, ſettled his hereditary dominions on his eldeſt daughter the archducheſs Maria Thereſa, which was confirmed by the diet of the empire, and guaranteed by Great Britain, France, the States-General, and moſt of the powers in Europe. The word *pragmatic* is derived from the Greek *πραγμα*, *negotium*, "buſineſs." It is ſometimes alſo called abſolutely *pragmatic*, *το πραγματικον*.

PRAGUE, a large and famous city, capital of Bohemia, and an archiepiſcopal ſee. It comprehends three towns, the Old, the New, and the Little Town, and is 15 miles in circumference. It is built upon ſeven mountains, and has above 100 churches, and as many palaces. The Muldaw runs through the city, ſeparating the old town from the new, and over it is a bridge of 18 arches, with a ſtrong tower at each end. The old town is very populous; the houſes are high, and the ſtreets narrow. In this part is the old palace, where the ancient kings reſided; but the fineſt ornament is the univerſity, frequented by a great number of ſtudents. The Jeſuits had a magnificent college here; and here the Jews have nine ſynagogues. The new town contains fine ſtructures, handſome gardens, and large ſtreets. In the church of St. Peter and St. Paul is a large column, broken in three pieces, which they pretend the devil brought from St. Mary's at Rome. The little town was built on the ſpot where there was a foreſt; and there is a poplar tree yet ſtanding, which they affirm has grown there about 1000 years. The principal buildings are the Royal Caſtle, the Radſhin, and the Straw-houſe. The firſt contains a hall, 100 paces long and 40 broad, without any pillar to ſupport the roof. The palace called Radſhin, is the place where prince Drahomire was ſwallowed up alive in 921. In the Straw-houſe they ſhow the place where the Swedes entered the city in 1648. Prague was taken by ſtorm by the French in 1741; but they were obliged to leave it in 1742. In 1744, it was taken by the king of Pruſſia; but he was obliged to abandon it the ſame year. It was beſieged again by the king of Pruſſia, in 1757, after a great victory, obtained near this city, over the Auſtrians; but being defeated ſome time after, he was obliged to raiſe the ſiege. It is 75 miles S. E. of Dreſden, 158 S. E. of Berlin, and 235 N. W. of Vienna. E. lon. 14. 45. N. lat. 50. 4.

PRAM, or PRAME, a kind of lighter uſed in Holland and the ports of the Baltic Sea, to carry the cargo of a merchant ſhip *along-ſide*, in order to lade or to bring it to ſhore to be lodged in the ſtorehouſes after being diſcharged out of the veſſel.

PRAME, in military affairs, a kind of floating battery, being a flat-bottomed veſſel, which draws little water, mounts ſeveral guns, and is very uſeful in covering the diſembarkation of troops. They are generally made uſe of in tranſporting troops over the lakes in America.

PRAMNION, in natural hiſtory, the name of a ſemipellucid gem. This is a very ſingular ſtone, and of a great concealed beauty. Our lapidaries, when they met with it, call it by the name of the *black agate*. It is of an extremely cloſe, compact, and firm texture, of a ſmooth and equal ſurface, and in ſhape very irregular, being ſometimes round, ſometimes oblong, and often flat; in ſize it ſeldom exceeds two inches. It appears on a common inſpection to be of a fine deep black, but held up againſt the ſun or the light of a candle, it is an elegant red, clouded by a quantity of ſubtile black earth. We have it from the Eaſt Indies.

PRASIUM, in botany: a genus of the gymnoſpermia order, belonging to the didynamia claſs of plants; and in the natural method ranking under the 42d order, *Verticillatæ*. There are four monoſpermous berries.

PRATINAS, a Greek poet contemporary with Æſchylus, born at Phlius. He was the firſt among the Greeks who compoſed ſatires, which were repreſented as farces. Of theſe 32 were acted, as alſo 18 of his tragedies, one of which only obtained the poetical prize. Some of his verſes are extant, quoted by Athenæus.

PRATIQUE, or PRATTIC, in commerce, a negociation or communication of commerce which a merchant veſſel obtains in the port it arrives in and the countries it diſcovers: hence to obtain a pratique is to obtain liberty to frequent a port, to go aſhore, to buy and ſell, &c.

PRATT (CHARLES), earl of Camden, was the third ſon of Sir John Pratt, knight, chief-juſtice of the court of king's-bench under George I. by his ſecond wife Elizabeth, daughter of the reverend Hugh Wilſon, canon of Bangor, and was born in 1713, the year before his father was called to the honour of the bench. He received the firſt rudiments of his education at Eton, and afterwards removed to king's college, Cambridge. Of his early life at both places there is little known, other than that at college he was found to be remarkably diligent and ſtudious, and particularly ſo in the hiſtory and conſtitution of this country. By ſome he was thought to be a little too tenacious of the rights and privileges of the college he belonged to; but perhaps it was to this early tendency that we are indebted for thoſe noble ſtruggles in defence of liberty, which, whether in or out of office, he diſplayed through the whole courſe of his political life. After ſtaying out the uſual time at college, and taking his maſter's degree, in 1730 he entered himſelf a ſtudent of the Inner Temple, and was in due time admitted by that honourable ſociety as a barriſter at law. And here a circumſtance developes itſelf in the hiſtory of this great man, which ſhows how much chance governs in the affairs of this world, and that the moſt conſiderable talents and indiſputable integrity will ſometimes require the introduction of this miſtreſs of the ceremonies, in order to obtain that which they ought to poſſeſs from their own intrinſic qualifications.

Mr. Pratt after his being called to the bar, notwithſtanding his family introduction, and his own perſonal character, was very near nine years in the profeſſion, without ever getting in any degree forward. Whether this aroſe from a natural timidity of conſtitution, ill-luck, or perhaps a mixture of deſpondence growing out of the two circumſtances, it is now difficult to tell; but the fact was ſo: and he was ſo diſpirited by it, that he had ſome thoughts of relinquiſhing the profeſſion of the law, and retiring to his college, where, in rotation, he might be ſure of a church living, that would give him a ſmall but honourable independence. With theſe melancholy ideas he went as uſual the weſtern circuit, to make one more experiment, and then to take his final determination. Mr. Henley, afterwards lord Northington and chancellor of England, was in the ſame circuit: he was Mr. Pratt's moſt intimate friend; and he now availed himſelf of that friendſhip, and told him his ſituation, and his intentions of retiring to the univerſity and going into the church. He oppoſed his intention with ſtrong raillery, and got him engaged in a cauſe along with himſelf; and Mr. Henley being ill, Mr. Pratt took the lead, and diſplayed a profeſſional knowledge and elocution that excited the admiration of his brother barriſters as much as that of the whole court. He gained his cauſe; and, beſides, he acquired the reputation of an eloquent, profound, and conſtitutional lawyer. It was this circumſtance, together with the continued good offices of his friend Henley, which led to his future greatneſs; for with all his abilities and all his knowledge, he might otherwiſe in all probability have paſſed his life in obſcurity unnoticed and unknown.

He became now one of the moſt ſucceſsful pleaders at the bar, and honours and emoluments flowed thick upon him. He was choſen to repreſent the borough of Downton, Wilts, after the general election in 1759; recorder of Bath 1759; and the ſame year was appointed attorney-general; in January 1762 he was called to the degree of ſerjeant at law, appointed chief-juſtice of the common pleas, and knighted. His lordſhip preſided in that court with a dignity, weight, and impartiality, never exceeded by any of his predeceſſors; and when John Wilkes, Eſq. was ſeized and committed to the Tower on an illegal general warrant, his lordſhip, with the intrepidity of a Britiſh magiſtrate, and the becoming fortitude of an Engliſhman, granted him a *habeas corpus*; and, on his being brought before the court of common pleas, diſcharged him from his confinement in the Tower, May 6, 1763, in a ſpeech which did him honour. His wiſe and ſpirited behaviour on this remarkable occaſion, ſo intereſting to every true-born Briton, and in the conſequent judicial proceedings between the printers of The North Briton and the meſſengers and others, was ſo acceptable to the nation, that the city of London preſented him with the freedom of their corporation in a gold box, and deſired his picture, which was put up in Guildhall, with this inſcription;

HANC ICONEM
CAROLI PRATT, EQ.
SUMMI JUDICIS C. B.
IN HONOREM TANTI VIRI,
ANGLICÆ LIBERTATIS LEGE
ASSERTORIS
S. P. Q. L.
IN CURIA MUNICIPALI
PONI JVSSERVNT
NONO KAL. MART. A. D. MDCCLXIV.
GULIELMO BRIDGEN, AR. PRÆ. VRB.

This portrait, painted by Reynolds, was engraved by Baſire. The corporations of Dublin, Bath, Exeter, and Norwich, paid him the like compliment; and in a petition entered in the journals of the city of Dublin, it was declared, that no man appeared to have acquitted himſelf in his high ſtation with ſuch becoming zeal for the honour and dignity of the crown, and the fulfilling his majeſty's moſt gracious intentions for preſerving the freedom and happineſs of his ſubjects, and ſuch invincible fortitude in adminiſtering juſtice and law, as the right honourable Sir Charles Pratt, knight, the preſent lord-chief-juſtice of his majeſty's court of common pleas in England, has ſhown in ſome late judicial determinations, which muſt be remembered to his lordſhip's honour while and wherever Britiſh liberties are held ſacred.

Higher honours, however, than the breath of popular applauſe awaited Sir Charles Pratt. On the 15th of July 1765, he was created a peer of Great Britain by the ſtyle and title of lord Camden, baron Camden, in the county of Kent; and, July 30, 1766, on the reſignation of Robert earl of Northington, he was appointed lord high chancellor of Great Britain; in which capacity he, in a ſpeech of two hours, declared, upon the firſt deciſion of the ſuit againſt the meſſengers who arreſted Mr. Wilkes, that "it was the unanimous opinion of the whole court, that general warrants, except in caſes of high treaſon, were illegal, oppreſſive, and unwarrantable. He conducted himſelf in this high office ſo as to obtain the love and eſteem of all parties; but when the taxation of America was in agitation, he declared himſelf againſt it, and ſtrongly oppoſing it, was removed from his ſtation in 1770.

Upon the fall of lord North he was again taken into the adminiſtration, and on the 27th of March 1782 appointed preſident of the council; an office which he reſigned in March 1783. On the 13th of May 1786, he was created viſcount Bayham of Bayham Abbey, Kent, and earl Camden.

Whether we conſider earl Camden as a *ſtateſman*, called to that high ſituation by his talents; as a *lawyer*, defending, ſupporting, and enlarging the conſtitution; or as a *man* ſuſtaining both by his firmneſs and unſhaken integrity—in all he excites our general praiſe; and when we contemplate his high and exalted virtue, we muſt allow him to have been an honour to his country. He died on the 18th of April 1794 at his houſe in Hill-ſtreet, Berkeley-ſquare, being at that time preſident of his majeſty's moſt honourable privy-council, a governor of the charter-houſe, recorder of the city of Bath, and F. R. S.

He married Elizabeth (daughter and coheir of Nicholas Jafferys, Eſq., ſon and heir of Sir Jeffery Jafferys of Brecknock priory, knight,) who died in December 1779, and by whom he had iſſue John Jafferys Pratt (now lord Camden), born 1759, M. P. for Bath, commiſſioner of the admiralty, 1782, reſigned and reappointed 1783; and four daughters,—Frances, married, 1775, Robert Stewart, Eſq. of Mount Stewart, county of Down, 1779, and M. P. for that county; Elizabeth, ſingle; Sarah, married Nicholas Saintfield, Eſq. county of Down, 1779; Jane, married, 1780, William Head James, Eſq. ſon and heir of Sir F. Head of Langley, county of Bucks. His ſeat at Camden Place, Chiſelhurſt, was the reſidence of the great William Camden; on whoſe death it came by ſeveral intermediate owners to Weſton, Spencer, and Pratt, and was much improved by his lordſhip. His remains were interred in the family burying-place at Seal, in Kent.

PRAXAGORAS, a native of Athens, at 19 years of age compoſed the Hiſtory of the Kings of Athens, in two books; and at 22 the Life of Conſtantine the Great, in which, though a pagan, he ſpeaks very advantageouſly of that prince. He alſo wrote the Hiſtory of Alexander the Great. He lived under Conſtantine about the year 345.

PRAXITELES, a very famous Greek ſculptor, who lived 330 years before Chriſt, at the time of the reign of Alexander the Great. All the ancient writers mention his ſtatues with a high commendation, eſpecially a Venus executed by him for the city of Cnidos, which was ſo admirable a piece, that king Nicomedes offered to releaſe the inhabitants from their tribute as the purchaſe of it; but they refuſed to part with it. The inhabitants of the iſle of Cos requeſted of Praxiteles a ſtatue of Venus; and in conſequence of this application the artiſt gave them their choice of two; one of which repreſented the goddeſs entirely naked, and the other covered with drapery. Both of theſe were of exquiſite workmanſhip; although the former was eſteemed the moſt beautiful, nevertheleſs the inhabitants of Cos had the wiſdom to give the preference to the latter, from a conviction that no motive whatever could juſtify their introducing into their city any indecent ſtatues or paintings, which are ſo likely to inflame the paſſions of young people, and lead them to immorality and vice. What a reproach will this be to many Chriſtians?—He was one of the gallants of of Phryne the celebrated courteſan.

PRAYER, a ſolemn addreſs to God, which, when it is of any conſiderable length, conſiſts of *adoration*, *confeſſion*, *ſupplication*, *interceſſion*, and *thankſgiving*.

By *adoration* we expreſs our ſenſe of God's infinite perfections, his power, wiſdom, goodneſs, and mercy; and acknowledge that our conſtant dependence is upon him by whom the univerſe was created and has been hitherto preſerved. By *confeſſion* is meant our acknowledgment of our manifold tranſgreſſions of the divine laws, and our conſequent unworthineſs of all the good things which we enjoy at preſent or expect to be conferred upon us hereafter. In *ſupplication* we intreat our omnipotent Creator and merciful judge, not to deal with us after our iniquities, but to pardon our tranſgreſſions, and by his grace to enable us to live henceforth righteouſly, ſoberly, and godly, in this preſent world; and by Chriſtians this intreaty is always made in the name and through the mediation of Jeſus Chriſt, becauſe to them it is known that there is none other name under heaven given unto men whereby they may be ſaved. To theſe ſupplications for mercy we may likewiſe add our prayers for the neceſſaries of life; becauſe if we ſeek *firſt* the kingdom of God and his righteouſneſs, we are aſſured that ſuch things ſhall be added unto us. *Interceſſion* ſignifies thoſe petitions which we offer up for others, for friends, for enemies, for all men, eſpecially for our lawful governors, whether ſupreme or ſubordinate. And *thankſgiving* is the expreſſion of our gratitude to God, the giver of every good and perfect gift, for all the benefits enjoyed by us and others, for the means of grace, and for the hope of glory. Such are the component parts of a regular and ſolemn prayer, adapted either for the church or for the cloſet. But an ejaculation to God, conceived on any emergency, is likewiſe a prayer, whether it be uttered by the voice or ſuffered to remain a mere affection of the mind; becauſe the Being to whom it is addreſſed diſcerneth the thoughts of the heart.

That prayer is a duty which all men ought to perform with humility and reverence, has been generally acknowledged as well by the untaught barbarian as by the enlightened Chriſtian.

Nothing ſo forcibly reſtrains from ill as the remembrance of a recent addreſs to heaven for protection and aſſurance. After having petitioned for power to reſiſt temptation, there is ſo great an incongruity in not continuing the ſtruggle, that we bluſh at the thought, and perſevere leſt we loſe all reverence for ourſelves. After fervently devoting our ſouls to God, we ſtart with horror at immediate apoſtacy: every act of deliberate wickedneſs is then complicated with hypocriſy and ingratitude: it is a mockery of the Father of Mercies, the forfeiture of that peace in which we cloſed our addreſs, and a renunciation of the hope which that addreſs inſpired. But if prayer and immorality be thus incompatible, ſurely the former ſhould not be neglected by thoſe who contend that moral virtue is the ſummit of human perfection.

PREACHING. See Declamation, Art. I.—The word is derived from the Hebrew *paraſch*, *expoſuit*, "he expounded."

PREADAMITE, a denomination given to the inhabitants of the earth, conceived, by ſome people, to have lived before Adam. Iſaac de la Pereyra, in 1655, publiſhed a book to evince the reality of Preadamites, by which he gained a conſiderable number of proſelytes to the opinion: but the anſwer of Demarets, profeſſor of theology at Groningen, publiſhed the year following, put a ſtop to its progreſs; though Pereyra made a reply —His ſyſtem was this: The Jews he calls *Adamites*, and ſuppoſes them to have iſſued from Adam; and gives the title *Preadamites* to the Gentiles, whom he ſuppoſes to have been a long time before Adam. But this being expreſsly contrary to the firſt words of Geneſis, Pereyra had recourſe to the fabulous antiquities of the Egyptians and Chaldæans, and to ſome idle rabbins, who imagined there had been another world before that deſcribed by Moſes. He was apprehended by the inquiſition in Flanders, and very roughly uſed, though in the ſervice of the dauphin. But he appealed from their ſentence to Rome; whither he went in the time of Alexander VII. and where he printed a retractation of his book of Preadamites. See Pre-existence.

PREAMBLE, in law, the beginning of an act of parliament, &c. which ſerves to open the intent of the act, and the miſchiefs intended to be remedied by it.

PREBEND, the maintenance a prebendary receives out of the eſtate of a cathedral or collegiate church. Prebends are diſtinguiſhed into ſimple and dignitary: a ſimple prebend has no more than the revenue for its ſupport; but a prebend with dignity has always a juriſdiction annexed to it.

PREBENDARY, an eccleſiaſtic who enjoys a prebend.—The difference between a prebendary and a canon is, that the former receives his prebend in conſideration of his officiating in the church, but the latter merely by his being received into the cathedral or college.

PRECEDENCE, a place of honour to which a perſon is entitled. This is either of courteſy or of right. The former is that which is due to age, eſtate, &c. which is regulated by cuſtom and civility: the latter is ſettled by authority; and, when broken in upon, gives an action at law.

The order of precedency in Great Britain is ſhown at the cloſe of the article Heraldry.

PRECEDENT, in law, a caſe which has been determined, and which ſerves as a rule for all of the ſame nature.

PRECENTOR, a dignitary in cathedrals, popularly called the *chantor*, or *maſter of the choir*.

PRECEPT, in law, a command in writing ſent by a chief juſtice or juſtice of the peace, for bringing a perſon, record, or other matter, before him.

PRECEPTIVE, any thing which gives or contains precepts.

Preceptive *Poetry*. See Poetry.

PRECESSION of the Equinoxes. The moſt obvious of all the celeſtial motions is the diurnal revolution of the ſtarry heavens. The whole appears to turn round an imaginary axis, which paſſes through two oppoſite points of the heavens, called the *poles*. One of theſe is in our ſight, being very near the ſtar and in the tail of the little bear. The great circle which is equidiſtant from both poles divides the heavens into the northern and ſouthern hemiſpheres, which are equal. It is called the *equator*, and it cuts the horizon in the eaſt and weſt points, and every ſtar in it is 12 ſiderial hours above and as many below the horizon, in each revolution.

The ſun's motions determine the length of day and night, and the viciſſitudes of the ſeaſons. By a long ſeries of obſervations, the ſhepherds of Aſia were able to mark out the ſun's path in the heavens; he being always in the oppoſite point to that which comes to the meridian at midnight, with equal but oppoſite declination. Thus they could tell the ſtars among which the ſun then was, although they could not ſee them. They diſcovered that his path was a great circle of the heavens, afterward called the ECLIPTIC; which cuts the equator in two oppoſite points, dividing it, and being divided by it, into two equal parts. They further obſerved, that when the ſun was in either of theſe points of interſection, his circle of diurnal revolution coincided with the equator, and therefore the days and nights were equal. Hence the equator came to be called the EQUINOCTIAL LINE, and the points in which it cuts the ecliptic were called the EQUINOCTIAL POINTS, and the ſun was then ſaid to be in the equinoxes. One of theſe was called the VERNAL and the other the AUTUMNAL EQUINOX.

It was evidently an important problem in practical aſtronomy to determine the exact moment of the ſun's occupying theſe ſtations; for it was natural to compute the courſe of the year from that moment. Accordingly this has been the leading problem in the aſtronomy of all nations. It is ſuſceptible of conſiderable preciſion, without any apparatus of inſtruments. It is only neceſſary to obſerve the ſun's declination on the noon of two or three days before and after the equinoctial day. On two conſecutive days of this number, his declination muſt have changed from north to ſouth, or from ſouth to north. If his declination on one day was obſerved to be 21′ north, and on the next 5′ ſouth, it follows that his declination was nothing, or that he was in the equinoctial point about 23 minutes after 7 in the morning of the ſecond day. Knowing the preciſe moments, and knowing the rate of the ſun's motion in the ecliptic, it is eaſy to aſcertain the preciſe point of the ecliptic in which the equator interſected it.

By a ſeries of ſuch obſervations made at Alexandria, between the years 161 and 127 before Chriſt, Hipparchus, the father of our aſtronomy, found that the point of the autumnal equinox was about ſix degrees to the eaſtward of the ſtar called SPICA VIRGINIS. Eager to determine every thing by multiplied obſervations, he ranſacked all the Chaldæan, Egyptian, and other records, to which his travels could procure him acceſs, for obſervations of the ſame kind; but he does not mention his having found any. He found, however, ſome obſervations of Ariſtillus and Timochares made about 150 years before. From theſe it appeared evident that the point of the autumnal equinox was then about eight degrees eaſt of the ſame ſtar. He diſcuſſes theſe obſervations with great ſagacity and rigour; and, on their authority, he aſſerts that the equinoctial points are not fixed in the heavens, but move to the weſtward about a degree in 75 years, or ſomewhat leſs.

This motion is called the PRECESSION OF THE EQUINOXES, becauſe by it the time and place of the ſun's equinoctial ſtation precedes the uſual calculations: it is fully confirmed by all ſubſequent obſervations. In 1750 the autumnal equinox was obſerved to be 20° 21′ weſtward of ſpica virginis. Suppoſing the motion to have been uniform during this period of ages, it follows that the annual preceſſion is about $50''\frac{1}{4}$; that is, if the celeſtial equator cut the ecliptic in a particular point on any day of this year, it will on the ſame day of the following year cut it in a point $50''\frac{1}{4}$ to the weſt of it, and the ſun will come to the equinox 20′ 23″ before he has completed his round of the heavens. Thus the equinoctial or tropical year, or true year of ſeaſons, is ſo much ſhorter than the revolution of the ſun or the ſidereal year.

It is this diſcovery that has chiefly immortalized the name of Hipparchus, though it muſt be acknowledged that all his aſtronomical reſearches have been conducted with the ſame ſagacity and intelligence It was natural therefore for him to value himſelf highly for the diſcovery. It muſt be acknowledged to be one of the moſt ſingular that has been made, that the revolution of the whole heavens ſhould not be ſtable, but its axis continually changing. For it muſt be obſerved, that ſince the equator changes its poſition, and the equator is only an imaginary circle, equidiſtant from the two poles or extremities of the axis; theſe poles and this axis muſt equally change their poſitions. The equinoctial points make a complete revolution in about 25745, the equator being all the while inclined to the ecliptic in nearly the ſame angle. Therefore the poles of this diurnal revolution muſt deſcribe a circle round the poles of the ecliptic at the diſtance of about $23\frac{1}{2}$ degrees in 25745 years; and in the time of Timochares the north pole of the heavens muſt have been 30 degrees eaſtward of where it now is.

Hipparchus has been accuſed of plagiariſm and inſincerity in this matter. It is now very certain that the preceſſion of the equinoxes was known to the aſtronomers of India many ages before the time of Hipparchus. It appears alſo that the Chaldæans had a pretty accurate knowledge of the year of ſeaſons. From their ſaros we deduce their meaſure of this year to be 365 days 5 hours 49 minutes and 11 ſeconds, exceeding the truth only by 26″, and much more exact than the year of Hipparchus. They had alſo a ſidereal year of 365 days 6 hours 11 minutes. Now what could occaſion an attention to two years, if they did not ſuppoſe the equinoxes moveable? The Egyptians alſo had a knowledge of ſomething equivalent to this; for they had diſcovered that the dog-ſtar was no longer the faithful forewarner of the overflowing of the Nile, and they combined him with the ſtar Fomalhaſet in their myſtical kalendar. This knowledge is alſo involved in the precepts of the Chineſe aſtronomy, of much older date than the time of Hipparchus.

But all theſe acknowledged facts are not ſufficient for depriving Hipparchus of the honour of the diſcovery, or fixing on him the charge of plagiariſm. This motion was a thing unknown to the aſtronomers of the Alexandrian ſchool, and it was pointed out to them by Hipparchus in the way in which he aſcertained every other poſition in aſtronomy, namely, as the mathematical reſult of actual obſervations, and not as a thing deducible from any opinions on other ſubjects related to it. We ſee him, on all other occaſions, eager to confirm his own obſervations, and his deductions from them, by every thing he could pick up from other aſtronomers; and he even adduced the above-mentioned practice of the Egyptians in corroboration of his doctrine. It is more than probable then that he did not know any thing more. Had he known the Indian preceſſion of 54″ annually, he had no temptation whatever to withold him from uſing it in preference to one which he acknowledges to be inaccurate, becauſe deduced from the ſhort period of 150 years, and from the obſervations of Timochares, in which he had no great confidence.

This motion of the ſtarry heavens was long a matter of diſcuſſion, as a thing for which no phyſical reaſon could be aſſigned. But the eſtabliſhment of the Copernican ſyſtem reduced it to a very ſimple affair; the motion which was thought to affect all the heavenly bodies, is now acknowledged to be a deception, or a falſe judgment from the appearances. The earth turns round its own axis while it revolves round the ſun, in the ſame manner as we may cauſe a child's top to ſpin on the brim of a mill-ſtone, while the ſtone is turning ſlowly round its axis. If the top ſpin ſteadily, without any wavering, its axis will always point to the zenith of the heavens; but we frequently ſee, that while it ſpins briſkly round its axis, the axis itſelf has a ſlow conical motion round the vertical line, ſo that, if produced, it would ſlowly deſcribe a circle in the heavens round the zenith point. The flat ſurface of the top may repreſent the terreſtrial equator, gradually turning itſelf round on all ſides. If this top were formed like a ball, with an equatorical circle on it, it would repreſent the whole motion very prettily, the only difference being, that the ſpinning motion and this wavering motion are in the ſame direction; whereas the diurnal rotation and the motion of the equinoctial points are in contrary directions. Even this diſſimularity may be removed, by making the top turn on a cap, like the card of a mariner's compaſs.

It is now a matter fully eſtabliſhed, that while the earth revolves round the ſun from weſt to eaſt, in the plane of the ecliptic, in the courſe of a year it turns round its own axis from weſt to eaſt in 23^h 56′ 4″, which axis is inclined to this plane in an angle of nearly 23° 28′; and that this axis turns round a line perpendicular to the ecliptic in 25,745 years from eaſt to weſt, keeping nearly the ſame inclination to the ecliptic.—By this means, its pole in the ſphere of the ſtarry heavens deſcribes a circle round the pole of the ecliptic at the diſtance of 23° 28′ nearly. The conſequence of this muſt be, that the terreſtial equator, when produced to the ſphere of the ſtarry heavens, will cut the ecliptic in two oppoſite points, through which the ſun muſt paſs when he makes the day and night equal; and that theſe points muſt ſhift to the weſtward, at the rate of $50\frac{1}{3}$ ſeconds annually, which is the preceſſion of the equinoxes. Accordingly this has been the received doctrine among aſtronomers for nearly three centuries, and it was thought perfectly conformable to appearances.

But Dr. Bradley, the moſt ſagacious of modern aſtronomers, hoped to diſcover the parallax of the earth's orbit by obſervations of the actual poſition of the pole of the celeſtial revolution. Dr. Hooke had attempted this before, but with very imperfect inſtruments. The art of obſerving being now prodigiouſly improved, Dr. Bradley reſumed this inveſtigation. It will eaſily appear, that if the earth's axis keep parallel to itſelf, its extremity muſt deſcribe in the ſphere of the ſtarry heavens a figure equal and parallel to its orbit round the ſun; and if the ſtars be ſo near that this figure is a viſible object, the pole of diurnal revolution will be in different diſtinguiſhable points of this figure. Conſequently, if the axis deſcribe the cone already mentioned, the pole will not deſcribe a circle round the pole of the ecliptic, but will have a looped motion along this circumference, ſimilar to the abſolute motion of one of Jupiter's ſatellites, deſcribing an epicycle whoſe centre deſcribes the circle round the pole of the ecliptic.

He accordingly obſerved ſuch an epicyclical motion, and thought that he had now overcome the only difficulty in the Copernican ſyſtem; but, on maturely conſidering his obſervations, he found this epicycle to be quite inconſiſtent with the conſequences of the annual parallax, and it puzzled him exceedingly. One day, while taking the amuſement of ſailing about on the Thames, he obſerved that every time the boat tacked, the direction of the wind, eſtimated by the direction of the vane, ſeemed to change. This immediately ſuggeſted to him the cauſe of his obſerved epicycle, and he found it an optical illuſion, occaſioned by a combination of the motion of light with the motion of his teleſcope while obſerving the polar ſtars. Thus he unwittingly eſtabliſhed an incontrovertible argument for the truth of the Copernican ſyſtem, and immortalized his name by his diſcovery of the ABERRATION of the ſtars.

He now engaged in a ſeries of obſervations for aſcertaining all the circumſtances of this diſcovery. In the courſe of theſe, which were continued for 28 years, he diſcovered another epicyclical motion of the pole of the heavens, which was equally curious and unexpected. He found that the pole deſcribed an epicycle, whoſe diameter was about 16′, having for its centre that point of the circle round the pole of the ecliptic in which the pole would have been found independent of this new motion. He alſo obſerved, that the period of this epicyclical motion was 18 years and ſeven months. It ſtruck him, that this was preciſely the period of the revolution of the nodes of the moon's orbit. He gave a brief account of theſe reſults to Lord Macclesfield, then preſident of the Royal Society, in 1747. Mr. Machin, to whom he alſo communicated the obſervations, gave him in return a very neat mathematical hypotheſis, by which the motion might be calculated.

Let E (pl. 19. fig. 1.), be the pole of the ecliptic, and SPQ a circle diſtant from it 23° 28′, repreſenting the circle deſcribed by the pole of the equator during one revolution of the equinoctial points. Let P be the place of this laſt mentioned pole at ſome given time. Round P deſcribe a circle ABCD, whoſe diameter AC is 15′. The real ſituation of the pole will be in the circumference of this circle; and its place, in this circumference depends on the place of the moon's aſcending node. Draw EPF and GPL perpendicular to it; let GL be the colure of the equinoxes, and EF the colure of the ſolſtices. Dr. Bradley's obſervations ſhowed that the pole was in A when the node was in L, the vernal equinox. If the node recede to H, the winter ſolſtice, the pole is in B. When the node is in the autumnal equinox at G. the pole is at C; and when the node is in F, the ſummer ſolſtice, the pole is in D. In all intermediate ſituations of the moon's aſcending node, the pole is in a point of the circumference ABCD, three ſigns or 90° more advanced.

Dr. Bradley, by comparing together a great number of obſervations, found that the mathematical theory, and the calculation depending on it, would correſpond much better with the obſervations, if an ellipſe were ſubſtituted for the circle ABCD, making the longer axis AC 18′, and the ſhorter, BD, 16″. Mr. D'Alembert determined, by the phyſical theory of gravitation, the axes to be 18″ and 13″,4.

Theſe obſervations, and this mathematical theory muſt be conſidered as ſo many facts in aſtronomy, and we muſt deduce from them the methods of computing the places of all celeſtial phenomena, agreeable to the univerſal practice of determining every point of the heavens by its longitude, latitude, right aſcenſion, and declination.

It is evident, in the firſt place, that this equation of the pole's motion makes a change in the obliquity of the ecliptic. The inclination of the equator to the ecliptic is meaſured by the arch of a great circle intercepted between their poles. Now, if the pole be in O inſtead of P, it is plain that the obliquity is meaſured by EO inſtead of EP. If EP be conſidered as the mean obliquity of the ecliptic, it is augmented by 9″ when the moon's aſcending node is in the vernal equinox, and conſequently the pole in A. It is, on the contrary, diminiſhed 9″ when the node is in the autumnal equinox, and the pole in C; and it is equal to the mean when the node is in the colure of the ſolſtices. This change of the inclination of the earth's axis to the plane of the ecliptic was called the NUTATION of the axis by Sir Iſaac Newton; who ſhowed that a change of nearly a ſecond muſt obtain in a year by the action of the ſun on the prominent parts of the terreſtial ſpheroid. But he did not attend to the change which would be made in this motion by the variation which obtains in the diſturbing force of the MOON, in conſequence of the different obliquity of her action on the equator, ariſing from the motion of her own oblique orbit. It is this change which now goes by the name NUTATION, and we owe its diſcovery entirely to Dr. Bradley. The general change of the poſition of the earth's axis has been termed DEVIATION by modern aſtronomers.

PRECESSION OF THE EQUINOXES.

Fig. 1.

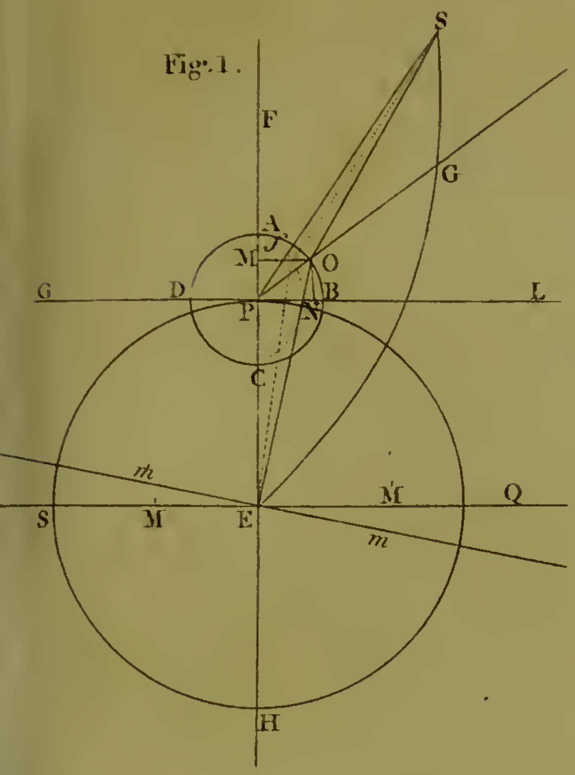


Fig. 2.

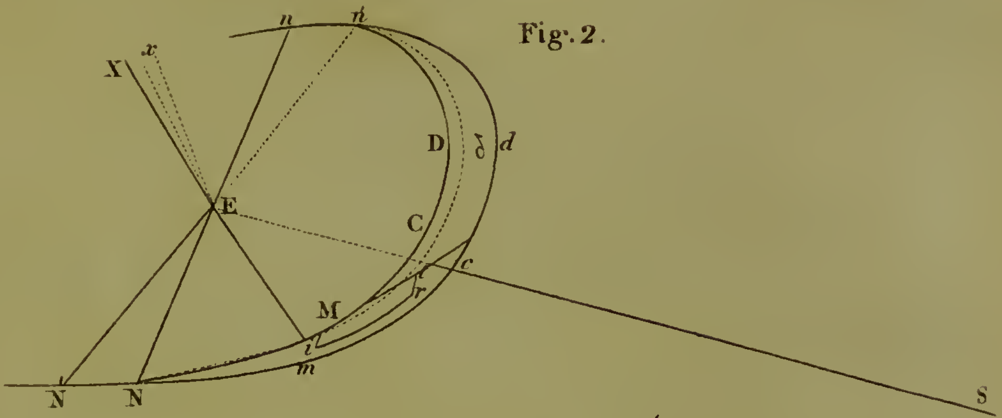


Fig. 3.

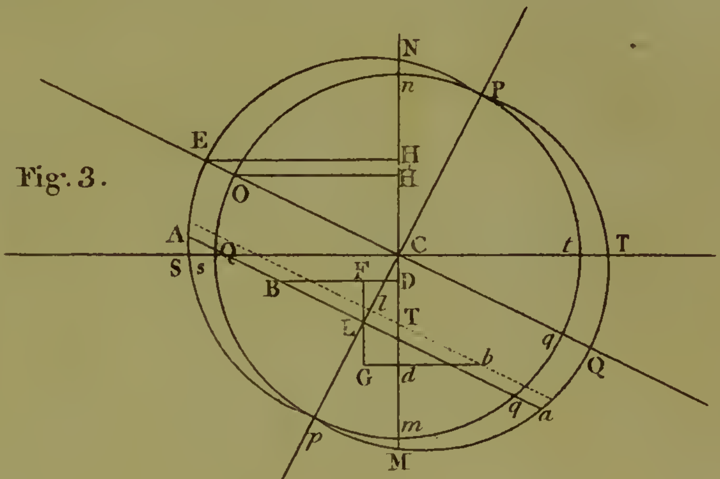


Fig. 5.

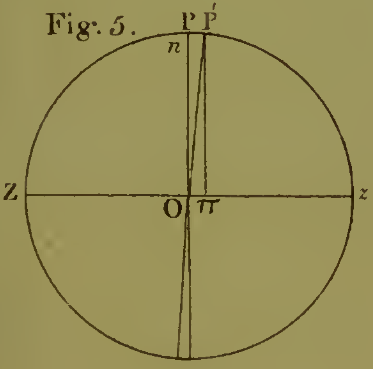


Fig. 4.

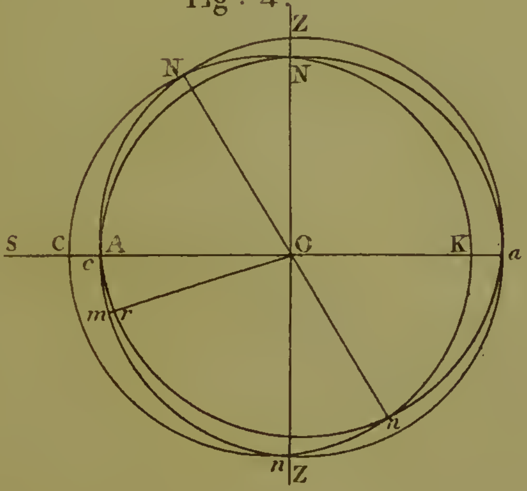


Fig. 6.

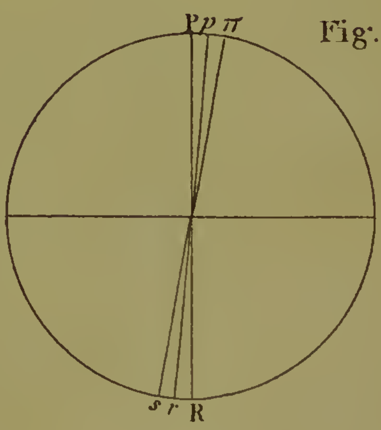


Fig. 7.

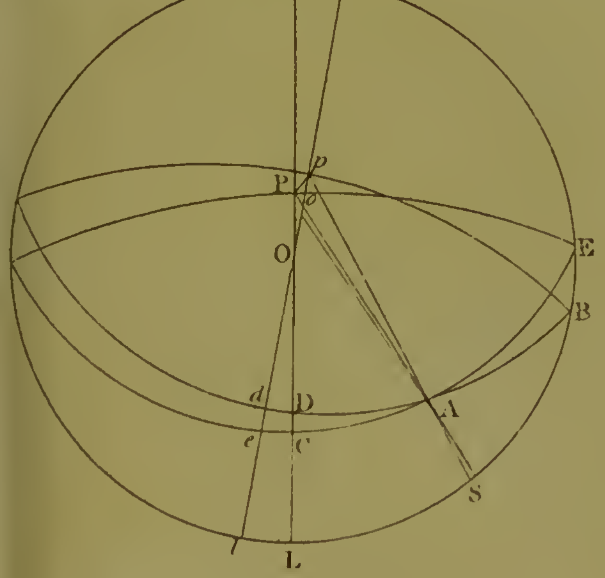
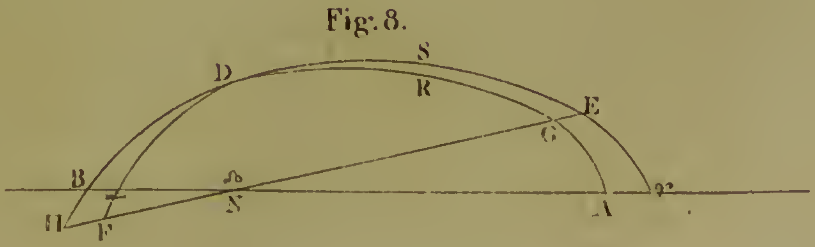


Fig. 8.



The quantity of this change of obliquity is eaſily aſcertained. It is evident, from what has been already ſaid, that when the pole is in O, the arch ADCO is equal to the node's longitude from the vernal equinox, and that PM is its coſine; and (on account of the ſmallneſs of AP in compariſon of EP) PM may be taken for the change of the obliquity of the ecliptic. This is therefore $= 9'' +$ coſ. long. node, and is additive to the mean obliquity, while O is in the ſemicircle BAD, that is, while the longitude of the node is from 9 ſigns to 3 ſigns; but ſubtractive while the longitude of the node changes from 3 to 9 ſigns.

But the nutation changes alſo the longitudes and right aſcenſions of the ſtars and planets, by changing the equinoctial points and thus occaſioning an equation in the preceſſion of the equinoctial points. It was this circumſtance which made it neceſſary for us to conſider it in this place, while expreſsly treating of this preceſſion. Let us attend to this derangement of the equinoctial points.

The great circle or meridian which paſſes through the poles of the ecliptic and equator is always the ſolſtitial colure, and the equinoctial colure is at right angles to it: therefore when the pole is in P or in O, EP or EO is the ſolſtitial colure. Let S be any fixed ſtar or planet, and let SE be a meridian or circle of longitude; draw the circles of declination PS, OS, and the circles $M'EM'$, mEm', perpendicular to PE, OE.

If the pole were in its mean place P, the equinoctial points would be in the ecliptic meridian $M'EM'$, or that meridian would paſs through the interſections of the equator and ecliptic, and the angle $M'ES$ would meaſure the longitude of the ſtar S. But when the pole is in O, the ecliptic meridian mEm' will paſs through the equinoctial points. The equinoctial points muſt therefore be to the weſtward of their mean place, and the equation of the preceſſion muſt be additive to that preceſſion: and the longitude of the ſtar S will now be meaſured by the angle mES, which, in the caſe here repreſented, is greater than its mean longitude. The difference, or the equation of longitude ariſing from the nutation of the earth's axis is the angle OEP, or $\frac{OM}{OE}$. OM is the ſine of the angle CPO, which, by what has been already obſerved, is equal to the longitude of the node: Therefore OM is equal to $9'' +$ long. node, and $\frac{OM}{OE}$ is equal to $\frac{9'' \times \text{ſin. long. node}}{\text{ſin. obliq. eclip.}}$. This equation is additive to the mean longitude of the ſtar when O is in the ſemicircle CBA, or while the aſcending node is paſſing backwards from the vernal to the autumnal equinox; but it is ſubtractive from it while O is in the ſemicircle ADC, or while the node is paſſing backwards from the autumnal to the vernal equinox; or, to expreſs it more briefly, the equation is ſubtractive from the mean longitude of the ſtar, while the aſcending node is in the firſt ſix ſigns, and additive to it while the node is in the laſt ſix ſigns.

This equation of longitude is the ſame for all the ſtars, for their longitude is reckoned on the ecliptic (which is here ſuppoſed invariable); and therefore is affected only by the variation of the point from which the longitude is computed.

The right aſcenſion, being computed on the equator, ſuffers a double change. It is computed from, or begins at, a different point of the equator, and it terminates at a different point; becauſe the equator having changed its poſition, the circles of declination alſo change theirs. When the pole is at P, the right aſcenſion of S from the ſolſtitial colure is meaſured by the angle SPE, contained between that colure and the ſtar's circle of declination. But when the pole is at O, the right aſcenſion is meaſured by the angle SOE, and the difference of SPE and SOE is the equation of right aſcenſion. The angle SOE conſiſts of two parts, GOE and GOS; GOE remains the ſame wherever the ſtar S is placed, but GOS varies with the place of the ſtar.—We muſt firſt find the variation by which GPE becomes GOE, which variation is common to all the ſtars. The triangles GPE, GOE, have a conſtant ſide GE, and a conſtant angle G; the variation PO of the ſide GP is extremely ſmall, and therefore the variation of the angles may be computed by Mr. Cotes's Fluxionary Theorems. See Simpſon's *Fluxions*, § 253, &c. As the tangent of the ſide EP, oppoſite to the conſtant angle G, is to the ſine of the angle EPG, oppoſite to the conſtant ſide EG, ſo is PO the variation of the ſide GP adjacent to the conſtant angle, to the variation x of the angle GPO, oppoſite to the conſtant ſide EG. This gives $x = \frac{9' \times \text{ſin. long. node}}{\text{tang. obl. eclip.}}$. This is ſubtractive from the mean right aſcenſion for the firſt ſix ſigns of the node's longitude, and additive for the laſt ſix ſigns. This equation is common to all the ſtars.

The variation or the other part SOG of the angle, which depends on the different poſition of the hour circles PS and OS, which cauſes them to cut the equation in different points, where the arches of right aſcenſion terminate may be diſcovered as follows. The triangles SPG, SOG, have a conſtant ſide SG, and a conſtant angle G. Therefore, by the ſame Coteſian theorem, tan. SP : ſin. SPG = PO : y, and y, or the ſecond part of the nutation in right aſcenſion, $= \frac{9'' \times \text{ſin. diff. R. A. of ſtar and node}}{\text{cotan. declin. ſtar}}$.

The nutation alſo effects the declination of the ſtars: For SP, the mean codeclination, is changed into SO.—Suppoſe a circle deſcribed round S, with the diſtance SO cutting SP in f; then it is evident that the equation of declin. is $Pf = PO \times$ coſine $OPf = 9'' \times \overline{\text{ſign. r. aſcen. of ſtar—long. of node}}$.

Such are the calculations in conſtant uſe in our aſtronomical reſearches, founded on Machin's Theory. When ſtill greater accuracy is required, the elliptical theory muſt be ſubſtituted, by taking (as is expreſſed by the dotted lines) O in that point of the ellipſe deſcribed on the tranſverſe axis AC, where it is cut by OM, drawn according to Machin's theory. All the change made here is the diminution of OM in the ratio of 18 to 13,4, and a correſponding diminution of the angle CPO. The detail of it may be ſeen in De la Lande's *Aſtronomy*, art. 2874; but is rather foreign to our preſent purpoſe of explaining the preceſſion of the equinoxes. The calculations being in every caſe tedious, and liable to miſtakes, on account of the changes of the ſigns of the different equations, the zealous promoters of aſtronomy have calculated and publiſhed tables of all theſe equations, both on the circular and elliptical hypotheſis. And ſtill more to abridge calculations, which occur in reducing every aſtronomical obſervation, when the place of a phenomenon is deduced from a compariſon with known fixed ſtars, there have been publiſhed tables of nutation and preceſſion, for ſome hundreds of the principal ſtars, for every poſition of the moon's node and of the ſun.

It now remains to conſider the preceſſion of the equinoctial points, with its equations, ariſing from the nutation of the earth's axis as a phyſical phenomenon, and to endeavour to account for it upon thoſe mechanical principles, which have ſo happily explained all the other phenomena of the celeſtial motions.

This did not eſcape the penetrating eye of Sir Iſaac Newton; and he quickly found it to be a conſequence, and the moſt beautiful proof, of the univerſal gravitation of all matter to all matter; and there is no part of his immortal work where his ſagacity and fertility of reſource ſhine more conſpicuouſly than in this inveſtigation. It muſt be acknowledged, however, that Newton's inveſtigation is only a ſhrewd gueſs founded on aſſumptions, of which it would be extremely difficult to demonſtrate either the truth or falſity, and which required the genius of a Newton to pick out in ſuch a complication of abſtruſe circumſtances. The ſubject has occupied the attention of the firſt mathematicians of Europe ſince his time; and is ſtill conſidered as the moſt curious and difficult of all mechanical problems. The moſt elaborate and accurate diſſertations on the preceſſion of the equinoxes are thoſe of Sylvabella and Walmeſly, in the Philoſophical Tranſactions, publiſhed about the year 1754; that of Thomas Simpſon, publiſhed in his Miſcellaneous Tracts; that of Father Friſius, in the Memoirs of the Berlin Academy, and afterwards, with great improvements in his Coſmographia; that of Euler in the Memoirs of Berlin; that of D'Alembert in a ſeparate diſſertation; and that of De la Grange on the Libration of the Moon, which obtained the prize in the Academy of Paris in 1769. We think the diſſertation of Father Friſius the moſt perſpicuous of them all, being conducted in the method of geometrical analyſis; whereas moſt of the others proceed in the fluxionary and ſymbolic method, which is frequently deficient in diſtinct notions of the quantities under conſideration, and therefore does not give us the ſame perſpicuous conviction of the truth of the reſults. In a work like ours, it is impoſſible to do juſtice to the problem, without entering into a detail which would be thought extremely diſproportioned to the ſubject by the generality of our readers. Yet thoſe who have the neceſſary preparation of mathematical knowledge, and wiſh to underſtand the ſubject fully, will find enough here to give them a very diſtinct notion of it; and in the article ROTATION, they will find the fundamental theorems, which will enable them to carry on the inveſtigation. We ſhall firſt give a ſhort ſketch of Newton's inveſtigation, which is of the moſt palpable and popular kind, and is highly valuable, not only for its ingenuity, but alſo becauſe it will give our unlearned readers diſtinct and ſatisfactory conceptions of the chief circumſtances of the whole phenomena.

Let S (fig. 2.) be the ſun, E the earth, and M the moon, moving in the orbit $NMCDn$, which cuts the plane of the ecliptic in the line of the nodes Nn, and has one half raiſed above it, as repreſented in the figure, the other half being hid below the ecliptic. Suppoſe this orbit folded down; it will coincide with the ecliptic in the circle $N\,m\,c\,d\,n$. Let EX repreſent the axis of this orbit, perpendicular to its plane, and therefore inclined to the ecliptic. Since the moon gravitates to the ſun in the direction MS, which is all above the ecliptic, it is plain that this gravitation has a tendency to draw the moon towards the ecliptic. Suppoſe this force to be ſuch that it would draw the moon down from M to i in the time that ſhe would have moved from M to t, in the tangent to her orbit. By the combination of theſe motions, the moon will deſert her orbit, and deſcribe the line Mr, which makes the diagonal of the parallelogram; and if no further action of the ſun be ſuppoſed, ſhe will deſcribe another orbit $M\delta n'$, lying between the orbit $MCDn$ and the ecliptic, and ſhe will come to the ecliptic, and paſs through it in a point n', nearer to M than n is, which was the former place of her deſcending node. By this change of orbit, the line EX will no longer be perpendicular to it; but there will be another line Ex, which will now be perpendicular to the new orbit. Alſo the moon, moving from M to r, does not move as if ſhe had come from the aſcending node N, but from a point N lying beyond it; and the line of the nodes of the orbit in this new poſition is $N'n'$. Alſo the angle $MN'm$ is leſs than the angle MNm.

Thus the nodes ſhift their places in a direction oppoſite to that of her motion, or move to the weſtward; the axis of the orbit changes its poſition, and the orbit itſelf changes its inclination to the ecliptic. Theſe momentary changes are different in different parts of the orbit, according to the poſition of the line of the nodes. Sometimes the inclination of the orbit is increaſed, and ſometimes the nodes move to the eaſtward. But, in general, the inclination increaſes from the time that the nodes are in the line of ſyzigee, till they get into quadrature, after which it diminiſhes till the nodes are again in ſyzigee. The nodes advance only while they are in the octants after the quadratures, and while the moon paſſes from quadrature to the node, and they recede in all other ſituations. Therefore the receſs exceeds the advance in every revolution of the moon round the earth, and, on the whole, they recede.

What has been ſaid of one moon would be true of each of a continued ring of moons ſurrounding the earth, and they would thus compoſe a flexible ring, which would never be flat, but waved according to the difference (both in kind and degree) of the diſturbing forces acting on its different parts. But ſuppoſe theſe moons to cohere, and to form a rigid and flat ring, nothing would remain in this ring but the exceſs of the contrary tendencies of its different parts. Its axis would be perpendicular to its plane, and its poſition in any moment will be the mean poſition of all the axis of the orbits of each part of the flexible ring; therefore the nodes of this rigid ring will continually recede, except when the plane of the ring paſſes through the ſun, that is, when the nodes are in ſyzigee; and (ſays Newton) the motion of theſe nodes will be the ſame with the mean motion of the nodes of the orbit of one moon. The inclination of this ring to the ecliptic will be equal to the mean inclination of the moon's orbit during any one revolution which has the ſame ſituation of the nodes. It will therefore be leaſt of all when the nodes are in quadrature, and will increaſe till they are in ſyzigee, and then diminiſh till they are again in quadrature.

Suppoſe this ring to contract in dimenſions, the diſturbing forces will diminiſh in the ſame proportion, and in this proportion will all their effects diminiſh. Suppoſe its motion of revolution to accelerate, or the time of a revolution to diminiſh; the linear effects of the diſturbing forces being as the ſquares of the times of their action, and their angular effects as the times, thoſe errors muſt diminiſh alſo on this account; and we can compute what thoſe errors will be for any diameter of the ring, and for any period of its revolution. We can tell, therefore, what would be the motion of the nodes, the change of inclination, and deviation of the axis, of a ring which would touch the ſurface of the earth, and revolve in 24 hours; nay, we can tell what theſe motions would be, ſhould this ring adhere to the earth. They muſt be much leſs than if the ring were detached; for the diſturbing forces of the ring muſt drag along with it the whole globe of the earth. The quantity of motion which the diſturbing forces would have produced in the ring alone, will now (ſays Newton) be produced in the whole maſs; and therefore the velocity muſt be as much leſs as the quantity of matter is greater: But ſtill all this can be computed.

Now there is ſuch a ring on the earth: for the earth is not a ſphere, but an elliptical ſpheroid. Sir Iſaac Newton therefore engaged in a computation of the effects of the diſturbing force, and has exhibited a moſt beautiful example of mathematical inveſtigation. He firſt aſſerts, that the earth *muſt* be an elliptical ſpheroid, whoſe polar axis is to its equatorial diameter, as 229 to 230, Then he demonſtrates, that if the ſine of the inclination of the equator be called π, and if t be the number of days (ſidereal) in a year, the annual motion of a detached ring will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{4t}$. He then ſhows that the effect of the diſturbing force on this ring is to its effect on the matter of the ſame ring, diſtributed in the form of an elliptical ſtratum (but ſtill detached) as 5 to 2; therefore the motion of the nodes will be $360^\circ \times \frac{3\sqrt{1-\pi^2}}{10t}$, or 16′ 16″

24‴ annually. He then proceeds to ſhow, that the quantity of motion in the ſphere is to that in an equatorial ring revolving in the ſame time, as the matter in the ſphere to the matter in the ring, and as three times the ſquare of a quadrantal arch to two ſquares of a diameter, jointly: Then he ſhows, that the quantity of matter in the terreſtrial ſphere is to that in the protuberant matter of the ſpheroid, as 52900 to 461 (ſuppoſing all homogeneous). From theſe premiſes it follows, that the motion of 16′ 16″ 24‴, muſt be diminiſhed in the ratio of 10·717 to 100, which reduces it to 9″ 07‴ annually. And this (he ſays) is the preceſſion of the equinoxes, occaſioned by the action of the ſun; and the reſt of the $50\frac{1}{3}$″, which is the obſerved preceſſion, is owing to the action of the moon, nearly five times greater than that of the ſun. This appeared a great difficulty: for the phenomena of the tides ſhow that it *cannot* much exceed twice the ſun's force.

Nothing can exceed the ingenuity of this proceſs. Juſtly does his celebrated and candid commentator, Daniel Bernoulli, ſay (in his Diſſertation on the Tides, which ſhared the prize of the French Academy with M'Laurin and Euler), that Newton ſaw through a veil what others could hardly diſcover with a microſcope in the light of the meridian ſun. His determination of the form and dimenſions of the earth, which is the foundation of the whole proceſs, is not offered as any thing better than a probable gueſs, *in re difficillima*; and it has been ſince demonſtrated with geometrical rigour by M'Laurin.

His next principle, that the motion of the nodes of the rigid ring is equal to the mean motion of the nodes of the moon, has been moſt critically diſcuſſed by the firſt mathematicians, as a thing which could neither be proved nor refuted. Friſius has at leaſt ſhown it to be a miſtake, and that the motion of the nodes of the ring is double the mean motion of the nodes of a ſingle moon; and that Newton's own principles ſhould have produced a preceſſion of $18\frac{1}{4}$ ſeconds annually, which removes the difficulty formerly mentioned.

His third aſſumption, that the quantity of motion of the ring muſt be ſhared with the included ſphere, was acquieſced in by all his commentators, till D'Alembert and Euler, in 1749, ſhewed that it was not the quantity of motion round an axis of rotation which remained the ſame, but the quantity of momentum or rotatory effort. The quantity of motion is the product of every particle by its velocity; that is, by its diſtance from the axis; while its momentum, or power of producing rotation, is as the ſquare of that diſtance, and is to be had by taking the ſum of each particle multiplied by the ſquare of its diſtance from the axis. Since the earth differs ſo little from a perfect ſphere, this makes no ſenſible difference in the reſult. It will increaſe Newton's preceſſion about three fourths of a ſecond.

We proceed now to the examination of this phenomenon upon the fundamental principles of mechanics.

Becauſe the mutual gravitation of the particles of matter in the ſolar ſyſtem is in the inverſe ratio of the ſquares of the diſtance, it follows; that the gravitations of the different parts of the earth to the ſun or to the moon are unequal. The nearer particles gravitate more than thoſe that are more remote.

Let PQpE (fig. 3.), be a meridional ſection of the terreſtrial ſphere, and POpq the ſection of the inſcribed ſphere. Let CS be a line in the plane of the ecliptic paſſing through the ſun, ſo that the angle ECS is the ſun's declination. Let NCM be a plane paſſing through the centre of the earth at right angles to the plane of the meridian PQpE; NCM will therefore be the plane of illumination.

In conſequence of the unequal gravitation of the matter of the earth to the ſun, every particle, ſuch as B, is acted on by a diſturbing force parallel to CS, and proportional to BD, the diſtance of the particle from the plane of illumination; and this force is to the gravitation of the central particle to the ſun, as three times BD is to CS, the diſtance of the earth from the ſun.

Let ABa be a plane paſſing through the particle B, parallel to the plane EQ of the equator. This ſection of the earth will be a circle, of which Aa is a diameter, and Qq will be the diameter of its ſection with the inſcribed ſphere. Theſe will be two concentric circles, and the ring by which the ſection of the ſpheroid exceeds the ſection of the ſphere will have AQ for its breadth; Pp is the axis of figure.

Let EC be repreſented by the ſymbol - -	a
OO or PC - - - - - -	b
EO their difference, $=\frac{a^2-b^2}{a+b}$ - - -	d
CL - - - - - - -	x
QL - - - - - -	$\sqrt{b^2-x^2}$
The periphery of a circle to radius 1 -	II
The diſturbing force at the diſtance 1 from the plane NCM - - - -	f
The ſine of declination ECS - - -	m
The coſine ECS - - - - -	n

It is evident that, with reſpect to the inſcribed ſphere, the diſturbing forces are completely compenſated, for every particle has a correſponding particle in the adjoining quadrant, which is acted on by an equal and oppoſite force. But this is not the caſe with the protuberant matter which makes up the ſpheroid. The ſegments NSsn and MTtm are more acted on than the ſegments NTtn and MSsm; and thus there is produced a tendency to a converſion of the whole earth, round an axis paſſing through the centre C, perpendicular to the plane PQpE. We ſhall diſtinguiſh this motion from all others to which the ſpheroid may be ſubject, by the name LIBRATION. The axis of this libration is always perpendicular to that diameter of the equator over which the ſun is, or to that meridian in which he is.

PROB. I. To determine the momentum of libration correſponding to any poſition of the earth reſpecting the ſun, that is, to determine the accumulated energy of the diſturbing forces on all the protuberant matter of the ſpheroid.

Let B and b be two particles in the ring formed by the revolution of AQ, and ſo ſituated, that they are at equal diſtances from the plane NM; but on oppoſite ſides of it. Draw BD, bd, perpendicular to NM, and FLG perpendicular to LT.

Then, becauſe the momentum, or power of producing rotation, is as the force and as the diſtance of its line of direction from the axis of rotation, jointly, the combined momentum of the particles B and b will be $f.\text{BD}.\text{DC}-f.bd.dc$, (for the particles B and b, are urged in contrary directions). But the momentum of B is $f.\text{BF}.\text{DC}+f.\text{FD}.\text{DC}$, and that of b is $f.b\text{G}.d\text{C}-f.d\text{G}.d\text{C}$; and the combined momentum is $f.\text{BF}.\text{D}d-f.\text{FD}.\overline{\text{DC}+d\text{C}},=2f.\text{BF}.\text{LF}-2f.\text{LT}.\text{TC}$.

Becauſe m and n are the ſine and coſine of the angle ECS or LCT, we have $\text{LT}=m.\text{CL}$, and $\text{CT}=n.\text{CL}$, and $\text{LF}=m.\text{BL}$, and $\text{BF}=n.\text{BL}$. This gives the momentum $=2fmn\,\overline{\text{BL}^2-\text{CL}^2}$.

The breadth AQ of the protuberant ring being very ſmall, we may ſuppoſe, without any ſenſible error, that all the matter of the line AQ is collected in the point Q; and, in like manner, that the matter of the whole ring is collected in the circumference of its inner circle, and that B and b now repreſent, not ſingle particles, but the collected matter of lines ſuch as AQ, which terminate at B and b. The combined momentum of two ſuch lines will therefore be $2mnf.\text{AQ}.\overline{\text{BL}^2-\text{CL}^2}$.

Let the circumference of each parallel of latitude be divided into a great number of indefinitely ſmall and equal parts. The number of ſuch parts in the circumference, of which Qq is the diameter, will be II·QL. To each pair of theſe there belongs a momentum $2\,mnf.AQ\cdot\overline{BL^2-CL^2}$. The ſum of all the ſquares of BL, which can be taken round the circle, is one half of as many ſquares of the radius CL: for BL is the ſine of an arch, and the ſum of its ſquare and the ſquare of its correſponding coſine is equal to the ſquare of the radius. Therefore the ſum of all the ſquares of the ſines, together with the ſum of all the ſquares of the coſines, is equal to the ſum of the ſame number of ſquares of the radius; and the ſum of the ſquares of the ſines is equal to the ſum of the ſquares of the correſponding coſines: therefore the ſum of the ſquares of the radius is double of either ſum. Therefore $\int \Pi\cdot QL\cdot BL^2=\frac{1}{2}\Pi\cdot QL.QL^2$. In like manner the ſum of the number $\Pi\cdot QL$ of CL^2s will be $=\Pi\cdot QL\cdot CL^2$. Theſe ſums, taken for the ſemicircle, are $\frac{1}{4}\Pi\cdot QL\cdot QL^2$, and $\frac{1}{2}\Pi\cdot QL\cdot CL^2$ or $\Pi\cdot QL\cdot\frac{1}{4}QL^2$, and $\Pi\cdot QL\cdot\frac{1}{2}CL^2$: therefore the momentum of the whole ring will be $2\,m\,n\,f\cdot AQ\cdot QL.\ \Pi(\frac{1}{4}QL^2-\frac{1}{2}CL^2)$: for the momentum of the ring is the combined momenta of a number of pairs, and this number is $\frac{1}{2}\Pi\cdot QL$.

By the ellipſe we have $OC : QL = EO : AQ$, and $AQ = QL\frac{EO}{OC}, = QL\frac{d}{b}$; therefore the momentum of the ring is $2\,mnf\frac{d}{b}QL^2\Pi(\frac{1}{4}QL^2-\frac{1}{2}CL^2), = mnf\frac{d}{b}QL^2\Pi(\frac{1}{2}QL^2-CL^2)$: but $QL^2 = b^2-x^2$; therefore $\frac{1}{2}QL^2-CL^2=\frac{1}{2}b^2-\frac{1}{2}x^2-x^2, =\frac{1}{2}b^2-\frac{3}{2}x^2, =\frac{b^2-3x^2}{2}$; therefore the momentum of the ring is $mnf\frac{d}{b}\Pi\,(b^2-x^2), \left(\frac{b^2-3x^2}{2}\right) = mnf\frac{d}{b}\Pi\,\left(\frac{b^4-4b^2x^2+3x^4}{2}\right)$, $= mnf\frac{d}{2b}\Pi\,(b^4-4l^2x^2+3x^4)$. If we now ſuppoſe another parallel extremely near to A a, as repreſented by the dotted line, the diſtance L l between them being x, we ſhall have the fluxion of the momentum of the ſpheroid $mnf\frac{d}{2b}\Pi\,(b^4\dot{x}-4b^2x^2\dot{x}+3x^4\dot{x})$, of which the fluent is $mnf\frac{d}{2b}\Pi\left(b^4x-4b^2\frac{x^3}{3}+\frac{3x^5}{5}\right)$. This expreſſes the momentum of the zone FAaQ, contained between the equator and the parallel of latitude Aa. Now let x become $= b$, and we ſhall obtain the momentum of the hemiſpheroid $= mnf\frac{d}{2b}\Pi\,(b^5-\frac{4}{3}b^5+\frac{3}{5}b^5)$, and that of the ſpheroid $= mnf\frac{d}{b}\Pi\,(b^5-\frac{4}{3}b^5+\frac{3}{5}b^5)=\frac{4}{15}mnfd\ \Pi b^4$.

This formula does not expreſs any motion, but only a preſſure tending to produce motion, and particularly tending to produce a libration by its action on the cohering matter of the earth, which is affected as a number of levers. It is ſimilar to the common mechanical formula $w.d$, where w means a weight, and d its diſtance from the fulcrum of the lever.

It is worthy of remark, that the momentum of this protuberant matter is juſt $\frac{1}{5}$ of what it would be if it were all collected at the point O of the equator: for the matter in the ſpheroid is to that in the inſcribed ſphere as a^2 to b^2, and the contents of the inſcribed ſphere is $\frac{2}{3}\Pi b^3$. Therefore $a^2 : a^2 - b^2=\frac{2}{3}\Pi b^3 : \frac{2}{3}\Pi b^3\frac{a^2-b^2}{a^2}$, which is the quantity of protuberant matter. We may, without ſenſible error, ſuppoſe $\frac{a^2-b^2}{a}, =2d$; then the protuberant matter will be $\frac{4}{3}\Pi b^2 d$. If all this were placed at O, the momentum would be $\frac{4}{3}\Pi db^2 f\cdot OH\cdot HC, =\frac{4}{3}m\,n\,f\,d\,b^4$, becauſe $OH\cdot HC=m\,n\,b^2$; now $\frac{4}{3}$ is 5 times $\frac{4}{15}$.

Alſo, becauſe the ſum of all the rectangles OH·HC round the equator is half of as many ſquares of OC, it follows that the momentum of the protuberant matter placed in a ring round the equator of the ſphere or ſpheroid is one half of what it would be if collected in the point O or E; whence it follows that the momentum of the protuberant matter in its natural place is two-fifths of what it would be if it were diſpoſed in an equatorial ring. It was in this manner that Sir Iſaac Newton was enabled to compare the effect of the ſun's action on the protuberant matter of the earth, with his effect on a rigid ring of moons. The preceding inveſtigation of the momentum is nearly the ſame with his, and appears to us greatly preferable in point of perſpicuity to the fluxionary ſolutions given by later authors. Theſe indeed have the appearance of greater accuracy, becauſe they do not ſuppoſe all the protuberant matter to be condenſed on the ſurface of the inſcribed ſphere: nor were we under the neceſſity of doing this, only it would have led to very complicated expreſſions had we ſuppoſed the matter in each line AQ collected in its centre of oſcillation or gyration. We made a compenſation for the error introduced by this, which may amount to $\frac{1}{115}$ of the whole, and ſhould not be neglected, by taking d as equal to $\frac{a^2-b_2}{2a}$ inſtead of $\frac{a^2-l^2}{a+b}$. The conſequence is, that our formula is the ſame with that of the later authors.

Thus far Sir Iſaac Newton proceeded with mathematical rigour; but in the application he made two aſſumptions, or, as he calls them, hypotheſes, which have been found to be unwarranted. The firſt was, that when the ring of protuberant matter is connected with the inſcribed ſphere, and ſubjected to the action of the diſturbing force, the ſame quantity of motion is produced in the whole maſs as in the ring alone. The ſecond was, that the motion of the nodes of a rigid ring of moons is the ſame with the mean motion of the nodes of a ſolitary moon. But we are now able to demonſtrate, that it is not the quantity of motion, but of momentum, which remains the ſame, and that the nodes of a rigid ring move twice as faſt as thoſe of a ſingle particle. We proceed therefore to

(1) *Prob.* 2. To determine the deviation of the axis, and the retrograde motion of the nodes which reſult from this libratory momentum of the earth's protuberant matter.

But here we muſt refer our readers to ſome fundamental propoſitions of rotatory motions which are demonſtrated in the article ROTATION.

If a rigid body is turning round an axis A, paſſing through its centre of gravity with the angular velocity a, and receives an impulſe which alone would cauſe it to turn round an axis B, alſo paſſing through its centre of gravity, with the angular velocity b, the body will now turn round a third axis C, paſſing through its centre of gravity, and lying in the plane of the axis A and B, and the ſine of the inclination of this third axis to the axis A will be to the ſine of inclination to the axis B as the velocity b to the velocity a.

When a rigid body is made to turn round any axis by the action of an external force, the quantity of momentum produced (that is, the ſum of the products of every particle by its velocity and by its diſtance from the axis) is equal to the momentum or ſimilar product of the moving force or forces.

If an oblate ſpheroid, whoſe equatorial diameter is a and polar diameter b, be made to librate round an equatorial diameter, and the velocity of that point of the equator which is furtheſt from the axis of libration be v, the momentum of the ſpheroid is $\frac{4}{15}\Pi a^2 b^2 v$.

The two laſt are to be found in every elementary book of mechanics.

Let AN $a\,n$ (fig. 4.) be the plane of the earth's equator, cutting the ecliptic CNK n in the line of the nodes or equinoctial points N n. Let OAS be the ſection of the earth by a meridian paſſing through the ſun, ſo that the line OCS is in the ecliptic, and CA is an arch of an hour-circle or meridian, meaſuring the ſun's declination. The ſun not being in the plane of the equator, there is, by prop. 1. a force tending to produce a libration round an axis ZO z at right angles to the diameter A a of that meridian in which the ſun is ſituated, and the momentum of all the diſturbing forces is $\frac{4}{15} m n f d \Pi b^4$. The product of any force by the moment $\dot{t}$ of its action expreſſes the momentary increment of velocity; therefore the momentary velocity, or the velocity of libration generated in the time $\dot{t}$ is $\frac{4}{15} m n f d \Pi b^4 \dot{t}$. This is the abſolute velocity of a point at the diſtance 1 from the axis, or it is the ſpace which would be uniformly deſcribed in the moment $\dot{t}$, with the velocity which the point has acquired at the end of that moment. It is double the ſpace actually deſcribed by the libration during that moment; becauſe this has been an uniformly accelerated motion, in conſequence of the continued and uniform action of the momentum during this time. This muſt be carefully attended to, and the neglect of it has occaſioned very faulty ſolutions of this problem.

Let v be the velocity produced in the point A, the moſt remote from the axis of libration. The momentum excited or produced in the ſpheroid is $\frac{4}{15} \Pi a^2 b^2 v$ (as above), and this muſt be equal to the momentum of the moving force, or to $\frac{4}{15} m n f d \Pi b^4 \dot{t}$; therefore we obtain $v = \frac{\frac{4}{15} m n f d \Pi b^4 \dot{t}}{\frac{4}{15} \Pi a^2 b^2}$, that is, $v = m n f d \dot{t} \frac{b^2}{a^2}$ or very nearly $m n f d \dot{t}$, becauſe $\frac{b^2}{a^2} = 1$ very nearly. Alſo, becauſe the product of the velocity and time gives the ſpace uniformly deſcribed in that time, the ſpace deſcribed by A in its libration round Z z is $m n f d \dot{t}^2$, and the angular velocity is $\frac{m n f d \dot{t}}{a}$.

Let $\dot{r}$ be the momentary angle of diurnal rotation. The arch A r, deſcribed by the point A of the equator in this moment $\dot{t}$ will therefore be $a \dot{r}$, that is, $a \times \dot{r}$, and the velocity of the point A is $\frac{a \dot{r}}{\dot{t}}$, and the angular velocity of rotation is $\frac{\dot{r}}{\dot{t}}$.

Here then is a body (fig. 5.) turning round an axis OP, perpendicular to the plane of the equator $z o z$, and therefore ſituated in the plane ZP z; and it turns round this axis with the angular velocity $\frac{\dot{r}}{\dot{t}}$. It has received an impulſe, by which alone it would librate round the axis Z z, with the angular velocity $\frac{m n f d \dot{t}}{a}$. It will therefore turn round neither axis (N° 1. p. 468.), but round a third axis OP′, paſſing through O, and lying in the plane ZP z, in which the other two are ſituated, and the ſine P′ Π of its inclination to the axis of libration Z z will be to the ſine P′ p of its inclination to the axis OP of rotation as $\frac{\dot{r}}{\dot{t}}$ to $\frac{m n f d \dot{t}}{a}$.

Now A, in fig. 4. is the ſummit of the equator both of libration and rotation; $m n f d \dot{t}^2$ is the ſpace deſcribed by its libration in the time $\dot{t}$; and $a \dot{r}$ is the ſpace or arch A r (fig. 4.) deſcribed in the ſame time by its rotation: therefore, taking A r to A c (perpendicular to the plane of the equator of rotation, and lying in the equator of libration), as $a \dot{r}$ to $m n f d \dot{t}^2$, and completing the parallelogram A r m c, A m will be the compound motion of A (N° 1. p. 468.), and $a \dot{r} : m n d f \dot{t}^2 = 1 : \frac{m n f d \dot{t}^2}{a \dot{r}}$, which will be the tangent of the angle m A r, or of the change of poſition of the equator. But the axes of rotation are perpendicular to their equator; and therefore the angle of deviation $\dot{w}$ is equal to this angle r A m. This appears from fig. 5.; for Π P′ : P′p = O p : P′p, = OP : tan. POP; and it is evident that $a \dot{r} : m n f d \dot{t}^2 = \frac{\dot{r}}{\dot{t}} : m n f d \frac{\dot{t}}{a}$, as is required by the compoſition of rotations.

In conſequence of this change of poſition, the plane of the equator no longer cuts the plane of the ecliptic in the line N n. The plane of the new equator cuts the former equator in the line AO and the part AN of the former equator lies between the ecliptic and the new equator AN′, while the part A n of the former equator is above the new one A n'; therefore the new node N′, from which the point A was moving, is removed to the weſtward, or further from A; and the new node n' to which A is approaching, is alſo moved weſtward, or nearer to A: and this happens in every poſition of A. The nodes, therefore, or equinoctial points, continually ſhift to the weſtward, or in a contrary direction to the rotation of the earth; and the axis of rotation always deviates to the eaſt ſide of the meridian which paſſes through the ſun.

This account of the motions is extremely different from what a perſon ſhould naturally expect. If the earth were placed in the ſummer ſolſtice, with reſpect to us who inhabit its northern hemiſphere, and had no rotation round its axis, the equator would begin to approach the ecliptic, and the axis would become more upright; and this would go on with a motion continually accelerating, till the equator coincided with the ecliptic. It would not ſtop here, but go as far on the other ſide, till its motion were extinguiſhed by the oppoſing forces; and it would return to its former poſition, and again begin to approach the ecliptic, playing up and down like the arm of a balance. On this account this motion is very properly termed *libration*; but this very ſlow libration, compounded with the incomparably ſwifter motion of diurnal rotation, produces a third motion extremely different from both. At firſt the north pole of the earth inclines forward toward the ſun; after a long courſe of years it will incline to the left hand, as viewed from the ſun, and be much more inclined to the ecliptic, and the plane of the equator will paſs through the ſun. Then the ſouth pole will come into view, and the north pole will begin to decline from the ſun; and this will go on (the inclination of the equator diminiſhing all the while) till, after a courſe of years, the north pole will be turned quite away from the ſun, and the inclination of the equator will be reſtored to its original quantity. After this the phenomena will have another period ſimilar to the former, but the axis will now deviate to the right hand. And thus, although both the earth and ſun ſhould not move from their places. the inhabitants of the earth would have a complete ſucceſſion of the ſeaſons accompliſhed in a period of many centuries. This would be prettily illuſtrated by an iron ring poiſed very nicely on a cap like the card of a mariner's compaſs, having its centre of gravity coinciding with the point of the cap, ſo that it may whirl round in any poſition. As this is extremely difficult to execute, the cap may be pierced a little deeper, which will cauſe the ring to maintain a horizontal poſition with a very ſmall force. When the ring is whirling very ſteadily, and pretty briſkly, in the direction of the hours of a watch-dial, hold a ſtrong magnet above the middle of the nearer ſemicircle (above the 6 hour point) at the diſtance of three or four inches. We ſhall immediately obſerve the ring riſe from the 9 hour point, and ſink at the 3 hour point, and gradually acquire a motion of preceſſion and nutation, ſuch as has been deſcribed.

If the earth be now put in motion round the ſun, or the ſun round the earth, motions of libration and deviation will ſtill obtain, and the ſucceſſion of their different phaſes, if we may ſo call them, will be perfectly analogous to the above ſtatement. But the quantity of deviation, and change of inclination, will now be prodigiouſly diminiſhed, becauſe the rapid change of the ſun's poſition quickly diminiſhes the diſturbing forces, annihilates them by bringing the ſun into the plane of the equator, and brings oppoſite forces into action.

We ſee in general that the deviation of the axis is always at right angles to the plane paſſing through the ſun, and that the axis, inſtead of being raiſed from the ecliptic, or brought nearer to it, as the libration would occaſion, deviates ſidewiſe; and the equator, inſtead of being raiſed or depreſſed round its eaſt and weſt points, is twiſted ſidewiſe round the north and ſouth points; or at leaſt things have this appearance; but we muſt now attend to this circumſtance more minutely.

The compoſition of rotation ſhows us that this change of the axis of diurnal rotation is by no means a tranſlation of the former axis (which we may ſuppoſe to be the axis of figure) into a new poſition, in which it again becomes the axis of diurnal motion; nor does the equator of figure, that is, the moſt prominent ſection of the terreſtrial ſpheroid, change its poſition, and in this new poſition continue to be the equator of rotation. This was indeed ſuppoſed by Sir Iſaac Newton; and this ſuppoſition naturally reſulted from the train of reaſoning which he adopted. It was ſtrictly true of a ſingle moon, or of the imaginary orbit attached to it; and therefore Newton ſuppoſed that the whole earth did in this manner deviate from its former poſition, ſtill, however, turning round its axis of figure. In this he has been followed by Walmeſly, Simpſon, and moſt of his commentators. D'Alembert was the firſt who entertained any ſuſpicion that this might not be certain; and both he and Euler at laſt ſhowed that the new axis of rotation was really a new line in the body of the earth, and that its axis and equator of figure did not remain the axis and equator of rotation. They aſcertained the poſition of the real axis by means of a moſt intricate analyſis, which obſcured the connection of the different poſitions of the axis with each other, and gave us only a kind of momentary information. Father Friſius turned his thoughts to this problem, and fortunately diſcovered the compoſition of rotations as a general principle of mechanical philoſophy. Few things of this kind have eſcaped the penetrating eye of Sir Iſaac Newton. Even *this* principle had been glanced at by him. He affirms it in expreſs terms with reſpect to a body that is perfectly ſpherical (cor. 22. prop. 66. B. I.) But it was reſerved for Friſius to demonſtrate it to be true of bodies of any figure, and thus to enrich mechanical ſcience with a principle which gives ſimple and elegant ſolutions of the moſt difficult problems.

But here a very formidable objection naturally offers itſelf. If the axis of the diurnal motion of the heavens be not the axis of the earth's ſpheroidal figure, but an imaginary line in it, round which even the axis of figure muſt revolve; and if this axis of diurnal rotation have ſo greatly changed its poſition, that it now points at a ſtar at leaſt 2 degrees diſtant from the pole obſerved by Timochares, how comes it that the equator has the very ſame ſituation on the ſurface of the earth that it had in ancient times? No ſenſible change has been obſerved in the latitudes of places.

The anſwer is very ſimple and ſatisfactory: Suppoſe that in 12 hours the axis of rotation has changed from the poſition PR (pl. 19. fig. 6.) to $p\,r$, ſo that the north pole inſtead of being at P, which we may ſuppoſe to be a particular mountain, is now at p. In this 12 hours the mountain P, by its rotation round $p\,r$, has acquired the poſition π. At the end of the next 12 hours, the axis of rotation has got the poſition $\pi\rho$, and the axis of figure has got the poſition $p\,r$, and the mountain P is now at p.

Thus, on the noon of the following day, the axis of figure PR is in the ſituation which the real axis of rotation occupied at the intervening midnight. This goes on continually, and the axis of figure follows the poſition of the axis of rotation, and is never further removed from it than the deviation of 12 hours, which does not exceed $\frac{1}{102}$th part of one ſecond, a quantity altogether imperceptible. Therefore the axis of figure will always ſenſibly coincide with the axis of rotation, and no change can be produced in the latitudes of places on the ſurface of the earth.

We have hitherto conſidered this problem in the moſt general manner; let us now apply the knowledge we have gotten of the deviation of the axis or of the momentary action of the diſturbing force to the explanation of the phenomena: that is, let us ſee what preceſſion and what nutation will be accumulated after any given time of action.

For this purpoſe we muſt aſcertain the preciſe deviation which the diſturbing forces are competent to produce. This we can do by comparing the momentum of libration with the gravitation of the earth to the ſun, and this with the force which would retain a body on the equator while the earth turns round its axis.

The gravitation of the earth to the ſun is in the proportion of the ſun's quantity of matter M directly, and to the ſquare of the diſtance A inverſely, and may therefore be expreſſed by the ſymbol $\frac{\text{M}}{\text{A}^2}$. The diſturbing force at the diſtance 1 from the plane of illumination is to the gravitation of the earth's centre to the ſun as 3 to A, (A being meaſured on the ſame ſcale which meaſures the diſtance from the plane of illumination. Therefore $\frac{3\text{M}}{\text{A}^3}$ will be the diſturbing force f of our formula.

Let p be the centrifugal force of a particle at the diſtance 1 from the axis of rotation; and let t and T be the times of rotation and of annual revolution, viz. ſidereal day and year. Then $p : \frac{\text{M}}{\text{A}^2} = \frac{1}{t^2} : \frac{\text{A}}{\text{T}^2}$. Hence we derive $\frac{3\text{M}}{\text{A}^3} = 3\,p\,\frac{t^2}{\text{T}^2}$. But ſince $\dot{r}$ was the angular velocity of rotation, and conſequently $1 \times \dot{r}$ the ſpace deſcribed, and $\frac{1 \times \dot{r}}{\dot{t}}$ the velocity; and ſince the centrifugal force is as the ſquare of the velocity divided by the radius, (this being the meaſure of the generated velocity, which is the proper meaſure of any accelerating force), we have $p = \frac{1^2 \times \dot{r}^2}{1^2 \times \dot{t}^2}, = \frac{\dot{r}^2}{\dot{t}^2}$, and $f = \frac{3\,\dot{r}^2}{\dot{t}^2} \times \frac{t^2}{\text{T}^2}$. Now the formula $f\,m\,n\,d\frac{\dot{t}^2}{a}$ expreſſed the ſine of the angle. This being extremely ſmall, the ſine may be conſidered as equal to the arc which meaſures the angle. Now, ſubſtitute for it the value now found, viz. $\frac{3\,\dot{r}^2}{\dot{t}^2} \times \frac{\dot{t}^2}{\text{T}^2}$, and we obtain the angle of deviation $\dot{w} = \dot{r}\,\frac{3\,t^2}{\text{T}^2}mn\frac{d}{a}$, and this is the ſimpleſt form in which it can appear. But it is convenient, for other reaſons, to expreſs it a little differently : d is nearly equal to $\frac{a^2-b^2}{2a^2}$, therefore $\dot{w} = \dot{r} \times \frac{3}{2}\frac{t^2}{\mathrm{T}^2} mn \frac{a^2-b^2}{a^2}$, and this is the form in which we ſhall now employ it.

The ſmall angle $\dot{r}\,\frac{3t^2}{2\mathrm{T}^2}\,m\,n\,\frac{a^2-b^2}{a^2}$ is the angle in which the new equator cuts the former one. It is different at different times, as appears from the variable part mn, the product of the ſine and coſine of the ſun's declination. It will be a maximum when the declination is in the ſolſtice, for mn increaſes all the way to 45°, and the declination never exceeds $23\frac{1}{2}$. It increaſes, therefore, from the equinox to the ſolſtice, and then diminiſhes.

Let ESL (fig. 7.) be the ecliptic, EAC the equator, BAD the new poſition which it acquires by the momentary action of the ſun, cutting the former in the angle BAE $= \dot{r}\,\frac{3}{2}\frac{t^2}{\mathrm{T}^2}\,m\,n\,\frac{a^2-b^2}{a^2}$. Let S be the ſun's place in the ecliptic, and AS the ſun's declination, the meridian AS being perpendicular to the equator. Let $\frac{a^2,-b^2}{a^2}$ be k. The angle BAE is then $= \dot{r}\,\frac{3t^2}{2\mathrm{T}^2}\,kmn$. In the ſpherical triangle BAE we have ſin. B : ſin. AE = ſin. A : ſin. BE, or = A : BE, becauſe very ſmall angles and arches are as their ſines. Therefore BE, which is the momentary preceſſion of the equinoctial point E, is equal to A $\frac{\text{ſin. AE}}{\text{ſin. B}}$, $= \dot{r} \times \frac{3t^2}{2\mathrm{T}^2}\,k\,m\,n$, $\frac{\text{ſin. R. aſcenſ.}}{\text{ſin. obl. ecl.}}$.

The equator EAC, by taking the poſition BAD, recedes from the ecliptic in the colure of the ſolſtices CL, and CD is the change of obliquity or the nutation. For let CL be the ſolſtitial colure of BAD, and $c\,l$ the ſolſtitial colure of EAC. Then we have ſin. B : ſin. E = ſin. LD : ſin. $l\,c$; and therefore the difference of the arches LD and $l\,c$ will be the meaſure of the difference of the angles B and E. But when BE is indefinitely ſmall, CD may be taken for the difference of LD and $l\,c$, they being ultimately in the ratio of equality. Therefore CD meaſures the change of the obliquity of the ecliptic, or the nutation of the axis with reſpect to the ecliptic.

The real deviation of the axis is the ſame with the change in the poſition of the equator, P p being the meaſure of the angle EAB. But this not being always made in a plane perpendicular to the ecliptic, the change of obliquity generally differs from the change in the poſition of the axis. Thus when the ſun is in the ſolſtice, the momentary change of the poſition of the equator is the greateſt poſſible; but being made at right angles to the plane in which the obliquity of the ecliptic is computed, it makes no change whatever in the obliquity, but the greateſt poſſible change in the preceſſion.

In order to find CD the change of obliquity, obſerve that in the triangle CAD, R : ſin. AC, or R : coſ. AE = ſin. A : ſin. CD, = A : CD (becauſe A and CD are exceedingly ſmall). Therefore the change of obliquity (which is the thing commonly meant by nutation) CD = A × coſ. AE, $= \dot{r}\,\frac{3t^2}{2\mathrm{T}^2}kmn$, coſ. AE' $= \dot{r}\,\frac{3t^2}{2\mathrm{T}^2}\,k$ × ſin. declin. × coſ. declin. × coſ. R. aſcenſ.

But it is more convenient for the purpoſes of aſtronomical computation to make uſe of the ſun's longitude SE. Therefore make

The ſun's longitude ES - - - - $= z$
Sine of ſun's long. - - - - $= x$
Coſine - - - $\sqrt{1-x^2} = y$
Sine obliq. eclipt. - - $23\frac{1}{2} = p$
Coſine obliq. - - - - $= q$

In the ſpherical triangle EAS, right angled at A (becauſe AS is the ſun's declination perpendicular to the equator), we have R : ſin. ES = ſin. E : ſin. AS, and ſin. AS $= px$. Alſo R : coſ. AS = coſ. AE : coſ. ES, and coſ. ES or y = coſ. AS × coſ. AE. Therefore pxy = ſin. AS × coſ. AS × coſ. AE, = mn × coſ. AE. Therefore the momentary nutation CD $= \dot{r} \times \frac{3t^2}{2\mathrm{T}^2}kpxy$.

We muſt recollect that this angle is a certain fraction of the momentary diurnal rotation. It is more convenient to conſider it as a fraction of the ſun's annual motion, that ſo we may directly compare his motion on the ecliptic with the preceſſion and nutation correſponding to his ſituation in the heavens. This change is eaſily made, by augmenting the fraction in the ratio of the ſun's angular motion to the motion of rotation or multiplying the fraction by $\frac{\mathrm{T}}{t}$; therefore the momentary nutation will be $\dot{r}\,\frac{3t}{2\mathrm{T}}\,k\,p\,xy$. In this value $\frac{3tkp}{2\mathrm{T}}$ is a conſtant quantity, and the momentary nutation is proportional to xy, or to the product of the ſine and coſine of the ſun's longitude, or to the ſine of twice the ſun's longitude; for xy is equal to half the ſine of twice z.

(1.) If therefore we multiply this fraction by the ſun's momentary angular motion, which we may ſuppoſe, with abundant accuracy, proportional to $\dot{z}$, we obtain the fluxion of the nutation, the fluent of which will expreſs the whole nutation while the ſun deſcribes the arch z of the ecliptic, beginning at the vernal equinox. Therefore, in place of y put $\sqrt{1-x^2}$, and in place of $\dot{z}$ put $\frac{\dot{x}}{\sqrt{1-x^2}}$, and we have the fluxion of the nutation for the moment when the ſun's longitude is z, and the fluent will be the whole nutation. The fluxion reſulting from this proceſs is $\frac{3tkp}{2\mathrm{T}}x\dot{x}$, of which the fluent is $\frac{3tkp}{4\mathrm{T}}x^2$. This is the whole change produced on the obliquity of the ecliptic while the ſun moves along the arch z ecliptic, reckoned from the vernal equinox. When this arch is 90°, x^2 is 1, and therefore $\frac{3tkp}{4\mathrm{T}}$ is the nutation produced while the ſun moves from the equinox to the ſolſtice.

The momentary change of the axis and plane of the equator (which is the meaſure of the changing force) is $\frac{3tk}{2\mathrm{T}}mn$.

The momentary change of the obliquity of the ecliptic is $\frac{3tkp}{2\mathrm{T}}x\dot{x}$

The whole change of obliquity is $\frac{3tkp}{4\mathrm{T}}x^2$.

Hence we ſee that the force and the real momentary change of poſition are greateſt at the ſolſtices, and diminiſh to nothing in the equinoxes.

The momentary change of obliquity is greateſt at the octants, being proportional to $x\dot{x}$ or to xy.

The whole accumulated change of obliquity is greateſt at the ſolſtices, the obliquity itſelf being then ſmalleſt.

We muſt in like manner find the accumulated quantity of the preceſſion after a given time, that is the arch BE for a finite time.

We have ER : CD = ſin. EA : ſin. CA (or coſ. EA) = tan. EA : 1, and EB : ER = 1 : ſin. B. Therefore EB : CD = tan. EA : ſin. B. But tan. EA = coſ. E × tan. ES, $= \text{coſ. E} \times \frac{\text{ſin. long.}}{\text{coſ. long.}} = \frac{q\,x}{\sqrt{1-x^2}}$. Therefore EB : CD = $\frac{q\,x}{\sqrt{1-x^2}}\,p$, and CD = EB : $\frac{\text{ſin. obliq. eclip.}}{\text{tan. long.} \odot}$. If we ſubſtitute for CD its value (found in N° 1. p. 471.) viz. $\frac{3\,t\,k\,p}{2\,\text{T}}\,x\,\dot{x}$, we obtain $\text{EB} = \frac{3\,t}{2\,\text{T}} \times \frac{k\,q\,x^2\,\dot{x}}{\sqrt{1-x^2}}$ the fluxion of the preceſſion of the equinoxes occcaſioned by the action of the ſun. The fluent of the variable part $\frac{x^2\dot{x}}{\sqrt{1-x^2}} = x\,\dot{y}$, of which the fluent is evidently a ſegment of a circle whoſe arch is z and ſine x, that is, $= \frac{z - x\sqrt{1-x^2},}{2}$ and the whole preceſſion, while the ſun deſcribes the arch z, is $\frac{3\,t}{2\,\text{T}} \times \frac{k\,q}{2}\left(z - x\sqrt{1-x^2}.\right)$ This is the preceſſion of the equinoxes while the ſun moves from the vernal equinox along the arch z of the ecliptic.

In this expreſſion, which conſiſts of two parts, $\frac{3\,t\,k\,q}{4\,\text{T}}\,z$, and $\frac{3\,t\,k\,q}{4\,\text{T}}\left(-x\sqrt{1-x^2}\right)$, the firſt is incomparably greater than the ſecond, which never exceeds 1'', and is always compenſated in the ſucceeding quadrant. The preceſſion occaſioned by the ſun will be $\frac{3\,t\,k\,q}{4\,\text{T}}\,z$, and from this expreſſion we ſee that the preceſſion increaſes uniformly, or at leaſt increaſes at the ſame rate with the ſun's longitude z, becauſe the quantity $\frac{3\,t\,k\,q}{4\,\text{T}}$ is conſtant.

In order to make uſe of theſe formulæ, which are now reduced to very great ſimplicity, it is neceſſary to determine the values of the two conſtant quantities $\frac{3\,t\,k\,p}{4\,\text{T}}$, $\frac{3\,t\,k\,q}{4\,\text{T}}$, which we ſhall call N and P, as factors of the nutation and preceſſion. Now t is one ſidereal day, and T is $366\frac{1}{4}$. k is $\frac{a^2-b^2}{a^2}$, which according to Sir Iſaac Newton is $\frac{231^2-230^2}{231^2}, = \frac{1}{115}$; p and q are the ſine and coſine of 23° 28', viz. 0,39822 and 0,91729.

Theſe data give $\text{N} = \frac{1}{141030}$ and $\text{P} = \frac{1}{61224}$ of which the logarithms are 4.85069 and 5.21308, viz. the arithmetical complements of 5.14931 and 4.78692.

Let us, for an example of the uſe of this inveſtigation, compute the preceſſion of the equinoxes when the ſun has moved from the vernal equinox to the ſummer ſolſtice, ſo that z is 90°, or 3240 0''.

Log. 3240 0'' = z - - -	5.51055
Log. P - - - -	5.21308
Log. 5'',292 - - -	0.72363

The preceſſion therefore in a quarter of a year is 5,292 ſeconds; and, ſince it increaſes uniformly, it is 21'', 168 annually.

We muſt now recollect the aſſumptions on which this computation proceeds. The earth is ſuppoſed to be homogeneous, and the ratio of its equatorial diameter to its polar axis is ſuppoſed to be that of 231 to 230. If the earth be more or leſs protuberant at the equator, the preceſſion will be greater or leſs in the ratio of this protuberance. The meaſures which have been taken of the degrees of the meridian are very inconſiſtent among themſelves; and although a compariſon of them all indicates a ſmaller protuberancy, nearly $\frac{1}{312}$ inſtead of $\frac{1}{231}$, their differences are too great to leave much confidence in this method. But if this figure be thought more probable, the preceſſion will be reduced to about 17'' annually. But even though the figure of the earth were accurately determined, we have no authority to ſay that it is homogeneous. If it be denſer towards the centre, the momentum of the protuberant matter will not be ſo great as if it were equally denſe with the inferior parts, and the preceſſion will be diminiſhed on this account. Did we know the proportion of the matter in the moon to that in the ſun, we could eaſily determine the proportion of the whole obſerved annual preceſſion of $50\frac{1}{3}''$ which is produced by the ſun's action. But we have no unexceptionable data for determining this; and we are rather obliged to infer it from the effect which ſhe produces in diſturbing the regularity of the preceſſion, as will be conſidered immediately. So far, therefore, as we have yet proceeded in this inveſtigation, the reſult is very uncertain. We have only aſcertained unqueſtionably the law which is obſerved in the ſolar preceſſion. It is probable, however, that this preceſſion is not very different from 20'' annually; for the phenomena of the tides ſhow the diſturbing force of the ſun to be very nearly $\frac{2}{5}$ of the diſturbing force of the moon. Now 20'' is $\frac{2}{5}$ of 50''.

But let us now proceed to conſider the effect of the moon's action on the protuberant matter of the earth; and as we are ignorant of her quantity of matter, and conſequently of her influence in ſimilar circumſtances with the ſun, we ſhall ſuppoſe the diſturbing force of the moon is to that of the ſun as m to 1. Then *(cæteris paribus)* the preceſſion will be to the ſolar preceſſion π in the ratio of the force and of the time of its action jointly. Let t and T therefore repreſent a periodical month and year, and the lunar preceſſion will be $= \frac{m\,\pi\,t}{\text{T}}$. This preceſſion muſt be reckoned on the plane of the lunar orbit, in the ſame manner as the ſolar preceſſion is reckoned on the ecliptic. We muſt alſo obſerve, that $\frac{m\,\pi\,t}{\text{T}}$ repreſents the lunar preceſſion only on the ſuppoſition that the earth's equator is inclined to the lunar orbit in an angle of $23\frac{1}{2}$ degrees. This is indeed the mean inclination; but it is ſometimes increaſed to above 28°, and ſometimes reduced to 18°. Now in the value of the ſolar preceſſion the coſine of the obliquity was employed. Therefore whatever is the angle E contained between the equator and the lunar orbit, the preceſſion will be $= \frac{m\,\pi\,t}{\text{T}} \cdot \frac{\text{Coſ. E}}{\text{Coſ. } 23\frac{1}{2}^{\circ}}$, and it muſt be reckoned on the lunar orbit.

Now let ♈B (fig. 8.) be the immoveable plane of the ecliptic, ♈ED♎F the equator in its firſt ſituation, before it has been deranged by the action of the moon, AGRDBH the equator in its new poſition, after the momentary action of the moon. Let EGNFH be the moon's orbit, of which N is the aſcending node, and the angle N = 5° 8' 46''.

Let N♈ the long. of the node be - -	z
Sine N♈ - - - - -	x
Coſine N♈ - - -	y
Sine ♈ = $23\frac{1}{2}$ - - - -	a
Coſine ♈ - - - -	b
Sine N = 5.8.46 - - -	c
Coſine N - - - -	d
Circumference to radius 1, = 6,28 - -	e

Force of the moon - - -	m
Solar preceſſion (ſuppoſed $= 14\frac{1}{2}''$ by obſervation) - - - . -	π
Revolution of ☾ $= 27^{d}\frac{1}{3}$	t
Revolution of ☉ $= 366\frac{1}{4}$ - - -	T
Revolution of N $=$ 18 years 7 months -	n

In order to reduce the lunar preceſſion to the ecliptic, we muſt recollect that the equator will have the ſame inclination at the end of every half revolution of the ſun or of the moon, that is, when they paſs through the equator, becauſe the ſum of all the momentary changes of its poſition begins again each revolution. Therefore, if we neglect the motion of the node during one month, which is only $1\frac{1}{2}$ degrees, and can produce but an inſenſible change, it is plain that the moon produces, in one half revolution, that is, while ſhe moves from H to G, the greateſt difference that ſhe can in the poſition of the equator. The point D, therefore, half-way from G to H, is that in which the moveable equator cuts the primitive equator, and DE and DF are each 90°. But S being the ſolſtitial point, ♈S is alſo 90°. Therefore DS $=$ ♈E. Therefore, in the triangle DGE, we have ſin. ED : ſin. G $=$ ſin. EG : ſin. D, $=$ EG : D. Therefore D $=$ EG $\times$ ſin. G, $=$ EG $\times$ ſin. E nearly. Again, in the triangle ♈DA we have ſin. A : ſin. ♈D (or coſ. ♈E) $=$ ſin. D : ſin. ♈A, $=$ D : ♈A. Therefore

$$\text{♈A} = \frac{\text{D}\cdot\text{Coſ. ♈E}}{\text{Sin. A}}, = \frac{\text{EG}\cdot\text{Sin. E}\cdot\text{Coſ. ♈E}}{\text{Sin. }23\frac{1}{2}}, = \frac{m\pi t}{\text{T}}\,\frac{\text{Sin. E}\cdot\text{Coſ. E}\cdot\text{Coſ. ♈E}}{\text{Sin. ♈}\cdot\text{Coſ. ♈}}.$$

This is the lunar preceſſion produced in the courſe of one month, eſtimated on the ecliptic, not conſtant like the ſolar preceſſion, but varying with the inclination or the angle E or F, which varies both by a change in the angle N, and alſo by a change in the poſition of N on the ecliptic.

We muſt find in like manner the the nutation SR produced in the ſame time, reckoned on the colure of the ſolſtices RL. We have R : ſin. DS $=$ D : RS, and RS $=$ D · ſin. DS, $=$ D · ſin. ♈E. But D $=$ EG · ſin. E. Therefore RS $=$ EG · ſin. E · ſin. ♈E, $= \frac{m\pi t\,\text{Coſ. E}}{\text{T}\cdot\text{Coſ. ♈}} \times \text{ſin. E} \times \text{ſin. ♈E}$. In this expreſſion we muſt ſubſtitute the angle N, which may be conſidered as conſtant during the month, and the longitude ♈N, which is alſo nearly conſtant, by obſerving that ſin. E : ſin. ♈N $=$ ſin. N : ſin. ♈E. Therefore RS $= \frac{m\pi t}{\text{T}} \times \frac{\text{Sin. N}\cdot\text{Sin. ♈N}\cdot\text{Coſ. E.}}{\text{Coſ. ♈}}$

But we muſt exterminate the angle E, becauſe it changes by the change of the poſition of N. Now, in the triangle ♈EN we have coſ. E $=$ coſ. ♈N · ſin. N · ſin. ♈ $-$ coſ. N · coſ. ♈, $= yca - db$. And becauſe the angle E is neceſſarily obtuſe, the perpendicular will fall without the triangle, the coſine of E will be negative, and we ſhall have coſ. E $= bd - acy$. Therefore the nutation for one month will be $= \frac{m\pi t}{\text{T}} \times \frac{cx(bd - acy)}{b}$. the node being ſuppoſed all the while in N.

Theſe two expreſſions of the monthly preceſſion and nutation may be conſidered as momentary parts of the moon's action, correſponding to a certain poſition of the node and inclination of the equator, or as the fluxions of the whole variable preceſſion and nutation, while the node continually changes its place, and in the ſpace of 18 years makes a complete tour of the heavens.

(1.) We muſt, therefore, take the motion of the node as the fluent of compariſon, or we muſt compare the fluxions of the node's motion with the fluxions of the preceſſion and nutation; therefore, let the longitude of the node be z, and its monthly change $= \dot{z}$; we ſhall then have $t : n = \dot{z} : e$, and $t = \frac{n\dot{z}}{e} = \frac{n\dot{x}}{e\sqrt{1-x^2}}$. Let T be $= 1$, in order that n may be 18,6, and ſubſtitute for t its value in the fluxion of the nutation, by putting $\sqrt{1-x^2}$ in place of y. By this this ſubſtitution we obtain $m\pi n\frac{c}{eb}\left(\frac{dbx\dot{x}}{\sqrt{1-x^2}} - acx\dot{x}\right)$. The fluent of this is $m\pi n\frac{c}{eb}\left(-db\sqrt{1-x^2} - \frac{acx^2}{2}\right)$. (*Vide* Simpſon's Fluxions, § 77). But when x is $= o$, the nutation muſt be $= o$, becauſe it is from the poſition in the equinoctial points that all our deviations are reckoned, and it is from this point that the periods of the lunar action recommences. But if we make $x = o$ in this expreſſion, the term $-\frac{acx^2}{2}$ vaniſhes, and the term $-db\sqrt{1-x^2}$ becomes $= -db$; therefore our fluent has a conſtant part $+ db$; and the complete fluent is $m\pi n\frac{c}{eb}\left(db - db\sqrt{1-x^2} - \frac{acx^2}{2}\right)$. Now this is equal to $m\pi n\frac{c}{eb}$ (db $\times$ verſed ſine, $z - \frac{1}{4}ac \times$ verſed ſine $2z$): For the verſed ſine of z is equal to $(1 - \text{coſ. } z)$; and the ſquare of the ſine of an arch is $\frac{1}{2}$ the verſed ſine of twice that arch.

This, then, is the whole nutation while the moon's aſcending node moves from the vernal equinox to the longitude ♈N $= z$. It is the expreſſion of a certain number of ſeconds, becauſe π, one of its factors, is the ſolar preceſſion in ſeconds; and all the other factors are numbers, or fractions of the radius 1; even e is expreſſed in terms of the radius 1.

(2.) The fluxion of the preceſſion, or the monthly preceſſion, is to that of the nutation as the cotangent of ♈E is to the ſine of ♈. This alſo appears by conſidering fig. 7. Pp meaſures the angle A, or change of poſition of the equator; but the preceſſion itſelf, reckoned on the ecliptic, is meaſured by Po, and the nutation by po; and the fluxion of the preceſſion is equa to the fluxion of nutation $\times \frac{\text{cot. ♈E}}{\text{ſine ♈}}$, but cot. ♈E $= \frac{ad + bcy}{cx}$; therefore $\frac{\text{cot. ♈E}}{\text{ſine ♈}} = \frac{ad + bc\sqrt{1-x^2}}{cx}$: This, multiplied into the fluxion of the nutation, gives $\frac{m\pi n}{abe}\left(\frac{abd^2}{\sqrt{1-xx}} + (b^2 - a^2)\,dc - abc^2.\sqrt{1-xx}\right)\dot{x}$ for the monthly preceſſion. The fluent of this $\frac{m\pi n}{abe}\left(ad^2bz + (b^2 - a^2)\,dcx - \frac{1}{2}abc^2z - \frac{1}{2}abc^2x\cdot\sqrt{1-x^2}\right)$, or it is equal to $\frac{m\pi n}{abe}\left((d^2 - \frac{1}{2}c^2)\,abz + (b^2 - a^2).\,dcz - \frac{1}{4}abc^2 \text{ ſine } 2z\right)$.

Let us now expreſs this in numbers: When the node has made a half revolution, we have $z = 180°$, whoſe verſed ſine is 2, and the verſed ſine of $2z$, or 360°, is $= 0$; therefore, after half a revolution of the node, the nutation (No. 1. p. 473.) becomes $\frac{m\pi nc}{eb}\,2bd$. If, in this expreſſion, we ſuppoſe $m = 2\frac{1}{2}$, and $\pi = 14\frac{1}{2}''$, we ſhall find the nutation to be $19\frac{1}{4}''$.

Now the obſerved nutation is about 18″. This requires m to be $2\frac{1}{10}$, and $\pi = 16\frac{1}{4}''$. But is evident, that no aſtronomer can pretend to warrant the accuracy of his obſervations of the nutation within 1″.

To find the lunar preceſſion during half a revolution of the node, obſerve, that then z becomes $= \frac{e}{2}$, and the ſine of z

and of $2z$ vaniſh, d^2 becomes $1-c^2$, and the preceſſion becomes $\frac{m\pi n}{2}(d^2-\frac{1}{2}c^2)$, $=\frac{m\pi n}{2}(1-\frac{3}{2}c^2)$, and the preceſſion in 18 years is $m\pi n\,\overline{1-\frac{3}{2}c^2}$.

We ſee by comparing the nutation and preceſſion for nine years, that they are as $\frac{4cd}{e}$ to $1-\frac{3}{2}c^2$ nearly as 1 to $17\frac{1}{3}$. This gives 313″ of preceſſion, correſponding to 18″, the obſerved nutation, which is about 35′ of preceſſion annually produced by the moon.

And thus we ſee, that the inequality produced by the moon in the preceſſion of the equinoxes, and, more particularly, the nutation occaſioned by the variable obliquity of her orbit, enables us to judge of her ſhare in the whole phenomenon; and therefore informs us of her diſturbing force, and therefore of her quantity of matter. This phenomenon, and thoſe of the tides, are the only facts which enable us to judge of this matter: and this is one of the circumſtances which has cauſed this problem to occupy ſo much attention. Dr. Bradley, by a nice compariſon of his obſervations with the mathematical theory, as it is called, furniſhed him by Mr. Machin, found that the equation of preceſſion computed by that theory was too great, and that the theory would agree better with the obſervations, if an ellipſe were ſubſtituted for Mr. Machin's little circle. He thought that the ſhorter axis of this ellipſe, lying in the colure of the ſolſtices, ſhould not exceed 16″. Nothing can more clearly ſhow the aſtoniſhing accuracy of Bradley's obſervations than this remark: for it reſults from the theory, that the pole muſt really deſcribe an ellipſe, having its ſhorter axis in the ſolſtitial colure, and the ratio of the axes muſt be that of 18 to 16,8; for the mean preceſſion during a half revolution of the node is $\frac{m\pi n}{2}(d^2-\frac{c^2}{2})$; and therefore, for the longitude z, it will be $\frac{zm\pi n}{e}\left(d^2-\frac{c^2}{2}\right)$; when this is taken from the true preceſſion for that longitude (No. 2. p. 473.), it leaves the equation of preceſſion $\frac{m\pi n}{abe}\left((b^2-a^2)\,dc\text{ ſine }z-\frac{1}{4}abc\text{ ſine }2z\right)$; therefore, when the node is in the ſolſtice, and the equation greateſt, we have it $=\frac{m\pi ncd}{abe}(b^2-a^2)$. We here neglect the ſecond term as inſignificant.

This greateſt equation of preceſſion is to $\frac{2m\pi ncd}{c}$, the nutation of 18″, as b^2-a^2 to $2ab$; that is as radius to the tangent of twice the obliquity of the ecliptic. This gives the greateſt equation of preceſſion 16″,8, not differing half a ſecond from Bradley's obſervations.

Thus have we attempted to give ſome account of this curious and important phenomenon. It is curious, becauſe it affects the whole celeſtial motions in a very intricate manner, and received no explanation from the more obvious application of mechanical principles, which ſo happily accounted for all the other appearances. It is one of the moſt illuſtrious proofs of Sir Iſaac Newton's ſagacity and penetration, which catched at a very remote analogy between this phenomenon and the libration of the moon's orbit. It is highly important to the progreſs of practical and uſeful aſtronomy, becauſe it has enabled us to compute tables of ſuch accuracy, that they can be uſed with confidence for determining the longitude of a ſhip at ſea. This alone fixes its importance: but it is ſtill more important to the philoſopher, affording the moſt inconteſtable proof of the univerſal and mutual gravitation of all matter to all matter. It left nothing in the ſolar ſyſtem unexplained from the theory of gravity but the acceleration of the moon's mean motion; and this has at laſt been added to the liſt of our acquiſitions by Mr. de la Place.

Quæ toties animos veterum torſere Sophorum,
Quæque ſcholas fruſtra rauco certamine vexant,
Obvia conſpicimus, nube pellente Matheſi,
Jam dubios nulla caligine prægravat error
Queis ſuperûm penetrare domos, atque ardua cœli
Scandere ſublimis genii conceſſit acumen.
Nec fas eſt propius mortali attingere divos.

Halley.

PRECIÆ, (*precius*, "early,") the name of the 21ſt order in Linnæus's fragments of a natural method; conſiſting of primroſe, an early flowering plant, and a few genera which agree with it in habit and ſtructure, though not always in the character or circumſtance expreſſed in the title. See Botany.

PRECIPITANT, in chemiſtry, is applied to any liquor, which, when poured on a ſolution, ſeparates what is diſſolved, and makes it precipitate, or fall to the bottom of the veſſel.

PRECIPITATE, in chemiſtry, a ſubſtance which, having been diſſolved in a proper menſtruum, is again ſeparated from its ſolvent, and thrown down to the bottom of the veſſel, by pouring ſome other liquor upon it.

PRECIPITATION. See Chemistry.

PRECORDIA, in anatomy, a general name for the parts ſituated about the heart, in the forepart of the thorax: as the diaphragm, pericardium, and even the heart itſelf, with the ſpleen, lungs, &c.

PREDECESSOR, properly ſignifies a perſon who has preceded or gone before another in the ſame office or employment; in which ſenſe it is diſtinguiſhed from anceſtor.

PREDESTINATION, the decree of God, whereby he is ſuppoſed to have, from all eternity, unchangeably appointed whatſoever comes to paſs; and hath more eſpecially fore-ordained certain individuals of the human race to everlaſting happineſs, and hath paſſed by the reſt, and fore-ordained them to everlaſting miſery. The former of theſe are called the *elect*, and the latter are called the *reprobate*.

This doctrine is the ſubject of one of the moſt perplexing controverſies that has occurred among mankind. But it is not altogether peculiar to the Chriſtian faith. The opinion, that whatever occurs in the world at large, or in the lot of private individuals, is the reſult of a previous and unalterable arrangement by that Supreme Power which preſides over nature, has always been a favourite opinion among the vulgar, and has been believed by many ſpeculative men.

The ancient Stoics, Zeno and Chryſippus, whom the Jewiſh Eſſenes ſeem to have followed, aſſerted the exiſtence of a Deity that, acting wiſely, but neceſſarily, contrived the general ſyſtem of the world; from which, by a ſeries of cauſes, whatever is now done in it unavoidably reſults. This ſeries or concatenation of cauſes, they held to be neceſſary in every part; and that God himſelf is ſo much the ſervant of neceſſity, and of his own decrees, that he could not have made the ſmalleſt object in the world otherwiſe than it now is, much leſs is he able to alter any thing.

According to the words of Seneca, *Eadem neceſſitas et Deos alligat. Irrevocabilis divina pariter atque humana curſus vehit. Ille ipſe omnium condito ac rector ſcripſit quidem fata ſed ſequitur. Semper paret, ſemel juſſit.* "The ſame chain of neceſſity conſtrains both gods and men. Its unalterable courſe regulates divine as well as human things. Even he who wrote the Fates, the Maker and Governor of all things, ſubmits to them. He did but once command, but he always obeys." The ſtoical fate differs, however, from the Chriſtian predeſtination in ſeveral points. They regarded the divine nature and will as a neceſſary part of a neceſſary chain of cauſes; whereas the Chriſtians conſider the Deity as the Lord and Ruler of the Univerſe, omnipotent and free, appointing all things according to his pleaſure. Being doubtful of the immortality of the ſoul, the Stoics could have no idea of the doctrine of election and reprobation; nor did they ever doubt their own freedom of will, or power of doing good as well as evil, as we ſhall preſently ſee the Chriſtian predeſtinarians have done.

Mahomet introduced into his Koran the doctrine of an abſolute predeſtination of the courſe of human affairs. He repreſented life and death, proſperity and adverſity, and every event that befals a man in this world, as the reſult of a previous determination of the one God who rules over all; and he found this opinion the beſt engine for inſpiring his followers with that contempt of danger which, united to their zeal, has extended the empire of their faith over the faireſt portion of the habitable globe.

The controverſy concerning predeſtination firſt made its appearance in the Chriſtian church about the beginning of the fifth century. See Mosheim's Inſtit. Hiſt. Eccl. Pelagius a Britiſh, and Cœleſtius an Iriſh, monk, who both lived at Rome during that period, and were with juſtice celebrated for their exemplary piety, and integrity, and great learning, contended that the doctrines of predeſtination and original ſin were falſe. On the contrary, the famous Auguſtine, biſhop of Hippo, ſtrenuouſly aſſerted the depravity of human nature ſince the fall of the firſt man, the neceſſity of a ſpecial interpoſition of divine grace to enable us to do any one good action; and, conſequently, that none could obtain ſalvation excepting thoſe whom God has thought fit to elect, and upon whom he beſtows this grace. In the courſe of the ſame century theſe opinions aſſumed a variety of forms and modifications. One party, called *Predeſtinarians*, carried Auguſtine's doctrine fully further than he himſelf had ventured to do in expreſs words; and aſſerted, that God had not only predeſtinated the wicked to *puniſhment*, but alſo that he had decreed that they ſhould commit thoſe very *ſins* on account of which they are hereafter to be puniſhed.—Another party moderated the doctrine of Pelagius, and were called *Semipelagians*. Their peculiar opinion is expreſſed in a different manner by different writers; but all the accounts ſufficiently agree. Thus, ſome repreſent them as maintaining that inward grace is not neceſſary to the firſt beginning of repentance, but only to our progreſs in virtue. Others ſay that they acknowledged the power of grace, but ſaid that faith depends upon ourſelves, and good works upon God; and it is agreed upon all hands, that theſe Semipelagians held that predeſtination is made upon the foreſight of good works. The aſſiſtance of Auguſtine, though then far advanced in life, was called in to combat theſe tenets, and he wrote ſeveral treatiſes upon the ſubject. In all theſe he ſtrenuouſly maintained, that the predeſtination of the elect was independent of any foreſight of their good works, but was according to the good pleaſure of God only; and that perſeverance comes from God, and not from man. Thereafter the doctrine of Auguſtine, or St. Auſtin as he is often called, became general. He was the oracle of ſchoolmen. They never ventured to differ from him in ſentiment; they only pretended to diſpute about the true ſenſe of his writings.

The whole of the earlieſt reformers maintained theſe opinions of Auguſtine. They aſſumed under Luther a more regular and ſyſtematic form than they had ever formerly exhibited. But as the Lutherans afterwards abandoned them, they are now known by the name of *Calviniſtic Doctrines*, from John Calvin of Geneva. He aſſerted, that the everlaſting condition of mankind in a future world was determined from all eternity by the unchangeable decree of the Deity, ariſing from his ſole good pleaſure or free will. Being a man of great ability, induſtry, and eloquence, Geneva, where he taught, and which was a free ſtate, ſoon became the reſort of all the men of letters belonging to the reformed churches, and was a kind of ſeminary from which miſſionaries iſſued to propagate the Proteſtant doctrines through Europe. Their ſucceſs was ſuch, that excepting a part of Germany, the principles of all the reformed churches are profeſſedly Calviniſtic or Predeſtinarian.

The opponents of the doctrine of predeſtination among the Proteſtants, uſually receive the appellation of *Arminians*, or *Remonſtrants*. They derive the firſt of theſe appellations from James Arminius, who was A. D. 1602, appointed profeſſor of theology at Leyden. He was violently oppoſed by Gomer his colleague, and died A. D. 1609. After his death the controverſy was conducted with great eagerneſs on both ſides. The Calviniſts however gradually prevailed. See Arminians. A ſynod was called at Dort, A. D. 1618, to which the moſt celebrated divines of different countries were invited. There, in a great meaſure by the authority and influence of Maurice prince of Orange, the Arminians were condemned as heretics; for by this time ambitious and powerful men found themſelves politically intereſted in this religious conteſt. The Arminians preſented to this ſynod a remonſtrance, containing a ſtatement of their faith upon the ſubjects in diſpute; and from this they derived the appellation of *Remonſtrants*. This ſtatement contained the following five articles: 1. That God from all eternity predeſtinated thoſe to everlaſting ſalvation whom he foreſaw would believe in Chriſt unto the end of their lives; and predeſtinated obſtinate unbelievers to everlaſting puniſhment. 2. Jeſus Chriſt died for the whole human race, and for every individual of it, but believers alone reap the benefit of his death. 3. No man can produce faith in his mind by his own free will, but it is neceſſary that man, who is by nature wicked and unfit for acting or thinking aright, ſhould be regenerated by the grace of the Holy Spirit, imparted by God for Chriſt's ſake. 4. This divine grace conſtitutes the ſource, the progreſs, and the fulfilment of all that is good in man; but it is not irreſiſtible in its operation. 5. Believers, by the aſſiſtance of the Holy Spirit, are abundantly fitted for every good work; but whether it be poſſible for thoſe who have once been truly ſuch to fall away, and to periſh finally, is not clear, and muſt be better inquired into by ſearching the ſacred ſcriptures.

In oppoſition to theſe, a counter-remonſtrance was preſented, containing the opinions of the Calviniſts, which was approved of by the ſynod. The ſubſtance of it was afterwards adopted, and in nearly the ſame expreſſions, into the Confeſſion of Faith compiled by the aſſembly of divines which met at Weſtminſter, A. D. 1643, and which every clergyman and probationer for the miniſtry in Scotland is at preſent required to ſubſcribe previous to his admiſſion. To give as clear and as fair an idea as poſſible of the Calviniſtic doctrine upon this head, we tranſcribe the following paſſage from that Confeſſion: “God from all eternity did, by the moſt wiſe and holy counſel of his own will, freely and unchangeably ordain whatſoever comes to paſs; yet ſo, as thereby neither is God the author of ſin, nor is violence offered to the will of the creatures, nor is the liberty or contingency of ſecond cauſes taken away, but rather eſtabliſhed. Although God knows whatſoever may or can come to paſs upon all ſuppoſed conditions; yet hath he not decreed any thing becauſe he foreſaw it as future, or that which would come to paſs upon ſuch conditions. By the decrees of God for the manifeſtation of his glory, ſome men and angels are predeſtinated unto everlaſting life, and others are fore-ordained to everlaſting death. Theſe angels and men, thus predeſtinated and fore-ordained, are particularly and unchangeably deſigned; and their number is ſo certain and definite, that it cannot be either increaſed or diminiſhed. Thoſe of mankind that are predeſtinated unto life, God, before the foundation of the world was laid, according to his eternal and and immutable purpoſe, and the ſecret counſel and good pleaſure of his will, hath choſen, in Chriſt, unto everlaſting glory, out of his mere free grace and love, without any foreſight of faith, or good works, or perſeverance in either of them, or any other thing in the creature, as conditions or cauſes moving him thereunto; and all to the praiſe of his glorious grace. As God hath appointed the elect unto glory, ſo hath he, by the eternal and moſt free purpoſe of his will, fore-ordained all the means thereunto. Wherefore, they who are elected, being fallen in Adam, are redeemed by Chriſt, are effectually called unto faith in Chriſt, by his ſpirit working in due ſeaſon; are juſtified, adopted, ſanctified and kept by his power through faith unto ſalvation. Neither are any other redeemed by Chriſt, effectually called, juſtified, adopted, ſanctified and ſaved, but the elect only. The reſt of mankind, God was pleaſed, according to the unſearchable counſel of his own will, whereby he extendeth or withholdeth mercy as he pleaſeth for the glory of his ſovereign power over his creatures, to paſs by, and to ordain them to diſhonour and wrath for their ſin, to the praiſe of his glorious juſtice."

There are two kinds of Calviniſts or Predeſtinarians, viz. the *Supralapſarians*, who maintain that God did originally and expreſsly decree the fall of Adam, as a foundation for the diſplay of his juſtice and mercy; while thoſe who maintain that God only *permitted* the fall of Adam, are called *Sublapſarians*, their ſyſtem of decrees concerning election and reprobation being, as it were, ſubſequent to that event. But, as Dr. Prieſtley juſtly remarks, if we admit the divine preſcience, there is not, in fact, any difference between the two ſchemes; and accordingly that diſtinction is now ſeldom mentioned.

Nor was the church of Rome leſs agitated by the conteſt about predeſtination than the firſt Proteſtants were. The council of Trent was much perplexed how to ſettle the matter without giving offence to the Dominicans, who were much attached to the doctrine of Auguſtine, and poſſeſſed great influence in the council. After much diſpute, the great object came to be, how to contrive ſuch a decree as might give offence to nobody, although it ſhould decide nothing. Upon the whole, however, they ſeem to have favoured the Semipelagian ſcheme. Among other things it was determined, that good works are of themſelves meritorious to eternal life; but it is added, by way of ſoftening, that it is through the goodneſs of God that he makes his own gifts to be merits in us. Catarin revived at that council an opinion of ſome of the ſchoolmen, that God choſe a ſmall number of perſons, ſuch as the bleſſed virgin, the apoſtles, &c. whom he was determined to ſave without any foreſight of their good works; and that he alſo wills that all the reſt ſhould be ſaved, providing for them all neceſſary means, that they are at liberty to uſe them or not. This is called the *Baxterian* ſcheme in England, from one of its promoters there. But at all events, the council of Trent ſeems to have been extremely anxious that any opinions entertained among them concerning predeſtination might have as little influence as poſſible upon practical morality. "Let no man (ſay they), while he remains in this mortal ſtate, preſume that he is among the number of the elect, and that therefore he cannot ſin, or ſin without repentance; for it cannot be known who are elected without a ſpecial revelation from God." Seſ. 6. c. 13.

The Jeſuits at firſt followed the opinion of Auguſtine; but they afterwards forſook it. *Molina*, one of their order, was the author of what is called the *middle ſcheme*, or the doctrine of *a grace ſufficient for all men*, but ſubject to the freedom of the human will. *Janſenius*, a doctor of Louvain, oppoſed the Jeſuits with great vigour, and ſupported the doctrine of Auguſtine. He wrote in a very artful manner. He declared, that he did not preſume to ſtate his own ſentiments upon the ſubject; he pretended only to explain and publiſh the ſentiments of that great father of the church St. Auguſtine. But the Jeſuits, in conſequence of that inviolable ſubmiſſion to the authority of the pope which they always maintained, had ſufficient intereſt at Rome to procure the opinions of Janſenius to be condemned there; but with this addition ſubjoined, that nothing was thereby intended to be done in prejudice of the doctrine of St. Auguſtine. This produced an abſurd diſpute about the pope's infallibility in matters of fact. The Janſeniſts affirmed, that the pope had made a miſtake in condemning the opinions of Janſenius as different from thoſe of Auguſtine; whereas in truth they are the ſame, and the one cannot be condemned without the other. But the Jeſuits affirmed, that the pope is no leſs infallible in points of fact than he is in queſtions of faith; and he having decided, that the opinions of Janſenius are different from thoſe of St. Auguſtine, every good Catholic is bound to believe accordingly that they are different. Theſe diſputes have never been fully ſettled, and ſtill divide the Roman Catholic churches. Some of the ableſt ſupporters of predeſtination have appeared among the Janſeniſts, and particularly among the gentlemen of Port-Royal.

With regard to Great Britain, the earlieſt Engliſh reformers were in general Sublapſarians, although ſome of them were Supralapſarians. But the rigid predeſtinarians have been gradually declining in number in that church, although they ſtill ſubſcribe the 39 articles of their faith, which are unqueſtionably Calviniſtic. The celebrated Scotch reformer John Knox having been educated at Geneva, eſtabliſhed in this country the doctrine of predeſtination in its ſtricteſt form: and it has probably been adhered to with more cloſeneſs in Scotland than in any country in Europe.

Of late years, however, the diſpute concerning predeſtination has aſſumed a form conſiderably different from that which it formerly poſſeſſed. Inſtead of being conſidered as a point to be determined almoſt entirely by the ſacred ſcriptures, in the hands of a number of able writers, it has in a great meaſure reſolved itſelf into a queſtion of natural religion, under the head of the philoſophical liberty or neceſſity of the will *; or, whether all human actions are or are not neceſſarily determined by motives ariſing from the character which God has impreſſed on our minds, and the train of circumſtances amidſt which his providence has placed us? We have already ſpoken of this under METAPHYSICS.

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* Dr. Prieſtley, the moſt celebrated Neceſſarian of the age, has written a whole ſection of his *Illuſtrations*, with a view to ſhow, that between "the two ſchemes of Calviniſtic predeſtination and philoſophical neceſſity, there is no ſort of reſemblance, except that the future happineſs or miſery of all men is certainly foreknown and appointed by God. In all other reſpects (ſays he) they are moſt eſſentially different; and even where they agree in the *end*, the difference in the *manner* by which that end is accompliſhed is ſo very great, that the *influence* of the two ſyſtems on the minds of thoſe that adopt and act upon them is the reverſe of one another." The Calviniſtic doctrine of predeſtination, according to a very authentic ſtatement of that doctrine, is, that "God, for his own glory, hath *fore-ordained whatſoever comes to paſs*." The ſcheme of philoſophical neceſſity, as ſtated by an intimate friend and warm admirer of Dr. Prieſtley's, is, "That *every thing is predetermined* by the Divine Being; that whatever has been, muſt have been; and that whatever will be, muſt be; that *all events* are *pre-ordained* by infinite wiſdom and unlimited goodneſs; that the will, in all its determinations, is governed by the ſtate of mind; that this ſtate of mind is in every inſtance determined by the Deity; and that there is a continued chain of cauſes and effects, of motives and actions, inſeparably connected, and originating from the condition in which we are brought into exiſtence by the Author of our being. The *author* or *compiler* of the ſame book affirms, "That all motion indeed originates in the Deity; that the Deity is ſelf-moved; that he poſſeſſes the ſingular attribute underived of moving himſelf." But it is added in the very ſame paragraph from which this laſt ſentence is quoted, that "the very argument we employ to prove one underived ſource of motion and exiſtence, is a groſs ſoloeciſm in logic; and that the aſcription of this power to the Divine Being is in fact nothing elſe than the leſs of two palpable

From what has been ſaid, it will appear that the points chiefly at iſſue between the parties are the following: Firſt, With what views and purpoſes did God create the world and frame his decrees concerning mankind? Did he contrive a great unalterable ſcheme of creation and providence only for the ſake of manifeſting his own glory and perfections? Or did he firſt conſider the free motions of thoſe rational agents whom he intended to create, and frame his decrees upon the conſideration of what they might chooſe or do in all the various circumſtances in which he intended to place them?—The ſecond and following queſtions are branches of this leading one. Did Chriſt die for a particular portion of the human race, who ſhall therefore certainly be ſaved? or was his death intended as a benefit to all, from which none are excluded excepting thoſe who willingly reject it? Is the divine grace certainly and irreſiſtibly efficacious in all thoſe minds to which it is given? or does its effect depend upon the good uſe which men may or may not make of it? Can any good action be done without it? Do thoſe who have once received it certainly perſevere and obtain ſalvation? or is it poſſible for any of them to fall away and periſh finally? Theſe are queſtions the diſcuſſion of which would lead us far beyond our uſual limits, and the tedioufneſs of it would hardly be compenſated by any proſpect of utility.

The weak ſide of the Calviniſtic doctrine conſiſts in the impoſſibility of reconciling the abſolute and unconditional decree of reprobation with our ideas of the juſtice and goodneſs of God. The weak ſide of the Arminian ſcheme conſiſts in the difficulty of accounting for the certainty of the divine foreknowledge, upon the ſuppoſition of a contingency of events, or an abſolute freedom of will in man.

To elude the former of theſe difficulties, ſome of the late writers upon philoſophical neceſſity, and Dr. Prieſtley is among the number, have given up the doctrine of reprobation, and aſſerted, that this world is only a ſtate of preparation for another, in which all men, of every deſcription and character, ſhall attain to final and everlaſting happineſs, when God *ſhall be all, and in all.* On the other ſide, ſome of the ſupporters of free agency, and Monteſquieu is among the number, have been diſpoſed to deny the divine attribute of preſcience.

Whatever may be thought of the practical tendency of the two moſt prevailing opinions, there is one remark which we think ourſelves bound in juſtice to make, although it appears to us to be ſomewhat ſingular. It is this, that from the earlieſt ages down to our own days, if we conſider the character of the ancient Stoics, the Jewiſh Eſſenes, the modern Calviniſts, and Janſeniſts, when compared with that of their antagoniſts the Epicureans, the Saducees, Arminians, and the Jeſuits, we ſhall find that they have excelled in no ſmall degree in the practice of the moſt rigid and reſpectable virtues, and have been the higheſt honour of their own ages, and the beſt models for imitation to every age ſucceeding. At the ſame time, it muſt be confeſſed, that their virtues have in general been rendered unamiable by a tinge of gloomy and ſevere auſterity.

So far as the ſpeculative foundation of their principles is conſidered, however, neither party ſeems liable to cenſure in a moral point of view. Each of them wiſhes to ſupport, though in a different manner from the other, the honour of the divine character. The Calviniſts begin their argument with the notion of infinite perfection, independency, and abſolute ſovereignty, and thence deduce their opinions; making every difficulty yield to theſe firſt and leading ideas. Their opponents are more jealous of the reſpect due to the divine attributes of juſtice, truth, holineſs, and mercy, and deduce their ſentiments from the idea which they have formed of theſe. Each party lays down general maxims that are admitted by the other, and both argue plauſibly from their firſt principles. Dr. Burnet, whom we have here followed very cloſely, juſtly obſerves, that "theſe are great grounds for mutual charity and forbearance."

PREDETERMINATION, in philoſophy and theology, is that concurrence of God which makes men act, and determines them in all their actions, both good and evil, and is called by the ſchoolmen *phyſical predetermination* or *premotion.* See METAPHYSICS and PREDESTINATION.

PREDIAL SLAVES. See *Predial*-SLAVES.

PREDIAL-*Tithes*, are thoſe that are paid of things ariſing and growing from the ground only; as corn, hay, fruit, &c.

PREDICABLE, among logicians, denotes a general quality which may be predicated, or aſſerted of ſeveral things: thus animal is predicable of mankind, beaſts, birds, fiſhes, &c.

PREDICAMENT, among logicians, the ſame with category. See CATEGORY and PHILOSOPHY.

PREDICATE, in logic, that which, in a propoſition, is affirmed or denied of the ſubject. In theſe propoſitions, *ſnow is white, ink is not white,* whiteneſs is the predicate which is affirmed of ſnow, and denied of ink.

PRE-EMPTION, a privilege anciently allowed the king's purveyor, of having the choice and firſt buying of corn and other proviſions for the king's houſe; but taken away by the ſtatute 19 Car. II.

PREENING, in natural hiſtory, the action of birds cleaning, compoſing, and dreſſing their feathers, to enable them to glide more eaſily through the air. For this purpoſe they have two peculiar glands on their rump, which ſecrete an unctuous matter into a bag that is perforated, out of which the bird occaſionally draws it with its bill.

PRE-EXISTENCE, a priority of being, or the being of one thing before another. Thus a cauſe, if not in time, is yet in nature pre-exiſtent to its effect. Thus God is pre-exiſtent to the univerſe. Thus a human father is pre-exiſtent to his ſon. The peripatetics, though they maintained the eternity of the world, were likewiſe dogmatical in their opinion, that the univerſe was formed, actuated, and governed, by a ſovereign intelligence. See *Ariſtotle on the Soul,* and our articles CREATION and EARTH. See alſo the *Philoſophical Eſſays of Dr. Iſaac Watts,* and the *Principles of natural and revealed Religion,* by the chevalier Ramſay, where the ſubject of the world's eternity is diſcuſſed. Mr. Hume's ſpeculations alſo, on this abſtruſe and arduous ſubject, had a greater tendency to diſſipate its gloom than that philoſopher himſelf could imagine.

The pre-exiſtence of the human ſoul to its corporeal vehicle had been from time-immemorial a prevailing opinion among

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abſurdities or rather *impoſſibilities,* if theſe could admit of degrees. See the Eſſay on Philoſophical Neceſſity by Alexander Crombie, A. M.

The piety of theſe aſſertions will be obvious, we are perſuaded, to every one of our readers; but to ſome it is poſſible that their conſiſtency may not be apparent. We would adviſe all ſuch "to peruſe once and again Dr. Prieſtley's Illuſtrations," which, we have the beſt authority to ſay, will remove from their minds all libertarian prejudices, convince them "that the hypotheſis of neceſſity is incontrovertibly true," and ſhow them that all the defenders of that hypotheſis are in perfect harmony with themſelves and with one another.

the Aſiatic ſages, and from them was perhaps transferred by Pythagoras to the philoſophy of the Greeks; but his metempſychoſis, or tranſmigration of ſouls, is too trivial either to be ſeriouſly propoſed or refuted. Nevertheleſs, from the ſentiments of Socrates concerning the immortality of the ſoul, delivered in his laſt interview with his friends, it is obvious that the tenet of pre-exiſtence was a doctrine of the Platonic ſchool. If at any period of life, ſay theſe philoſophers, you ſhould examine a boy, of how many ideas, of what number of principles, of what an extent of knowledge, will you find him poſſeſſed! theſe without doubt could neither be ſelf-derived nor recently acquired. With what avidity and promptitude does he attain the knowledge of arts and ſciences, which appear entirely new to him! theſe rapid and ſucceſsful advances in knowledge can only be the effects of reminiſcence, or of a fainter and more indiſtinct ſpecies of recollection. But in all the other operations of memory, we find retroſpective impreſſions attending every object or idea which emerges to her view; nor does ſhe ever ſuggeſt any thought, word, or action, without informing us, in a manner equally clear and evident, that thoſe impreſſions have been made upon our ſenſes, mind, or intellect, on ſome former occaſion. Whoever contemplates her progreſs, will eaſily diſcover, that aſſociation is her moſt faithful and efficacious auxiliary; and that by joining impreſſion with impreſſion, idea with idea, circumſtance with circumſtance, in the order of time, of place, of ſimilarity or diſſimilarity, ſhe is capacitated to accumulate her treaſures and enlarge her province even to an indefinite extent. But when intuitive principles, or ſimple concluſions, are elicited from the puerile underſtanding by a train of eaſy queſtions properly arranged, where is the retroſpective act of memory, by which the boy recogniſes thoſe truths as having formerly been perceived in his mind? Where are the crowds of concomitant, antecedent, or ſubſequent ideas, with which thoſe recollections ought naturally to have been attended? In a word, where is the ſenſe of perſonal identity, which ſeems abſolutely inſeparable from every act of memory? This hypotheſis, therefore, will not ſupport pre-exiſtence. After the Chriſtian religion had been conſiderably diffuſed, and warmly combated by its philoſophical antagoniſts, the ſame doctrine was reſumed and taught at Alexandria, by Platonic proſelytes, not only as a topic conſtituent of their maſter's philoſophy, but as an anſwer to thoſe formidable objections which had been deduced from the doctrine of original ſin, and from the vices which ſtain, and from the calamities which diſturb human life: hence they ſtrenuouſly aſſerted, that all the human race were either introduced to being prior to Adam, or pre-exiſtent in his perſon; that they were not, therefore, repreſented by our firſt parents, but actually concurred in their crime, and participated their ruin.

The followers of Origen, and ſuch as entertained the notion of PRE-ADAMITES, might argue from the doctrine of pre-exiſtence with ſome degree of plauſibility. For the human beings introduced by them to the theatre of probation had already attained the capacity or dignity of moral agents; as their crime therefore was voluntary, their puniſhment might be juſt. But thoſe who believe the whole human race created in Adam to be only pre-exiſtent in their germs or ſtamina, were even deprived of this miſerable ſubterfuge; for in theſe homunculi we can neither ſuppoſe the moral nor rational conſtitution unfolded. Since, therefore, their degeneracy was not ſpontaneous, neither could their ſufferings be equitable. Should it be ſaid that the evil of original ſin was penal, as it extended to our firſt parents alone, and merely conſequential as felt by their poſterity, it will be admitted that the diſtinction between penal and conſequential evil may be intelligible in human affairs, where other laws, aſſortments, and combinations than thoſe which are ſimply and purely moral, take place. But that a moral government, at one of the moſt cardinal periods of its adminiſtration, ſhould admit gratuitous or conſequential evil, ſeems to us irreconcileable with the attributes and conduct of a wiſe and juſt legiſlator. Conſequential evil, taken as ſuch, is miſery ſuſtained without demerit; and cannot reſult from the procedure of wiſdom, benignity, and juſtice; but muſt flow from neceſſity, from ignorance, from cruelty, or from caprice, as its only poſſible ſources. But even upon the ſuppoſition of thoſe who pretend that man was mature in all his faculties before the commiſſion of original ſin, the objections againſt it will ſtill remain in full force: for it is admitted by all except the Samian ſage, that the conſciouſneſs of perſonal identity which was felt in pre-exiſtence, is obliterated in a ſubſequent ſtate of being.

Now it may be demanded, whether agents thus reſuſcitated for puniſhment have not the ſame right to murmur and complain as if they had been perfectly innocent, and only created for that dreadful cataſtrophe? It is upon this principal alone that the effects of puniſhment can be either exemplary or diſciplinary; for how is it poſſible, that the puniſhment of beings unconſcious of a crime ſhould ever be reconciled either to the juſtice or beneficence of that intention with which their ſufferings are inflicted? or how can others be ſuppoſed to become wiſe and virtuous by the example of thoſe who are neither acquainted with the origin nor the tendency of their miſeries, but have every reaſon to think themſelves afflicted merely for the ſake of afflicting? To us it ſeems clear, that the nature and *rationale* of original ſin lie inſcrutably retired in the boſom of Providence; nor can we, without unpardonable preſumption and arrogance, form the moſt ſimple concluſion, or attempt the minuteſt diſcovery, either different from or extraneous to the clear and obvious ſenſe of revelation. This ſenſe indeed may with propriety be extracted from the whole, or from one paſſage collated with another; but, independent of it, as reaſon has no premiſes, ſhe can form no deductions. The boldneſs and temerity of philoſophy, not ſatisfied with contemplating pre-exiſtence as merely relative to human nature, has dared to try how far it was compatible with the glorious Perſons of the ſacred Trinity. The Arians, who allowed the ſubordinate divinity of our Saviour, believed him pre-exiſtent to all time, and before all worlds; but the Socinians, who eſteemed his nature as well as his perſon merely human, inſiſted, that before his incarnation he was only pre-exiſtent in the divine idea, not in nature or perſon. But, when it is conſidered that children do not begin to deduce inſtructions from nature and experience, at a period ſo late as we are apt to imagine; when it is admitted, that their progreſs, though inſenſible, may be much more rapid than we apprehend; when the opportunities of ſenſe, the ardour of curioſity, the avidity of memory, and the activity of underſtanding, are remarked—we need not have recourſe to a pre-exiſtent ſtate for our account of the knowledge which young minds diſcover. It may likewiſe be added, that moral agents can only be improved and cultivated by moral diſcipline. Such effects therefore of any ſtate, whether happy or miſerable, as are merely mechanical, may be noxious or ſalutary to the patient, but can never enter into any moral economy as parts of its own adminiſtration. Pre-exiſtence, therefore, whether rewarded or puniſhed, without the continued impreſſion of perſonal identity, affords no ſolution of original ſin.

PREFACE, ſomething introductory to a book, to inform the reader of the deſign, method, &c. obſerved therein, and generally whatever is neceſſary to the underſtanding of a book.

PREFECT, in ancient Rome, one of the chief magiſtrates who governed in the abſence of the kings, conſuls, and emperors. This power was greateſt under the emperors. His chief care was the government of the city, taking cognizance of all crimes committed therein and within 100 miles. He judged capitally and finally, and even preſided in the ſenate. He had the ſuperintendance of the proviſions, building, and navigation. The prefect of modern Rome differs little from the ancient *præfectus*, his authority only extending to 40 miles round the city.

Prefect *of the Prætorium*, the leader of the pretorian bands deſtined for the emperor's guards, conſiſting, according to Dion, of 10,000 men. This officer, according to Suetonius, was inſtituted by Auguſtus, and uſually taken from among the knights. By the favour of the emperors his power grew very conſiderable; to reduce which, Conſtantine divided the prefecture of the prætorium into four prefectures, and each of theſe again he ſubdivided into civil and military departments, though the name was only reſerved to him who was inveſted with the civil authority, and that of *comes belli* given him who commanded the cohorts.

PREGADI, in hiſtory, a denomination given to the ſenate of Venice, in which reſides the whole authority of the republic. At its firſt inſtitution it was compoſed of 60 ſenators, to whom 60 more have been added. See Venice.

PREGNANCY, the ſtate of a woman who has conceived, or is with child. See Midwifery.

PREHNITE, a ſtone ſo named by Mr. Werner, inſpector of the mines of Freyburg, brought by colonel Prehn from the Cape of Good Hope. In the firſt volume of *Chemical Annals* there is a chemical analyſis of this ſtone extracted from the *Acta Naturæ Curioſorum*, Berlin, tom. viii. p. 211. ann. 1788, part 2. by Klaproth; from which it appears, that 100 parts of prehnite contain

Silice	- -	$43\frac{5}{6}$ grains.
Alumine	- - -	$30\frac{1}{3}$
Lime	- - -	$18\frac{1}{5}$
Oxyd of iron	- - -	$5\frac{2}{5}$
Water and air	- - -	$1\frac{1}{6}$
	Total -	100

Colonel Prehn gave it the name of emerald, and Mr. Bruckmann adopted that denomination, but changed his opinion on conſidering that it had neither the hardneſs, the bright green colour, nor the property of cryſtallizing in hexagonal priſms like the emerald. The Dutch dealers call it *chryſopraſus* of the Cape; but chryſopraſus is nothing but quartz tinged green by the oxyd of nickel. Profeſſor Haquet, in the 4th volume of the Berlin Tranſactions, has named it *cryſtallized praſus*. In the 8th volume, however, Mr. Bruckmann conſiders it as a cryſtallized felt-ſpar. Mr. Sage calls it *chryſolite*. Mr. Romé de l'Iſle claſſes it among the ſchoerls. To this claſſification Mr. Klaproth objects, and is rather diſpoſed with Mr. Werner to conſider it as a zeolite; on the whole, he thinks it may be conveniently ranked between zeolite and ſchoerl. Mr. Haſſenfratz publiſhed in the *Journal de Phyſique* for February 1788, an analyſis of the ſame ſtone, under the title of *Pierre Silice, calcaire, alumineuſe, &c. &c. de couleur verte, &c.* And according to his reſults, which are ſomewhat different from thoſe of Mr. Klaproth, and obtained by a different proceſs, it contains, ſilice 50, lime 23.4, alumine 20.4, oxyd of iron 4.9, water 0.9, magneſia 0.5 = 100. The ſpecific gravity of this ſtone, according to the experiments of Mr. Briſſon, is 2.9423. The diſſection of its cryſtals, made by Abbé Haüy and Mr. Haſſenfratz, diſcovered one angle of 60 degrees, as in ſchoerls; but it has hitherto been impoſſible to determine the others. The Abbé Haüy has convinced himſelf, that it bears no reſemblance to zeolite in its cryſtals. This ſtone ſcratches glaſs, and is itſelf ſcratched by rock cryſtal.

PREJUDICE, or Prejudgment, from *præ* and *judicium*, means a judgment formed beforehand, without examination; the prepoſition *præ* expreſſing an anticipation, not ſo much of time as of knowledge and due attention: hence the ſchoolmen have called it *anticipation and a preconceived opinion*.

Prejudice ariſes from the aſſociating principle, and it is a weakneſs from which no human mind can be wholly free. Some are indeed much more than others under its influence; but there is no man who does not occaſionally act upon principles, the propriety of which he never inveſtigated; or who does not hold ſpeculative opinions, into the truth of which he never ſeriouſly inquired. Our parents and tutors, yea our very nurſes, determine a multitude of our ſentiments: our friends, our neighbours, the cuſtom of the country where we dwell, and the eſtabliſhed opinions of mankind, form our belief; the great, the pious, the learned, and the ancient, the king, the prieſt, and the philoſopher, are characters of mighty efficacy to perſuade us to regulate our conduct by their practice, and to receive as truth whatever they may dictate.

The caſe cannot indeed be otherwiſe. The occaſions of acting are ſo frequent, and the principles of action are ſo various, that were a man to inveſtigate accurately the value of every ſingle motive which preſents itſelf to his mind, and to balance them fairly againſt each other, the time of acting would in moſt inſtances paſs away long before he could determine what ought to be done; and life would be waſted in uſeleſs ſpeculation. The great laws of religion and morality, which ought to be the general and leading principles of action, no man of ſcience will take upon truſt; but in the courſe of a buſy life a thouſand circumſtances will occur in which we muſt act with ſuch rapidity, that, after being ſatisfied of the lawfulneſs of what we are about to do, we muſt, for the prudence of it, confide entirely in the general cuſtoms of our country, or in the practice of other individuals placed in circumſtances ſimilar to ours. In all ſuch caſes, though we may act properly, we act from *prejudice*.

But the dominion of prejudice is not confined to the actions of the man of buſineſs: it extends over the ſpeculations of the philoſopher himſelf, one half of whoſe knowledge reſts upon no other foundation. All human ſciences are related to each other (ſee Philosophy), and there is hardly one of them in which a man can become eminent unleſs he has ſome general acquaintance with the whole circle; but no man could ever yet inveſtigate for himſelf all thoſe propoſitions which conſtitute the circle of the ſciences, or even comprehend the evidence upon which they reſt, though he admits them perhaps as truths incontrovertible. He muſt therefore receive many of them upon the authority of others, or, which is the ſame thing, admit them by *prejudice*.

To this reaſoning it may be objected, that when a man admits as true abſtract propoſitions, which, though not ſelf-evident, he cannot demonſtrate, he admits them not by prejudice, but upon teſtimony, which has been elſewhere ſhown to be a ſufficient foundation for human belief (ſee Metaphysics). The objection is plauſible, but it is not ſolid; for teſtimony *commands* belief only concerning *events* which, falling under the cognizance of the ſenſes, preclude all poſſibility of miſtake; whereas abſtract propoſitions, not ſelf-evident, can be proved true only by a *proceſs of reaſoning* or by a *ſeries of experiments*; and in conducting both theſe, the moſt vigorous mind is liable to miſtake. When Sir Iſaac Newton told the world that it was the fall of an apple which firſt ſuggeſted to him the general law of gravitation, he bore teſtimony to a fact concerning which he could not be miſtaken; and we receive his teſtimony for the reaſons aſſigned in the article referred to. When he lays down the method of obtaining the fluxion or momentum of the rectangle or product of two indeterminate quantities, which is the main point in his doctrine of fluxions, he labours to eſtabliſh that method on the baſis of demonſtration; and whoever makes uſe of it in practice, without underſtanding that demonſtration, receives the whole doctrine of the modern geometrical analyſis, not as a matter of *fact* upon the credit of Sir Iſaac's *teſtimony*, but as a ſyſtem of abſtract *truth* on the credit of his *underſtanding*: in other words he is a fluxioniſt by *prejudice*.

In vain will it be ſaid, that in mathematical demonſtration there is no room for miſtake; and that therefore the man who implicitly adopts the method of fluxions may be conſidered as relying upon the *veracity* of its author, who had no inducement to deceive him, and whoſe comprehenſion was confeſſedly greater than his. In fluxionary mathematics, which treat of matters of which it is extremely difficult, if not impoſſible, to have adequate and ſteady conceptions, the moſt comprehenſive mind is liable to miſtake: and it is well known that the celebrated biſhop of Cloyne wrote his *Analyſt* to prove that the incomparable author of the method of fluxions had committed *two miſtakes* in his fundamental propoſition, which balancing one another, produced a true concluſion by falſe reaſoning. One or other of theſe great men, of whom the leaſt was an eminent mathematician, muſt have been bewildered in his reaſoning, and have fallen into error; and therefore whoever follows either of them implicitly without perceiving the error of the other, is unqueſtionably under the influence of prejudice. This is the caſe with the writer of the preſent article. He perceives not the error of biſhop Berkeley's reaſoning, and yet he admits the doctrine of fluxions on the authority of Sir Iſaac's demonſtration. That demonſtration however, he pretends not to underſtand; and therefore he admits the doctrine through *prejudice*.

We have made theſe obſervations to point out the abſurdity of the faſhionable cry againſt the harbouring of any prejudices. To eradicate all prejudices from the human mind is impoſſible; and if it were poſſible, it would be very unwiſe: for we ſee that prejudice may exiſt on the ſide of truth as well as on that of falſehood; and that principles profeſſed and believed by any individual may be uſeful and true, though he was brought to them not by a train of fair and candid reaſoning, but through the medium of prepoſſeſſion or authority. Indeed ſuch is our nature, and ſuch are the laws of aſſociation, that many of our beſt principles, and our obligation to perform many of the moſt amiable of our duties in common life, muſt evidently be acquired in this way. From endearing aſſociations, and authoritative inſtruction, we acquire a knowledge of our duty to our parents, and a facility in performing it, together with the firſt principles of religion, without a ſingle effort of our own reaſon. Even when reaſon has begun to aſſert its power, and ſhows us the propriety of ſuch duties, we are wonderfully aſſiſted in performing them by the amiable prejudices which we had before acquired and which now appear to be natural to us. He who has never had the advantage of ſuch aſſociations, and who acquires a knowledge of the duties ſuggeſted by them after he has come to years of diſcretion, and chiefly by the efforts of his own reaſon, will ſeldom, *cæteris paribus*, perform theſe duties with an energy and delight equal to that of the perſon who has. This remark appears to be confirmed by experience; for it is often found, that the children of the great, who have been given out to nurſe in their infancy, and who have ſeldom been in the company of their parents till their reaſoning faculties have been far advanced, are much leſs dutiful and affectionate than thoſe in the middle or lower ſtations of life, who have ſcarcely ever been out of their parents company.

Would it then be wiſe, even if it were practicable, to diſſolve all thoſe aſſociations which tend ſo powerfully to increaſe the mutual affections of parents and children? We cannot think that it would; as we believe it might be eaſily ſhown that public ſpirit ſprings out of private affection. Plato indeed held an opinion very different from ours; for in order to extend that affection which is uſually laviſhed at home to the whole ſtate, he propoſed that children ſhould be educated at the public expenſe, and never permitted to know the authors of their being. But this is only one of the many viſionary projects of that great man, of which daily experience ſhows the abſurdity. In modern times, we are certain that leſs dependence is to be had upon the *patriotiſm* of the man who, for the love which he pretends to his country, can overlook or forget his own partial connections in it, than to him who, at the ſame time that he wiſhes his country well, is feelingly alive to all the endearments of kindred affection.

Such affection may be called *partial*, and very probably has its foundation in that which is the ſource of all our prejudices: but if it be properly trained in early life, it will gradually extend from our neareſt relations to the perſons with whom we aſſociate, and to the place which not only gave us birth, but alſo furniſhed our youthful and moſt innocent enjoyments. It is thus that the *amor patriæ* is generated, which in minds unſeduced by falſe principles is exceedingly ſtrong; and though a partial affection, is of the moſt general utility. It is this prejudice which reconciles the Laplander to his freezing ſnows, and the African to his burning ſun; which attaches the native of the Highlands or of Wales as much to his mountains and rocks, as the apparently happier inhabitant of the ſouthern counties of England is to the more fertile and delightful ſpot where he drew his firſt breath. And we find in fact, that when a native of Kent and a Scotch Highlander have in ſome diſtant corner of the world gained a competent fortune without being corrupted by luxury, they return, the one to his hop-gardens, and the other to his mountains. Were this prejudice, for ſuch it ſurely is, wholly eradicated from the human mind, it is obvious that large tracts of country which are now full of inhabitants would be totally deſerted; and that the hungry barbarians, to make room for themſelves, would exterminate the proprietors of more favourable climes. From an affection to our friends and to our country, we naturally contract an affection for that mode of government under which we live; and unleſs it be particularly oppreſſive to ourſelves or any order of citizens, we come as naturally to prefer it to all other modes, whether it deſerve that preference or not. This no doubt is prejudice, but it is a beneficial prejudice; for were the multitude, who are wholly incapable of eſtimating the excellencies and defects of the various modes of government, to become diſſatisfied with their own, and riſe in a maſs to change it for the better, the moſt horrible conſequences might juſtly be dreaded. Of this truth the preſent ſtate of Europe affords too melancholy and convincing a proof. The man, therefore, who, under the pretence of enlightening the public mind and extirpating prejudices, paints to the illiterate vulgar, in aggravated colours, the abuſe of that government which has hitherto protected them from the ferocity of each other, is one of the greateſt criminals if his views be ſelfiſh, and one of the worſt reaſoners, if they be diſintereſted, that human imagination can eaſily conceive.

With the ſelfiſh patriot we have at preſent no concern; but we may with propriety aſk the diſintereſted lover of truth, whether he thinks it poſſible, that in a large community, of which nine-tenths of the members are neceſſarily incapable of taking comprehenſive views of things, or feeling the force of political reaſonings, any form of government can be acceptable to the people at large, which does not gain their affections through the medium of prejudice? It has been ſhown by Mr. Hume with great ſtrength of argument, that government is founded on *opinion*, which is of two kinds, viz. opinion of intereſt, and opinion of right. By opinion of intereſt, he underſtands the ſenſe of the general advantage which is reaped from government, together with the perſuaſion that the particular government which is eſtabliſhed is equally advantageous with any other that could eaſily be ſettled. The opinion entertained of the *right* of any government, is always founded in its antiquity; and hence ariſes the paſſionate regard which under ancient monarchies the people have for the true heir of their royal family. Theſe opinions, as held by the philoſopher, converſant with the hiſtory of nations, are founded upon reaſoning more or leſs concluſive; but it is obvious, that in the minds of the multitude they can have no other foundation than prejudice. An illiterate clown or mechanic does not *ſee how* one form of government promotes the general intereſt more than another; but he may *believe* that it does, upon no other evidence than the declamation of a demagogue, who, for ſelfiſh purpoſes, contrives to flatter his pride. The ſame is the caſe with reſpect to the rights of hereditary monarchy. The anatomiſt finds nothing more in the greateſt monarch than in the meaneſt peaſant, and the moraliſt may perhaps frequently find leſs; but the true philoſopher acknowledges his right to the ſovereignty: and though he be weak in underſtanding, or infirm in years, would, for the ſake of public peace and the ſtability of government, maintain him in his throne againſt every competitor of the moſt ſhining talents. The vulgar, however, who would act with this philoſopher, are influenced by no ſuch views, but merely by their prejudices in favour of birth and family; and therefore it is ridiculous to think of changing the public mind with reſpect to any form of government by pure reaſoning. In France a total change in the minds of the people has indeed been effected, and from the moſt violent prejudices in favour of royalty, they have now become more violently prejudiced in favour of republicaniſm. Bad as their government unqueſtionably was, the change that has now taken place is not the effect of calm reaſoning and accurate inquiry (for of that the bulk of mankind appears to be incapable), nor are their prejudices leſs violent than they were before. They are changed indeed; but no one will deny that prejudice, and that of the moſt violent kind, leads them on at preſent; nor can any one aſſert that their new prejudices have rendered them more happy, or their country more flouriſhing, than their former ones, which made them cry *Vive le Roi* under the tyrannic government of Louis XIV.

The influence of prejudice is not more powerful in fixing the political opinions of men, than in dictating their religious creed. Every child of a religious father receives his faith by inheritance long before he is capable of judging whether it be agreeable or diſagreeable to the word of God and the light of reaſon. This experience ſhows to be the fact; and ſound philoſophy declares that it cannot be otherwiſe. Parents are appointed to judge for their children in their younger years, and to inſtruct them in what they ſhould believe, and what they ſhould practiſe in the civil and religious life. This is a dictate of nature, and doubtleſs would have been ſo in a ſtate of perfect innocence. It is impoſſible that children ſhould be capable of judging for themſelves before their minds are furniſhed with a competent number of ideas, and before they are acquainted with any *principles* and *rules* of juſt reaſoning; and therefore they can do nothing better than run to their parents, and receive their directions what they ſhould believe and what they ſhould practiſe.

This mode of tutoring the infant mind, and giving to our inſtructions the force of prejudice, before reaſon can operate with much effect, will, we know, be highly diſpleaſing to many who challenge to themſelves alone the epithet of liberal. With them it will be cramping the genius and perverting the judgment: but we cannot help thinking that ſuch an objection, if it ſhould be made, would be the offspring of ignorance; for it requires but very little knowledge of human nature to be able to ſee, that if children be not reſtrained by authority, and if we do not inſinuate a love of good principles into their minds, bad ones will inſinuate themſelves, and a little time will give *them* the force of inveterate prejudice, which all the future efforts of reaſon and philoſophy will find it difficult to eradicate. The idea of keeping a child ignorant of the being of a God, and the grand duties of morality and religion, till he ſhall come to years of diſcretion, and then allowing him to reaſon them for himſelf, is an abſurd chimæra: it is an experiment which never has been tried, which to us it appears impoſſible to try, and which, if it could be tried, could not poſſibly produce any good effect. For ſuppoſe we had a youth juſt arrived at years of diſcretion, totally ignorant of all theſe things, and unbiaſſed to any ſyſtem of opinions, or rather poſſeſſed of no opinions at all—it would, in the firſt place, we ſuſpect, be abſolutely neceſſary to direct his thoughts into a particular train, and for ſome perſon to lead him on from one idea to another, till he ſhould arrive at ſome concluſion: but in all this there is the influence of authority, aſſociation, and of prejudice.

It being therefore abſolutely neceſſary that ſentiments of religion be inſtilled into the minds of children before they be capable of diſcovering by the uſe of their reaſon whether thoſe ſentiments be juſt or not, it need not excite wonder, nor is it any reflection upon religion, that moſt men adhere with bigotry to the creed of their fathers, and ſupport that creed by arguments which could carry conviction to no minds but their own. The love and veneration which they bear to the memory of thoſe from whom they imbibed their earlieſt opinions, do not permit them to perceive either the falſehood of thoſe opinions, or their little importance ſuppoſing them true. Hence the many frivolous diſputes which have been carried on among Chriſtians; and hence the zeal with which ſome of them maintain tenets which are at once contrary to ſcripture, to reaſon, and to common ſenſe. A due reflection, however, on the ſource of all prejudices, ought to moderate this zeal; for no man is wholly free from that bias which he is ſo ready to condemn in others; and indeed a man *totally free from prejudice*, would be a more unhappy being than the moſt violent bigot on earth. In ſcience, he would admit nothing which he could not himſelf demonſtrate; in buſineſs, he would be perpetually at a ſtand for want of motives to influence his conduct: he could have no attachment to a particular country; and therefore muſt be without patriotiſm, and without the ſolaces of friendſhip; and his religion, we are afraid, would be cold and lifeleſs.

What, it will be ſaid, are the authors of a work which profeſſes to enlighten the public mind by laying before it a general view of ſcience and literature, become at laſt the advocates of *prejudice*, which is the *bane* of *ſcience*, and the *prop* of *ſuperſtition?* No, we are advocates for no prejudice which is either inimical to ſcience or friendly to abſurdity; but we do not think that the moraliſt would act wiſely who ſhould deſert his proper buſineſs to make himſelf maſter of the higher mathematics, merely that he might not be obliged to truſt occaſionally to the demonſtrations of others. The writer of this article is not ſkilled in trade; but it is not his opinion that the merchant would ſoon grow rich, who ſhould never make a bargain till he had previouſly calculated with mathematical exactneſs all the probabilities of his gain or loſs. That to diſſolve all the aſſociations which are the ſource of partial attachments of kindred, affection, and private friendſhip, would tend to promote the public happineſs, we cannot poſſibly believe. And we think that the experience of the preſent eventful day abundantly confirms Mr. Hume's opinion, that far from endeavouring to extirpate the people's prejudices in favour of birth and family, we ſhould cheriſh ſuch ſentiments, as being abſolutely requiſite to preſerve a due ſubordination in ſociety. That men would be better Chriſtians if they were to receive no religious inſtruction till they ſhould be able by their own reaſon to judge of its truth, daily obſervation does not warrant us to conclude; for we ſee thoſe who have ſeldom heard of God when children, "live without him in the world" when they are men.

Pernicious prejudices ſhould be prevented by proper attention in the education of children; and the earlier ſuch attention is paid, the more effectual it will be found; for it is much eaſier to keep prejudices out of the mind than to remove them after they have been admitted. This, however, muſt be ſometimes attempted; and where prejudices are ſtrong, ſeveral methods have been recommended for rendering the attempt ſucceſsful. The following are taken moſtly from Dr. Watts's Improvement of the Mind.

1. Never attack the prejudice *directly*, but lead the perſon who is under its influence ſtep by ſtep to the truth. Perhaps your neighbour is under the influence of *ſuperſtition and bigotry in the ſimplicity of his ſoul*; you muſt not immediately run upon him with violence, and ſhow him the abſurdity or folly of his own opinions, though you might be able to ſet them in a glaring light; but you muſt rather begin at a diſtance, and eſtabliſh his aſſent to ſome familiar and eaſy propoſitions, which have a tendency to refute his miſtakes, and to confirm the truth; and then ſilently obſerve what impreſſion this makes upon him, and proceed by ſlow degrees as he is able to bear, and you muſt carry on the work perhaps at diſtant ſeaſons of converſation. The tender or diſeaſed eye cannot bear a deluge of light at once.

Overhaſtineſs and vehemence in arguing is oftentimes the effect of *pride*; it blunts the poignancy of the argument, breaks its force, and diſappoints the end. If you were to convince a perſon of the falſehood of the *doctrine of tranſubſtantiation*, and you take up the conſecrated bread before him and ſay, "You may ſee, and taſte, and feel *this is nothing but bread*; therefore whilſt you aſſert that God commands you to believe *it is not bread*, you moſt wickedly accuſe God of commanding you to tell a lie." This ſort of language would only raiſe the indignation of the perſon againſt you, inſtead of making any impreſſions upon him. He will not ſo much as think at all on the argument you have brought, but he rages at you as a *profane wretch*, ſetting up your own ſenſe and reaſon above ſacred authority; ſo that though what you affirm is a truth of great evidence, yet you loſe the benefit of your whole argument by an ill management, and the unreaſonable uſe of it.

2. Where the prejudices of mankind cannot be conquered at once, but will riſe up in arms againſt the evidence of truth, there we muſt make ſome allowances, and yield to them for the preſent, as far as we can ſafely do it without real injury to truth; and if we would have any ſucceſs in our endeavours to convince the world, we muſt practiſe this complaiſance for the benefit of mankind. Take a ſtudent who has deeply imbibed the principles of the *Peripatetics*, and imagines certain immaterial beings, called *ſubſtantial forms*, to inhabit every herb, flower, mineral, metal, fire, water, &c. and to be the ſpring of all its properties and operations; or take a Platoniſt, who believes an *anima mundi*, "an univerſal ſoul of the world," to pervade all bodies, to act in and by them according to their nature, and indeed to give them their nature and their ſpecial powers; perhaps it may be very hard to convince theſe perſons by arguments, and conſtrain them to yield up thoſe fancies. Well then, let the one believe his *univerſal ſoul*, and the other go on with his notion of *ſubſtantial forms*, and at the ſame time teach them how by certain original laws of motion, and the various ſizes, ſhapes, and ſituations of the parts of matter, allowing a continued divine concourſe in and with all, the ſeveral appearances in nature may be ſolved and the variety of effects produced, according to the corpuſcular philoſophy, improved by *Deſcartes, Mr. Boyle,* and *Sir Iſaac Newton*; and when they have attained a degree of ſkill in this ſcience, they will ſee theſe airy notions of theirs, theſe imaginary powers, to be ſo uſeleſs and unneceſſary, that they will drop them of their own accord. The *Peripatetic forms* will vaniſh from the mind like a dream, and the *Platonic ſoul of the world will expire*.

We may give another inſtance of the ſame practice, where there is a prejudicate fondneſs of particular words and phraſes. Suppoſe a man is educated in an *unhappy form of ſpeech*, whereby he explains ſome *great doctrine of the goſpel*, and by the means of this phraſe he has imbibed a very falſe idea of that doctrine; yet he is ſo bigotted to his form of words, that he imagines if thoſe words are omitted the form is loſt. Now, if we cannot poſſibly perſuade him to part with his improper terms, we will indulge them a little, and try to explain them in a ſcriptural ſenſe, rather than let him go on in his miſtaken ideas. A perſon who has been bred a *Papiſt*, knows but little of religion, yet he reſolves never to part from the *Roman Catholic faith*, and is obſtinately bent againſt a change. Now it cannot be unlawful to teach ſuch an one the true Chriſtian, *i. e.* the *Proteſtant religion*, out of the *Epiſtle to the Romans*, and ſhow him that the ſame doctrine is contained in the *Catholic Epiſtles of St. Peter, James, and Jude*, and thus let him live and die a good Chriſtian in the belief of the religion taught him out of the New Teſtament, while he imagines he is a *Roman Catholic* ſtill, becauſe he finds the doctrine he is taught in the *Catholic* Epiſtles and in that to the *Romans*. Sometimes we may make uſe of the very prejudices under which a perſon labours, in order to convince him of ſome particular truth, and argue with him upon his own profeſſed principles as though they were true. Suppoſe a *Jew* lies ſick of a fever, and is forbid fleſh by his phyſician; but hearing that rabbits were provided for the dinner of the family, deſired earneſtly to eat of them; and ſuppoſe he became impatient, becauſe his phyſician did not permit him, and he inſiſted upon it that it could do him no hurt—ſurely rather than let him perſiſt in that fancy and that deſire to the danger of his life, we might tell him that theſe animals were ſtrangled, a ſort of food forbidden by the Jewiſh law, though we ourſelves might believe that law to be aboliſhed.

Where we find any perſon obſtinately perſiſting in a miſtake in oppoſition to all reaſon, eſpecially if the miſtake be very injurious or pernicious, and we know this perſon will hearken to the ſentiment or authority of ſome favourite name; it is needful ſometimes to urge the *opinion and authority* of that favourite perſon, ſince that is likely to be regarded much more than *reaſon*. We are almoſt aſhamed indeed to ſpeak of uſing any *influence of authority* in reaſoning or argument; but in ſome caſes it is better that poor, ſilly, perverſe, obſtinate creatures, ſhould be perſuaded to judge and act right, by a veneration for the ſenſe of others, than to be left to wander in pernicious errors, and continue deaf to all argument, and blind to all evidence. They are but children of a larger ſize; and ſince they perſiſt all their lives in their minority, and reject all true reaſoning, ſurely we may try to perſuade them to practiſe what is for their own intereſt by ſuch childiſh reaſons as they will hearken to. We may overawe them from purſuing their own ruin by the terrors of a ſolemn ſhadow, or allure them by a ſugar plum to their own happineſs. But after all, we muſt conclude, that whereſoever it can be done, it is beſt to *remove and root out thoſe prejudices* which obſtruct the entrance of truth into the mind, rather than to palliate, humour, or indulge them; and ſometimes this muſt neceſſarily be done, before you can make a perſon part with ſome beloved error, and lead him into better ſentiments.

On the whole, we would recommend more mutual forbearance and leſs acrimony than is commonly found among writers on diſputed ſubjects, as the only means by which our differences in religion, politics, and ſcience, ever can be healed, and truth certainly diſcovered. If men were leſs violent in defending their particular opinions, they would always gain a more patient hearing, they would be leſs ſuſpected of, and leſs liable to, prejudice, and of courſe more apt either to convince or to be convinced. They would likewiſe by ſo doing ſhow, in the moſt unequivocal manner, their attention to ſound philoſophy, and above all to genuine Chriſtianity; which, though it is far from encouraging ſcepticiſm, or a temporizing ſpirit, recommends, in the ſtrongeſt terms, among all its profeſſors, *univerſal charity and mutual forbearance.* See PROBABILITY, TRUTH, and SUPERSTITION.

PRELATE, an eccleſiaſtic raiſed to ſome eminent and ſuperior dignity in the church; as biſhops, archbiſhops, patriarchs, &c.

PRELIMINARY, in general, denotes ſomething to be examined and determined before an affair can be treated of to the purpoſe.

PRELUDE, in muſic, is uſually a flouriſh or irregular air, which a muſician plays off-hand, to try if his inſtrument be in tune, and ſo lead him into the piece to be played.

PREMISSES, in logic, an appellation given to the two firſt propoſitions of a ſyllogiſm. See LOGIC.

PREMISSES, in law, properly ſignifies the land, &c. mentioned in the beginning of a deed.

PREMIUM, or PRÆMIUM, properly ſignifies a reward or recompenſe: but it is chiefly uſed in a mercantile ſenſe for the ſum of money given to an inſurer, whether of ſhips, houſes, lives, &c. See INSURANCE.

PREMNA, in botany; a genus of the angioſpermia order, belonging to the didynamia claſs of plants. The calyx is bilobed; the corolla quadrifid; the berry quadrilocular; the ſeeds ſolitary.

PREMONSTRANTES, or PRÆMONSTRATENSES, a religious order of regular canons inſtituted in 1120, by S. Norbert; and thence alſo called *Norbertines.* The firſt monaſtery of this order was built by Norbert in the Iſle of France, three leagues to the weſt of Laon; which he called *Præmonſtre, Præmonſtratum,* and hence the order itſelf derived its name; though as to the occaſion of that name the writers of that order are divided. At firſt the religious of this order were ſo very poor, that they had only a ſingle aſs, which ſerved to carry the wood they cut down every morning, and ſent to Laon in order to purchaſe bread. But they ſoon received ſo many donations, and built ſo many monaſteries, that in 30 years after the foundation of the order, they had above 100 abbeys in France and Germany: and in proceſs of time the order ſo increaſed, that it had monaſteries in all parts of Chriſtendom, amounting to 1000 abbeys, 300 provoſtſhips, a vaſt number of priories, and 500 nunneries. But they are now greatly diminiſhed. The rule they followed was that of St. Auguſtine, with ſome ſlight alterations, and an addition of certain ſevere laws, whoſe authority did not long ſurvive their founder.

The order was approved by Honorius II. in 1126, and again by ſeveral ſucceeding popes. At firſt the abſtinence from fleſh was rigidly obſerved. In 1245 Innocent IV. complained of its being neglected to a general chapter. In 1288 their general, William, procured leave of pope Nicholas IV. for thoſe of the order to eat fleſh on journeys. In 1460 Pius II. granted them a general permiſſion to eat meat, excepting from Septuageſima to Eaſter. The dreſs of the religious of this order is white, with a ſcapulary before the caſſock. Out of doors they wear a white cloak and white hat; within, a little camail; and at church, a ſurplice, &c.

In the firſt monaſteries built by Norbert, there was one for men and another for women, only ſeparated by a wall. In 1137, by a decree of a general chapter, this practice was prohibited, and the women removed out of thoſe already built, to a greater diſtance from thoſe of the men.

The Præmonſtratenſes, or monks of Premontre, vulgarly called *white canons,* came firſt into England, A. D. 1146. Their firſt monaſtery, called *New-houſe,* was erected in Lincolnſhire, by Peter de Saulia, and dedicated to St. Martial. In the reign of Edward I. this order had 27 monaſteries in England.

PRENANTHES, in botany: A genus of the polygamia æqualis order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ.* The receptacle is naked; the calyx calyculated; the pappus is ſimple, and almoſt ſeſſile; the florets are placed in a ſingle ſeries.

PRENOMEN, PRÆNOMEN, among the ancient Romans, a name prefixed to their family name, and anſwering to our Chriſtian name: ſuch are Caius, Lucius, Marcus, &c.

PRENOTION, PRÆNOTIO, or *Præcognitio,* is a notice or piece of knowledge preceding ſome other in reſpect of time. Such is the knowledge of the antecedent, which muſt precede that of the concluſion. It is uſed by Lord Bacon for breaking of an endleſs ſearch, which he obſerves to be one of the principal parts of the art of memory. For when one endeavours to call any thing to mind, without ſome previous notion or perception of what is ſought for, the mind exerts itſelf and ſtrives in an endleſs manner: but if it hath any ſhort notion before-hand, the infinity of the ſearch is preſently cut off, and the mind hunts nearer home, as in an incloſure. Thus verſe is eaſier remembered than proſe; becauſe if we ſtick at any word in a verſe, we have a previous notion that it is ſuch a word as muſt ſtand in a verſe. Hence alſo, order is a manifeſt help to memory; for here is a previous notion that the thing ſought for muſt be agreeable to order. Bacon's *Works Abr.* vol. i. p. 136, and vol. ii. p. 473.

PREPARATION, in a general ſenſe, the act of diſpoſing things in ſuch a manner as to render any foreſeen event more advantageous or leſs hurtful according to its nature.

PREPARATION *of Diſſonances,* in muſic, is their diſpoſition in harmony in ſuch a manner, that, by ſomething congenial in what precedes, they may be rendered leſs harſh to the ear than they would be without that precaution: according to this definition, every diſcord ought to be prepared. But when, in order to prepare a diſſonance, it is exacted that the ſound which forms it ſhould before have formed a conſonance, then there is fundamentally but one ſingle diſſonance which is prepared, viz. the ſeventh. Nor is even this preparation neceſſary in the chord which contains the ſenſible note, becauſe then the diſſonance being characteriſtical, both in its chord and in its mode, the ear has ſufficient reaſon to expect it: it accordingly does expect it, and recogniſe it; nor is either deceived with reſpect to its chord nor its natural progreſs. But when the ſeventh is heard upon a fundamental ſound which is not eſſential to the mode, it ought then to be prepared, in order to prevent all ambiguity; to prevent the ear, whilſt liſtening to this note, from loſing its train: and as this chord of the ſeventh may be inverted and combined in ſeveral different manners, from this ariſe likewiſe a number of different ways by which it may ſeem to be prepared, which, in the main, always iſſue however in the ſame thing.

In making uſe of diſſonances, three things are to be conſidered; viz. the chord which precedes the diſſonance, that in which it is found, and that which is immediately ſubſequent to it. Preparation only reſpects the two firſt; for the third, ſee RESOLUTION.

When we would regularly prepare a diſcord in order to arrive at its chord, we muſt chooſe ſuch a career of the fundamental baſs, that the ſound which forms the diſſonance may be a protraction into the perfect time of the ſame note which formed a conſonance formerly ſtruck in the imperfect in the preceding chord; this is what we call *ſincopation*. See SINCOPATION.

From this preparation two advantages reſult; viz. 1. That there is neceſſarily a harmonical connection between the two chords, ſince that connection is formed by the diſſonance itſelf; and, 2. That this diſſonance, as it is nothing elſe but the continuation of the ſame ſound which had formed a conſonance, becomes much leſs harſh to the ear than it would have been with any ſound recently ſtruck. Now this is all that we expect to gain by a preparation. See CADENCE, DISCORD, and HARMONY.

By what has been juſt ſaid, it will appear that there is no other part peculiarly deſtined for preparing the diſſonance, except that in which it is heard; ſo that if the treble ſhall exhibit a diſſonance, that muſt be ſincopated; but if the diſſonance is in the baſs, the baſs muſt be ſincopated. Though there is nothing here but what is quite ſimple, yet have maſters of muſic miſerably embroiled the whole matter.

Some diſſonances may be found which are never prepared: ſuch is the ſixth ſuperadded: ſome which are very unfrequently prepared; ſuch is the diminiſhed ſeventh.

PREPARATIONS, in pharmacy, the medicines when mixed together in ſuch a manner as to be fit for the uſe of the patient. See PHARMACY.

PREPARATIONS, in anatomy, the parts of animal bodies prepared and preſerved for anatomical uſes. The manner of preſerving anatomical preparations, is either by drying them thoroughly in the air, or putting them into a proper liquor. In *drying* parts which are thick, when the weather is warm, care muſt be taken to prevent putrefaction, fly-blows, inſects, &c. This is eaſily done by the uſe of a ſolution of corroſive ſublimate in ſpirit of wine, in the proportion of two drams of ſublimate to a pound of ſpirit: the part ſhould be moiſtened with this liquor as it dries, and by this method the body of a child may be kept ſafe even in ſummer. Dried preparations are apt to crack and moulder away in keeping; to prevent this, their ſurface ſhould be covered with a thick varniſh, repeated as often as occaſion requires.

Though ſeveral parts prepared dry are uſeful, yet others muſt be ſo managed as to be always flexible, and nearer a natural ſtate. The difficulty has been to find a proper liquor for this purpoſe. Dr. Monro ſays, the beſt he knows is a well rectified colourleſs ſpirit of wine, to which is added a ſmall quantity of the ſpirit of vitriol or nitre. When theſe are properly mixed, they neither change their colour nor the conſiſtence of the parts, except where there are ſerous or mucous liquors contained in them. The brain, even of a young child, in this mixture grows ſo firm as to admit of gentle handling, as do alſo the vitreous and cryſtalline humours of the eye. The liquor of the ſebaceous glands and the ſemen are coagulated by this ſpirituous mixture; and it heightens the red colour of the injection of the blood-veſſels, ſo that after the part has been in it a little time, ſeveral veſſels appear which were before inviſible. If you will compare theſe effects with what Ruyſch has ſaid of his balſam, you will find the liquor above-mentioned to come very near to it.

The proportion of the two ſpirits muſt be changed according to the part prepared. For the brain and humours of the eye, you muſt put two drams of ſpirit of nitre to one pound of ſpirit of wine. In preſerving other parts which are harder, 30 or 40 drops of the acid will be ſufficient; a larger quantity will make bones flexible, and even diſſolve them. The part thus preſerved ſhould be always kept covered with the liquor: therefore great care ſhould be taken to ſtop the mouth of the glaſs with a waxed cork and a bladder tied over it, to prevent the evaporation of the ſpirit; ſome of which, notwithſtanding all this care, will fly off; therefore freſh muſt be added as there is occaſion. When the ſpirits change to a dark tincture, which will ſometimes happen, they ſhould be poured off, and freſh put in their room; but with ſomewhat leſs acid than at firſt.

The glaſſes which contain the preparations ſhould be of the fineſt ſort, and pretty thick; for through ſuch the parts may be ſeen very diſtinctly, and of a true colour, and the object will be ſo magnified as to ſhow veſſels in the glaſs which out of it were not to be ſeen.

As the glaſs when filled with the liquor has a certain focus, it is neceſſary to keep the preparation at a proper diſtance from the ſides of it, which is eaſily done by little ſticks ſuitably placed, or by ſuſpending it by a thread in a proper ſituation. The operator ſhould be cautious of putting his fingers in this liquor oftener than is abſolutely neceſſary; becauſe it brings on a numbneſs on the ſkin, which makes the fingers unfit for any nice operation. The beſt remedy for this is to waſh them in water mixed with a few drops of oil of tartar per deliquium.

Dr. Chriſt. Jac. Trew prefers the rectified ſpirit of grain for preſerving anatomical preparations to ſpirit of wine, or to compoſitions of alcohol, amber, camphor, &c. becauſe theſe ſoon change into a brown colour, whereas the ſpirit from malt preſerves its limpid appearance. When any part is to be preſerved wet, waſh it with water till it is no more tinctured. The water is next to be waſhed away with ſpirits, and then the preparation is to be put among ſpirits in a glaſs, the mouth of which is to be cloſely covered with a glaſs head, over which a wet bladder and leaf-tin are to be tied. *Com. Lit. Norimb.* 1731, *ſemeſt.* 1 *ſpecim.* 9. See alſo *Pole's Anatomical Inſtructor*, and *American Tranſactions*, vol. ii. p. 366.

PREPENSED, in law, denotes fore-thought. In which ſenſe we ſay *prepenſed malice*, &c. If, when a man is ſlain upon a ſudden quarrel, there were malice prepenſed formerly between them, it makes it murder; and, as it is called in ſome ſtatutes, *prepenſed murther*.

PREPOSITION, in grammar, one of the parts of ſpeech; being an indeclinable particle which yet ſerves to govern the nouns that follow it; ſuch as *per*, *pro*, *propter*; and through, for, with, &c. F. Buffier allows it to be only a modificative of a part of ſpeech, ſerving to circumſtantiate a noun.

PREPUCE, in anatomy, the foreſkin; being a prolongation of the cutis of the penis, covering the glans. See ANATOMY.

PREROGATIVE, an excluſive or peculiar privilege.

Royal PREROGATIVE, that ſpecial pre-eminence which the king hath over and above all other perſons, and out of the ordinary courſe of the common law, in right of his regal dignity. It ſignifies in its etymology (from *præ* and *rogo*) ſomething that is required or demanded before, or in preference to, all others. And hence it follows, that it muſt be in its nature ſingular and eccentrical; that it can only be applied to thoſe rights and capacities which the king enjoys alone in contradiſtinction to others, and not to thoſe which he enjoys in common with any of his ſubjects: for if once any one prerogative of the crown could be held in common with the ſubject, it would ceaſe to be prerogative any longer. And therefore Finch lays it down as a maxim, that the prerogative is that law in caſe of the king, which is law in no caſe of the ſubject.

Prerogatives are either *direct* or *incidental*. The *direct* are ſuch poſitive ſubſtantial parts of the royal character and authority, as are rooted in, and ſpring from, the king's political perſon, conſidered merely by itſelf, without reference to any other extrinſic circumſtance; as, the right of ſending ambaſſadors, of creating peers, and of making war or peace. But ſuch prerogatives as are *incidental* bear always a relation to ſomething elſe, diſtinct from the king's perſon; and are indeed only exceptions, in favour of the crown, to to thoſe general rules that are eſtabliſhed for the reſt of the community: ſuch as, that no coſts ſhall be recovered againſt the king; that the king can never be a joint tenant; and that his debt ſhall be preferred before a debt to any of his ſubjects.

Theſe ſubſtantive or direct prerogatives may again be divided into three kinds: being ſuch as regard, firſt, the king's royal *character* or *dignity*; ſecondly, his royal *authority* or *power*; and, laſtly, his royal *income*. Theſe are neceſſary, to ſecure reverence to his perſon, obedience to his commands, and an affluent ſupply for the ordinary expenſes of government; without all of which it is impoſſible to maintain the executive power in due independence and vigour. Yet, in every branch of this large and extenſive dominion, our free conſtitution has interpoſed ſuch ſeaſonable checks and reſtrictions, as may curb it from trampling on thoſe liberties which it was meant to ſecure and eſtabliſh. The enormous weight of prerogative, if left to itſelf, (as in arbitrary governments it is) ſpreads havoc and deſtruction among all the inferior movements: but, when balanced and bridled (as with us) by its proper counterpoiſe, timely and judiciouſly applied, its operations are then equable and regular; it invigorates the whole machine, and enables every part to anſwer the end of its conſtruction.

I. Of the royal *dignity*. Under every monarchical eſtabliſhment, it is neceſſary to diſtinguiſh the prince from his ſubjects, not only by the outward pomp and decorations of majeſty, but alſo by aſcribing to him certain qualities as inherent in his royal capacity, diſtinct from, and ſuperior to, thoſe of any other individual in the nation. For though a philoſophical mind will (ſays Sir William Blackſtone) conſider the royal perſon merely as one man appointed by mutual conſent to preſide over many others, and will pay him that reverence and duty which the principles of ſociety demand; yet the maſs of mankind will be apt to grow inſolent and refractory, if taught to conſider their prince as a man of no greater perfection than themſelves.—The law therefore aſcribes to the king, in his high political character, not only large powers and emoluments, which form his prerogative and revenue, but likewiſe certain attributes of a great and tranſcendent nature; by which the people are led to conſider him in the light of a ſuperior being, and to pay him that awful reſpect which may enable him with greater eaſe to carry on the buſineſs of government. This is what we underſtand by the royal dignity: the ſeveral branches of which we ſhall now proceed to enumerate.

1. And, firſt, the law aſcribes to the king the attribute of *ſovereignty*, or pre-eminency. See Sovereignty.

2. "The law alſo (according to Sir William Blackſtone) aſcribes to the king, in his political capacity, abſolute *perfection*. 'The king can do no wrong.' Which ancient and fundamental maxim (ſays he) is not to be underſtood as if every thing tranſacted by the government was of courſe juſt and lawful; but means only two things. Firſt, that whatever is exceptionable in the conduct of public affairs is not to be imputed to the king, nor is he anſwerable for it perſonally to his people: for this doctrine would totally deſtroy that conſtitutional independence of the crown, which is neceſſary for the balance of power, in our free and active, and therefore compounded, conſtitution. And, ſecondly, it means that the prerogative of the crown extends not to do any injury; it is created for the benefit of the people, and therefore cannot be exerted to their prejudice.—"The king, moreover, (he obſerves,) is not only incapable of *doing* wrong, but even of *thinking* wrong: he can never mean to do an improper thing: in him is no folly or weakneſs. And, therefore, if the crown ſhould be induced to grant any franchiſe or privilege to a ſubject contrary to reaſon, or in anywiſe prejudicial to the commonwealth or a private perſon, the law will not ſuppoſe the king to have meant either an unwiſe or an injurious action, but declares that the king was deceived in his grant; and thereupon ſuch grant is rendered void, merely upon the foundation of fraud and deception either by or upon thoſe agents whom the crown has thought proper to employ. For the law will not caſt an imputation on that magiſtrate whom it entruſts with the executive power, as if he was capable of intentionally diſregarding his truſt; but attributes to mere impoſition (to which the moſt perfect of ſublunary beings muſt ſtill continue liable) theſe little inadvertencies, which, if charged on the will of the prince, might leſſen him in the eyes of his ſubjects."

But this doctrine has been expoſed as ridiculous and abſurd, by Lord Abingdon, in his *Dedication to the collective Body of the People of England.* "Let us ſee (ſays he) how theſe maxims and their comments agree with the conſtitution, with nature, with reaſon, with common ſenſe, with experience, with fact, with precedent, and with Sir William Blackſtone himſelf; and whether, by the application of theſe rules of evidence thereto, it will not be found, that (from the want of attention to that important line of diſtinction which the conſtitution has drawn between the *king* of England and the *crown* of England) what was attributed to the *monarchy* has not been given to the *monarch*, what meant for the *kingſhip* conveyed to the *king*, what deſigned for the *thing* transferred to the *perſon*, what intended for *theory* applied to *practice*; and ſo in conſequence, that whilſt the premiſſes (of the perfection of the monarchy) be true, the concluſion (that the king can do no wrong) be not falſe.

"And, firſt, in reference to the conſtitution: to which if this matter be applied (meaning what it expreſſes, and if it do not it is unworthy of notice), it is ſubverſive of a principle in the conſtitution, upon which the preſervation of the conſtitution depends; I mean the principle of *reſiſtance;* a principle which, whilſt no man will now venture to gainſay, Sir William Blackſtone himſelf admits, '*is juſtifiable to the perſon of the prince*, when the being of the ſtate is endangered, and the public voice proclaims ſuch reſiſtance neceſſary;' and thus, by ſuch admiſſion, both diſproves the maxim, and overſets his own comment thereupon: for, to ſay that 'the king can do no wrong,' and that 'he is incapable even of thinking wrong,' and then to admit that 'reſiſtance to his perſon is juſtifiable,' are ſuch jarring contradictions in themſelves, that, until reconciled, the neceſſity of argument is ſuſpended.

"With reſpect then, in the next place, to the agreement of this maxim, and its comment, with nature, with reaſon, and with common ſenſe, I ſhould have thought myſelf ſufficiently juſtified in appealing to every man's own reflection for deciſion, if I had not been made to underſtand that nature, reaſon, and common ſenſe, had had nothing to do with either. Sir William Blackſtone ſays, 'That though a philoſophical mind will conſider the royal perſon merely as one man appointed by mutual conſent to preſide over others, and will pay him that reverence and duty which the principles of ſociety demand, yet the maſs of mankind will be apt to grow inſolent and refractory if taught to conſider their prince as a man of no greater perfection than themſelves; and therefore the law aſcribes to the king, in his high political character, certain attributes of a great and tranſcendent nature, by which the people are led to conſider him in the light of a ſuperior being, and to pay him that awful reſpect which may enable him with greater eaſe to carry on the buſineſs of government.' So that, in order to govern with greater eaſe (which by the bye is mere aſſertion without any proof), it is neceſſary to deceive the maſs of mankind, by making them believe, not only what a philoſophical mind cannot believe, but what it is impoſſible for any mind to believe; and therefore, in the inveſtigation of this ſubject, according to Sir William, neither nature, reaſon, nor common ſenſe can have any concern.——

"It remains to examine in how much this maxim and its comment agree with experience, with fact, with precedent, and with Sir William Blackſtone himſelf. And here it is matter of moſt curious ſpeculation, to obſerve a maxim laid down, and which is intended for a rule of government, not only without a ſingle caſe in ſupport of it, but with a ſtring of caſes, that may be carried back to Egbert the firſt monarch of England, in direct oppoſition to the doctrine. Who is the man, that, reading the paſt hiſtory of this country, will ſhow us any king that has done no wrong? Who is the reader that will not find, that all the wrongs and injuries which the free conſtitution of this country has hitherto ſuffered, have been ſolely derived from the arbitrary meaſures of our kings? And yet the maſs of mankind are to look upon the king as a ſuperior being; and the maxim, that 'the king can do no wrong,' is to remain as an article of belief. But, without puſhing this inquiry any further, let us ſee what encouragement Sir William Blackſtone himſelf has given us for our credulity. After ſtating the maxim, and preſenting us with a moſt lively picture, 'of our ſovereign lord thus *all perfect* and *immortal*,' what does he make this all-perfection and immortality in the end to come to? His words are theſe: 'For, when king Charles's deluded brother attempted to *enſlave* the nation,' (*no wrong this, to be ſure,*) 'he found it was beyond his power: the people both *could*, and *did*, reſiſt him; and, in conſequence of ſuch reſiſtance, obliged him to quit his enterpriſe and his throne together.'"

The ſum of all is this: That the crown of England and the king of England are diſtinguiſhable, and not ſynonymous terms: that allegiance is due *to the crown*, and through the crown *to the king*: that the attributes of the crown are ſovereignty, perfection, and perpetuity; but that it does not therefore follow that the king can do no wrong. It is indeed to be admitted, that, in high reſpect for the crown, high reſpect is alſo due to the wearer of that crown; that is, to the king: but the crown is to be preferred to the king, for the firſt veneration is due to the conſtitution. It is likewiſe *to be ſuppoſed* that the king *will* do no wrong: and as, to prevent this, a privy council is appointed by the conſtitution to aſſiſt the king in the execution of the government; ſo, if any wrong be done, 'theſe men,' as Monteſquieu expreſſes it, 'may be examined and puniſhed*.'

"But if any future king ſhall think to ſcreen theſe evil counſellors from the juſt vengeance of the people, by becoming *his own miniſter*; and, in ſo doing, ſhall take for his ſanction *the attribute of perfection*, ſhall truſt to the deception of his being *a ſuperior being*, and cloak himſelf under the maxim that *the king can do no wrong*; I ſay, in ſuch a caſe, let the appeal already made to the conſtitution, to nature, to reaſon, to common ſenſe, to experience, to fact, to precedent, and to Sir William Blackſtone himſelf, ſuffice; and preclude the neceſſity of any further remarks from me †."

To proceed now to other particulars: The law determines, that in the king can be no negligence, or LACHES; and therefore no delay will bar his right. *Nullum tempus occurrit regi*, is the ſtanding maxim upon all occaſions: for the law intends that the king is always buſied for the public good, and therefore has not leiſure to aſſert his right within the times limited to ſubjects. In the king alſo can be no ſtain or corruption of blood: for, if the heir to the crown were attainted of treaſon or felony, and afterwards the crown ſhould deſcend to him, this would purge the attainder *ipſo facto*. And therefore, when Henry VII. who as earl of Richmond ſtood attainted, came to the crown, it was not thought neceſſary to paſs an act of parliament to reverſe this attainder; becauſe, as Lord Bacon in his hiſtory of that prince informs us, it was agreed that the aſſumption of the crown had at once purged all attainders. Neither can the king, in judgment of law, as king, ever be a minor or under age; and therefore his royal grants and aſſents to acts of parliament are good, though he has not in his natural capacity attained the legal age of 21. By a ſtatute, indeed, 28 Hen. VIII. c. 17. power was given to future kings to reſcind and revoke all acts of parliament that ſhould be made while they were under the age of 24: but this was repealed by the ſtatute 1 Edward VI. c. 11. ſo far as related to that prince, and both ſtatutes are declared to be determined by 24 Geo. II c. 24. It hath alſo been uſually thought prudent, when the heir apparent has been very young, to appoint a protector, guardian, or regent, for a limited time: but the very neceſſity of ſuch extraordinary proviſion is ſufficient to demonſtrate the truth of that maxim of common law, that in the king is no minority; and therefore he hath no legal guardian. See REGENT.

3. A third attribute of the king's majeſty is his *perpetuity*. The law aſcribes to him, in his political capacity, an abſolute immortality. The king never dies. Henry, Edward, or George, may die; but the king ſurvives them all. For, immediately upon the deceaſe of the reigning prince in his natural capacity, his kingſhip or imperial dignity, by act of law, without any *interregnum* or interval, is veſted at once in his heir; who is, *eo inſtanti*, king to all intents and purpoſes. And ſo tender is the law of ſuppoſing even a poſſibility of his death, that his natural diſſolution is generally called his *demiſe*; *dimiſſio regis vel coronæ*: an expreſſion which ſignifies merely a transfer of property: for, as is obſerved in Plowden, when we ſay the demiſe of the crown, we mean only, that, in conſequence of the diſunion of the king's body-natural from his body-politic, the kingdom is transferred or demiſed to his ſucceſſor, and ſo the royal dignity remains perpetual. Thus, too, when Edward the fourth, in the tenth year of his reign, was driven from his throne for a few months by the houſe of Lancaſter, this temporary transfer of his dignity was denominated his *demiſe*: and all proceſs was held to be diſcontinued, as upon a natural death of the king.

II. We are next to conſider thoſe branches of the royal prerogative which inveſt this our ſovereign lord with a number of *authorities* and *powers*; in the exertion whereof conſiſts the executive part of government. This is wiſely placed in a ſingle hand by the Britiſh conſtitution, for the ſake of unanimity, ſtrength, and diſpatch. Were it placed in many hands, it would be ſubject to many wills: many wills, if diſunited, and drawing different ways, create weakneſs in a government; and to unite thoſe ſeveral wills, and reduce them to one, is a work of more time and delay than the exigencies of ſtate will afford. The king of England is therefore not only the chief, but properly the ſole, magiſtrate of the nation; all others acting by commiſſion from, and in due ſubordination to, him: in like manner as, upon the great revolution in the Roman ſtate, all the powers of the ancient magiſtracy of the commonwealth were concentred in the new emperor, ſo that, as Gravina expreſſes it, *in ejus unius perſona veteris rei publicæ vis atque majeſtas per cumulatas magiſtratuum poteſtates exprimebatur.*

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* Except the parliament, which is the great council of the nation, the judges, and the peers, who, being the hereditary counſellors of the crown, have not only a right, but are bound *in foro conſcientiæ* to adviſe the king for the public good, the conſtitution knows of no other counſel than the privy council. Any other counſel, like Clifford, Arlington, Buckingham, Aſhley, Lauderdale, and as the initial letters of theſe names expreſs, is a CABAL, and as ſuch ſhould be ſuppreſſed. Nat. Bacon, ſpeaking of the loſs of power in the grand council of lords, ſays, "The ſenſe of ſtate once contracted into a privy council, is ſoon recontracted into a cabinet-council, and laſt of all into a *favourite* or two; which many times brings damage to the public, and both *themſelves* and *kings* into extreme *precipices*; partly for want of maturity, but principally through the providence of God over-ruling irregular courſes to the hurt of ſuch as walk in them." *Pol Diſc.* part 2. p. 201.

† For experience, fact, and precedent, ſee the reigns of king John, Henry III. Edward II. Richard II. Charles I. and James II. See alſo *Mirror of Juſtices*: where it is ſaid, "that this grand aſſembly (meaning the now parliament, or then Wittena-gemotte) is to confer the government of God's people, how they may be kept from ſin, live in quiet, and have right done them according to the cuſtoms and laws; and more eſpecially *of wrong done by the king*, queen, or their children:" to which Nat. Bacon adds this note: "At this time *the king might do wrong*, &c. and ſo ſay Bracton and Fleta of the *kings* in their time." *Diſc.* part 1. p. 37. Lond. 1739.

In the exertion of lawful prerogative the king is held to be abſolute; that is, ſo far abſolute, that there is no legal authority that can either delay or reſiſt him. He may reject what bills, may make what treaties, may coin what money, may create what peers, may pardon what offences, he pleaſes: unleſs where the conſtitution hath expreſsly, or by evident conſequence, laid down ſome exception or boundary; declaring, that thus far the prerogative ſhall go, and no further. For otherwiſe the power of the crown would indeed be but a name and a ſhadow, inſufficient for the ends of government, if, where its juriſdiction is clearly eſtabliſhed and allowed, any man or body of men were permitted to diſobey it, in the ordinary courſe of law: we do not now ſpeak of thoſe *extraordinary* recourſes to the firſt principles, which are neceſſary when the contracts of ſociety are in danger of diſſolution, and the law proves too weak a defence againſt the violence of fraud or oppreſſion. And yet the want of attending to this obvious diſtinction has occaſioned theſe doctrines, of abſolute power in the prince and of national reſiſtance by the people, to be much miſunderſtood and perverted, by the advocates for ſlavery on the one hand, and the demagogues of faction on the other. The former, obſerving the abſolute ſovereignty and tranſcendent dominion of the crown laid down (as it certainly is) moſt ſtrongly and emphatically in our law-books as well as our homilies, have denied that any caſe can be excepted from ſo general and poſitive a rule; forgetting how impoſſible it is, in any practical ſyſtem of laws, to point out beforehand thoſe eccentrical remedies, which the ſudden emergence of national diſtreſs may dictate, and which that alone can juſtify. On the other hand, over-zealous republicans, feeling the abſurdity of unlimited paſſive obedience, have fancifully (or ſometimes factiouſly) gone over to the other extreme: and, becauſe reſiſtance is juſtifiable to the perſon of the prince when the being of the ſtate is endangered, and the public voice proclaims ſuch reſiſtance neceſſary, they have therefore allowed to every individual the right of determining this expedience, and of employing private force to reſiſt even private oppreſſion. A doctrine productive of anarchy, and (in conſequence) equally fatal to civil liberty as tyranny itſelf. For civil liberty, rightly underſtood, conſiſts in protecting the rights of individuals by the united force of ſociety: ſociety cannot be maintained, and of courſe can exert no protection, without obedience to ſome ſovereign power; and obedience is an empty name, if every individual has a right to decide how far he himſelf ſhall obey.

In the exertion, therefore, of thoſe prerogatives which the law has given him, the king is irreſiſtible and abſolute, according to the forms of the conſtitution. And yet, if the conſequence of that exertion be manifeſtly to the grievance or diſhonour of the kingdom, the parliament will call his adviſers to a juſt and ſevere account. For, prerogative conſiſting (as Mr. Locke has well defined it) in the diſcretionary power of acting for the public good where the poſitive laws are ſilent, if that diſcretionary power be abuſed to the public detriment, ſuch prerogative is exerted in an unconſtitutional manner. Thus, the king may make a treaty with a foreign ſtate, which ſhall irrevocably bind the nation; and yet, when ſuch treaties have been judged pernicious, impeachments have purſued thoſe miniſters by whoſe agency or advice they were concluded.

The prerogatives of the crown (in the ſenſe under which we are now conſidering them) reſpect either this nation's intercourſe with foreign nations, or its own domeſtic government and civil polity.

With regard to *foreign concerns*, the king is the delegate or repreſentative of his people. It is impoſſible that the individuals of a ſtate, in their collective capacity, can tranſact the affairs of that ſtate with another community equally numerous as themſelves. Unanimity muſt be wanting to their meaſures, and ſtrength to the execution of their counſels. In the king therefore, as in a centre, all the rays of his people are united, and form by that union a conſiſtency, ſplendor, and power, that make him feared and reſpected by foreign potentates; who would ſcruple to enter into any engagement, that muſt afterwards be reviſed and ratified by a popular aſſembly. What is done by the royal authority, with regard to foreign powers, is the act of the whole nation: what is done without the king's concurrence, is the act only of private men. And ſo far is this point carried by our law, that it hath been held, that, ſhould all the ſubjects of England make war with a king in league with the king of England, without the royal aſſent, ſuch war is no breach of the league. And, by the ſtatute 2 Hen. V. c. 6. any ſubject committing acts of hoſtility upon any nation in league with the king, was declared to be guilty of high treaſon: and, though that act was repealed by the ſtatute 20 Hen. VI. c. 11 ſo far as relates to the making this offence high treaſon, yet ſtill it remains a very great offence againſt the law of nations, and puniſhable by our laws, either capitally or otherwiſe, according to the circumſtances of the caſe.

1. The king therefore, conſidered as the repreſentative of his people, has the ſole power of ſending ambaſſadors to foreign ſtates, and receiving ambaſſadors at home.

2. It is alſo the king's prerogative to make treaties, leagues, and alliances, with foreign ſtates and princes. For it is, by the law of nations, eſſential to the goodneſs of a league, that it be made by the ſovereign power; and then it is binding upon the whole community: and in Britain the ſovereign power, *quoad hoc*, is veſted in the perſon of the king. Whatever contracts therefore he engages in, no other power in the kingdom can legally delay, reſiſt, or annul. And yet, leſt this plenitude of authority ſhould be abuſed to the detriment of the public, the conſtitution (as was hinted before) hath here interpoſed a check, by the means of parliamentary impeachment, for the puniſhment of ſuch miniſters as from criminal motives adviſe or conclude any treaty, which ſhall afterwards be judged to derogate from the honour and intereſt of the nation.

3. Upon the ſame principle the king has alſo the ſole prerogative of making war and peace. For it is held by all the writers on the law of nature and nations, that the right of making war, which by nature ſubſiſted in every individual, is given up by all private perſons that enter into ſociety, and is veſted in the ſovereign power: and this right is given up, not only by individuals, but even by the entire body of people that are under the dominion of a ſovereign. It would indeed be extremely improper, that any number of ſubjects ſhould have the power of binding the ſupreme magiſtrate, and putting him againſt his will in a ſtate of war. Whatever hoſtilities, therefore, may be committed by private citizens, the ſtate ought not to be

affected thereby; unleſs that ſhould juſtify their proceedings, and thereby become partner in the guilt. And the reaſon which is given by Grotius, why, according to the law of nations, a denunciation of war ought always to precede the actual commencement of hoſtilities, is, not ſo much that the enemy may be put upon his guard (which is matter rather of magnanimity than right), but that it may be certainly clear that the war is not undertaken by private perſons, but by the will of the whole community; whoſe right of willing is in this caſe transferred to the ſupreme magiſtrate by the fundamental laws of ſociety. So that, in order to make a war completely effectual, it is neceſſary with us in Britain that it be publicly declared and duly proclaimed by the king's authority; and then, all parts of both the contending nations, from the higheſt to the loweſt, are bound by it. And wherever the right reſides of beginning a national war, there alſo muſt reſide the right of ending it, or the power of making peace. And the ſame check of parliamentary impeachment, for improper or inglorious conduct, in beginning, conducting, or concluding a national war, is in general ſufficient to reſtrain the miniſters of the crown from a wanton or injurious exertion of this great prerogative.

4. But, as the delay of making war may ſometimes be detrimental to individuals who have ſuffered by depredations from foreign potentates, our laws have in ſome reſpects armed the ſubject with powers to impel the prerogative; by directing the miniſters of the crown to iſſue letters of marque and repriſal upon due demand: the prerogative of granting which is nearly related to, and plainly derived from, that other of making war; this being indeed only an incomplete ſtate of hoſtilities, and generally ending in a formal denunciation of war. Theſe letters are grantable, by the law of nations, whenever the ſubjects of one ſtate are oppreſſed and injured by thoſe of another, and juſtice is denied by that ſtate to which the oppreſſor belongs. In this caſe, letters of marque and repriſal (words in themſelves ſynonymous, and ſignifying a taking in return) may be obtained, in order to ſeize the bodies or goods of the ſubjects of the offending ſtate, until ſatisfaction be made, wherever they happen to be found. And indeed this cuſtom of repriſals ſeems dictated by nature herſelf; for which reaſon, we find in the moſt ancient times very notable inſtances of it. But here the neceſſity is obvious of calling in the ſovereign power, to determine when repriſals may be made; elſe every private ſufferer would be a judge in his own cauſe. In purſuance of which principle, it is with us declared by the ſtatute 4 Hen. V. c. 7. that if any ſubjects of the realm are oppreſſed in time of truce by any foreigners, the king will grant marque in due form to all that feel themſelves grieved. See MARQUE.

5. Upon exactly the ſame reaſon ſtands the prerogative of granting ſafe-conducts; without which, by the law of nations, no member of one ſociety has a right to intrude into another. And therefore Puffendorff very juſtly reſolves, that it is left in the power of all ſtates to take ſuch meaſures about the admiſſion of ſtrangers as they think convenient; thoſe being ever excepted who are driven on the coaſts by neceſſity, or by any cauſe that deſerves pity or compaſſion. Great tenderneſs is ſhown by our laws, not only to foreigners in diſtreſs (ſee WRECK), but with regard alſo to the admiſſion of ſtrangers who come ſpontaneouſly: for, ſo long as their nation continues at peace with ours, and they themſelves behave peaceably, they are under the king's protection; though liable to be ſent home whenever the king ſees occaſion. But no ſubject of a nation at war with us can, by the law of nations, come into the realm, nor can travel himſelf upon the high ſeas, or ſend his goods and merchandiſe from one place to another, without danger of being ſeized by our ſubjects, unleſs he has letters of ſafe-conduct; which, by divers ancient ſtatutes, muſt be granted under the king's great ſeal and inrolled in chancery, or elſe they are of no effect; the king being ſuppoſed the beſt judge of ſuch emergencies, as may deſerve exception from the general law of arms. But paſſports under the king's ſign-manual, or licences from his ambaſſadors abroad, are now more uſually obtained, and are allowed to be of equal validity.

Theſe are the principal prerogatives of the king reſpecting this nation's intercourſe with foreign nations; in all of which he is conſidered as the delegate or repreſentative of his people. But, in domeſtic affairs, he is conſidered in a great variety of characters, and from thence there ariſes an abundant number of other prerogatives.

1. He is a conſtituent part of the ſupreme legiſlative power; and, as ſuch, has the prerogative of rejecting ſuch proviſions in parliament as he judges improper to be paſſed. The expediency of which conſtitution has before been evinced at large under the article PARLIAMENT. We ſhall only further remark, that the king is not bound by any act of parliament, unleſs he be named therein by ſpecial and particular words. The moſt general words that can be deviſed (any perſon or perſons, bodies politic, or corporate, &c.) affect not him in the leaſt, if they may tend to reſtrain or diminiſh any of his rights or intereſts. For it would be of moſt miſchievous conſequence to the public, if the ſtrength of the executive power were liable to be curtailed, without its own expreſs conſent, by conſtructions and implications of the ſubject. Yet, where an act of parliament is expreſsly made for the preſervation of public rights and the ſuppreſſion of public wrongs, and does not interfere with the eſtabliſhed rights of the crown, it is ſaid to be binding as well upon the king as upon the ſubject: and, likewiſe, the king may take the benefit of any particular act, though he be not eſpecially named.

2. The king is conſidered, in the next place, as the generaliſſimo, or the firſt in military command, within the kingdom. The great end of ſociety is to protect the weakneſs of individuals by the united ſtrength of the community; and the principal uſe of government is to direct that united ſtrength in the beſt and moſt effectual manner, to anſwer the end propoſed. Monarchical government is allowed to be the fitteſt of any for this purpoſe: it follows therefore, from the very end of its inſtitution, that in a monarchy the military power muſt be truſted in the hands of the prince.

In this capacity, therefore, of general of the kingdom, the king has the ſole power of raiſing and regulating fleets and armies. The manner in which they are raiſed and regulated is explained under the article MILITARY *State*. We are now only to conſider the prerogative of enliſting and of governing them: which indeed was diſputed and claimed, contrary to all reaſon and precedent, by the long parliament of Charles I.; but, upon the reſtoration of his ſon, was ſolemnly declared by the ſtatute 3 Charles II. c. 6. to be in the king alone: for that the ſole ſupreme government and command of the militia within all his majeſty's realms and dominions, and of all forces by ſea and land, and of all forts and places of ſtrength, ever was and is the undoubted right of his majeſty, and his royal predeceſſors, kings and queens of England; and that both or either houſe of parliament cannot, nor ought to, pretend to the ſame.

This ſtatute, it is obvious to obſerve, extends not only to fleets and armies, but alſo to forts and other places of ſtrength within the realm; the ſole prerogative, as well of erecting, as manning and governing of which, belongs to the king in his capacity of general of the kingdom: and all lands were formerly ſubject to a tax, for building of caſtles wherever the king thought proper. This was one of the three things, from contributing to the performance of which no lands were exempted, and therefore called by the Anglo-Saxons the *trinoda neceſſitas*; *ſc. pontis reparatio, arcis conſtructio, et expeditio contra hoſtem.* And this they were called upon to do ſo often, that, as Sir Edward Coke from M. Paris aſſures us, there were in the time of Henry II. 1115 caſtles ſubſiſting in England. The inconveniencies of which, when granted out to private ſubjects, the lordly barons of thoſe times, were ſeverely felt by the whole kingdom; for, as William of Newburgh remarks, in the reign of king Stephen *erant in Anglia quodammodo tot reges, vel potius tyranni, quot domini caſtellorum*: but it was felt by none more ſenſibly than by two ſucceeding princes, king John and king Henry III. And therefore, the greateſt part of them being demoliſhed in the barons' wars, the kings of after-times have been very cautious of ſuffering them to be rebuilt in a fortified manner: and Sir Edward Coke lays it down, that no ſubject can build a caſtle, or houſe of ſtrength imbattled, or other fortreſs defenſible, without the licence of the king; for the danger which might enſue if every man at his pleaſure might do it.

It is partly upon the ſame, and partly upon a fiſcal foundation, to ſecure his marine revenue, that the king has the prerogative of appointing *ports* and *havens*, or ſuch places only, for perſons and merchandiſe to paſs into and out of the realm, as he in his wiſdom ſees proper. By the feodal law, all navigable rivers and havens were computed among the regalia, and were ſubject to the ſovereign of the ſtate. And in England it hath always been held, that the king is lord of the whole ſhore, and particularly is the guardian of the ports and havens, which are the inlets and gates of the realm: and therefore, ſo early as the reign of king John, we find ſhips ſeized by the king's officers for putting in at a place that was not a legal port. Theſe legal ports were undoubtedly at firſt aſſigned by the crown; ſince to each of them a court of portmote is incident, the juriſdiction of which muſt flow from the royal authority: the *great ports* of the ſea are alſo referred to, as well known and eſtabliſhed, by ſtatute 4 Hen. IV. c. 20. which prohibits the landing elſewhere under pain of confiſcation: and the ſtatute 1 Eliz. c. 11. recites, that the franchiſe of lading and diſcharging had been frequently granted by the crown.

But though the king had a power of granting the franchiſe of havens and ports, yet he had not the power of reſumption, or of narrowing and confining their limits when once eſtabliſhed; but any perſon had a right to load or diſcharge his merchandiſe in any part of the haven: whereby the revenue of the cuſtom was much impaired and diminiſhed, by fraudulent landings in obſcure and private corners. This occaſioned the ſtatutes of 1 Eliz. c. 11. and 13 and 14 Car. II. c. 11. § 14. which enable the crown, by commiſſion, to aſcertain the limits of all ports, and to aſſign proper wharfs and quays in each port, for the excluſive landing and loading of merchandiſe.

The erection of beacons, light-houſes, and ſea-marks, is alſo a branch of the royal prerogative: whereof the firſt was anciently uſed in order to alarm the country, in caſe of the approach of an enemy; and all of them are ſignally uſeful in guiding and preſerving veſſels at ſea by night as well as by day. See Beacon.

3. Another capacity in which the king is conſidered in domeſtic affairs, is as the fountain of juſtice and general conſervator of the peace of the kingdom. See the article *Fountain of* Justice.

4. The king is likewiſe the fountain of honour, of office, and of privilege: and this in a different ſenſe from that wherein he is ſtyled the *fountain of juſtice*; for here he is really the parent of them. See the articles *Fountain of* Justice and *Fountain of* Honour.

5. Another light, in which the laws of England conſider the king with regard to domeſtic concerns, is as the arbiter of commerce. By commerce, we at preſent mean domeſtic commerce only; for the king's prerogative with regard to which, ſee *Regulation of* Weights *and Meaſures*, Money, &c.

6. The king is, laſtly, conſidered by the laws of England as the head and ſupreme governor of the national church.

To enter into the reaſons upon which this prerogative is founded is matter rather of divinity than of law. We ſhall therefore only obſerve, that by ſtatute 26 Hen. VIII. c. 1. (reciting that the king's majeſty juſtly and rightfully is and ought to be the ſupreme head of the church of England; and ſo had been recogniſed by the clergy of that kingdom in their convocation) it is enacted, that the king ſhall be reputed the only ſupreme head in earth of the church of England; and ſhall have, annexed to the imperial crown of this realm, as well the title and ſtyle thereof, as all juriſdictions, authorities, and commodities, to the ſaid dignity of ſupreme head of the church appertaining. And another ſtatute to the ſame purport was made, 1 Eliz. c. 1.

In virtue of this authority the king convenes, prorogues, reſtrains, regulates, and diſſolves, all eccleſiaſtical ſynods or convocations. This was an inherent prerogative of the crown long before the time of Henry VIII. as appears by the ſtatute 8 Henry VI. c. 1. and the many authors, both lawyers and hiſtorians, vouched by Sir Edward Coke. So that the ſtatute 25 Hen. VIII. c. 19. which reſtrains the convocation from making or putting in execution any canons repugnant to the king's prerogative, or the laws, cuſtoms, and ſtatutes of the realm, was merely declaratory of the old common law: that part of it only being new, which makes the king's royal aſſent actually neceſſary to the validity of every canon. The convocation or eccleſiaſtical ſynod, in England, differs conſiderably in its conſtitution from the ſynods of other Chriſtian kingdoms; thoſe conſiſting wholly of biſhops; whereas in England the convocation is the miniature of a parliament, wherein the archbiſhop preſides with regal ſtate; the upper houſe of biſhops repreſents the houſe of lords; and the lower houſe, compoſed of repreſentatives of the ſeveral dioceſes at large, and of each particular chapter therein, reſembles the houſe of commons with its knights of the ſhire and burgeſſes. This conſtitution is ſaid to be owing to the policy of Edward I. who thereby at one and the ſame time let in the inferior clergy to the privileges of forming eccleſiaſtical canons (which before they had not), and alſo introduced a method of taxing eccleſiaſtical benefices by conſent of convocation.

From this prerogative alſo, of being the head of the church, ariſes the king's right of nomination to vacant biſhoprics, and certain other eccleſiaſtical preferments.

As head of the church, the king is likewiſe the *dernier reſort* in all eccleſiaſtical cauſes; an appeal lying ultimately to him in chancery from the ſentence of every eccleſiaſtical judge: which right was reſtored to the crown by ſtatute 25 Hen. VIII. c. 9.

III. The king's fiſcal prerogatives, or ſuch as regard his revenue. See the article Revenue.

Prerogative *Court*, a court which is eſtabliſhed for the trial of all teſtamentary cauſes, where the deceaſed hath left *bona notabilia* within two different dioceſes. In which caſe the probate of wills belongs to the archbiſhop of the province, by way of ſpecial prerogative. And all cauſes relating to the wills, adminiſtrations, or legacies of ſuch perſons are originally cognizable herein, before a judge appointed by the archbiſhop, called the *judge of the prerogative-court*; from whom an appeal lies by ſtatute 25 Hen. VIII. c. 19. to the king in chancery, inſtead of the pope as formerly.

PRESAGE, in antiquity, denotes an augury, or ſign of ſome future event; which was chiefly taken from the flight of birds, the entrails of victims, &c. See Augury and Aruspices.

PRESBURG, the capital of the kingdom of Lower Hungary, called by the inhabitants *Poſony* and *Preſporen*, ſituated on the Danube, about 46 miles eaſt from Vienna, and 75 from Buda. The caſtle, in which the regalia are kept, ſtands on a hill above the town. Here the ſtates aſſemble; and in the cathedral, dedicated to St. Martin, the king is crowned. The town is not very large, nor well built; but is very ancient, pleaſantly ſituated, and enjoys a good air. Its fortifications are only a double wall and ditch. In the lower ſuburbs is a hill, where the king, after his coronation, goes on horſeback, and brandiſhes St. Stephen's ſword towards the four cardinal points, intimating, that he will defend his country againſt all its enemies. Beſides the cathedral, there are ſeveral other Popiſh and one Lutheran church, with a Jeſuits college, three convents, and two hoſpitals. It gives name to a county; and is the reſidence of the archbiſhop of Gran, who is primate, chief ſecretary, and chancellor of the kingdom, *legatus natus* of the Papal ſee, and prince of the holy Roman empire. E. lon. 17. 30. N. lat. 48. 20.

PRESBYTÆ, perſons whoſe eyes are too flat to refract the rays ſufficiently, ſo that, unleſs the object is at ſome diſtance, the rays coming from it will paſs through the retina before their union, conſequently viſion is confuſed; old people are uſually the ſubjects of this diſeaſe. In order to remedy, or at leaſt to palliate, this defect, the perſon ſhould firſt uſe glaſſes which do not magnify, and from them paſs gradually to more convex ſpectacles, which ſhorten the focus.

PRESBYTER, in the primitive Chriſtian church, an elder, one of the ſecond order of eccleſiaſtics; the other two being biſhops and deacons. See the articles BISHOP and DEACON. Preſbyter or elder is a word borrowed from the Greek tranſlation of the Old Teſtament, where it commonly ſignifies ruler or governor; it being a note of office and dignity, not of age; and in this ſenſe biſhops are ſometimes called *preſbyters* in the New Teſtament. The preſbyters might baptize, preach, conſecrate, and adminiſter the euchariſt in the biſhop's abſence, or in his preſence if he authoriſed and deputed them; and the biſhops did ſcarce any thing in the government of the church without their advice, conſent, and amicable concurrence. The grand diſpute between the followers of the Geneva and Roman diſcipline, is about the ſameneſs and difference of preſbyters and biſhops at the time of the apoſtles. See EPISCOPACY, INDEPENDENTS, and the following article.

PRESBYTERIANS, Proteſtants ſo called from their maintaining that the government of the church appointed in the New Teſtament was by preſbyteries, that is, by aſſociations of miniſters and ruling elders, poſſeſſed all of equal powers, without any ſuperiority among them either in office or in order.

The Preſbyterians believe, that the authority of their miniſters to preach the goſpel, to adminiſter the ſacraments of baptiſm and the Lord's ſupper, and to feed the flock of Chriſt, is derived from the Holy Ghoſt by the impoſition of the hands of the preſbytery; and they oppoſe the independent ſcheme of the common rights of Chriſtians by the ſame arguments which are uſed for that purpoſe by the Epiſcopalians (ſee EPISCOPACY). They affirm, however, that there is no order in the church as eſtabliſhed by Chriſt and his apoſtles ſuperior to that of preſbyters; that all miniſters, being ambaſſadors of Chriſt, are equal by their commiſſion; that *preſbyter* and *biſhop*, though different words, are of the ſame import; and that prelacy was gradually eſtabliſhed upon the primitive practice of making the *moderator* or ſpeaker of the preſbytery a permanent officer.

Theſe poſitions they maintain againſt the Epiſcopalians by the following ſcriptural arguments. They obſerve, that the apoſtles planted churches by ordaining biſhops and deacons in every city; that the miniſters which in one verſe are called biſhops are in the next perhaps denominated preſbyters; that we nowhere read in the New Teſtament of biſhops, preſbyters, and deacons, in any one church; and that therefore we are under the neceſſity of concluding *biſhop* and *preſbyter* to be two names for the ſame church officer. This is apparent from Peter's exhortation to the *elders* or *preſbyters* who were among the Jewiſh Chriſtians. "The *elders* (preſbyters) which are among you I exhort, who am alſo an *elder*, and a witneſs of the ſufferings of Chriſt, and alſo a partaker of the glory that ſhall be revealed: Feed the flock of God which is among you, taking the *overſight* thereof (επισκοπουντες, acting as *biſhops* thereof), not by conſtraint, but willingly; not for filthy lucre, but of a ready mind; neither as being LORDS over God's heritage, but being enſamples to the flock." From this paſſage it is evident, that the preſbyters not only fed the flock of God, but alſo governed that flock with epiſcopal powers; and that the apoſtle himſelf, as a church officer, was nothing more than a preſbyter or elder. The identity of the office of biſhop and preſbyter is ſtill more apparent from Heb. xiii. 7. 17. and 1 Theſſ. v. 12.; for the biſhops are there repreſented as governing the flock, ſpeaking to them the word of God, watching for their ſouls, and diſcharging various offices, which it is impoſſible for any man to perform to more than one congregation.

From the laſt cited text it is evident, that the biſhops (προισταμενους) of the Theſſalonian churches had the paſtoral care of no more ſouls than they could hold perſonal communion with in God's worſhip; for they were ſuch as all the people were to *know*, *eſteem*, and *love*, as thoſe that not only were *over them*, but alſo "cloſely laboured among them and admoniſhed them." But diœceſan biſhops, whom ordinarily the hundredth part of their flock never hear nor ſee, cannot be thoſe biſhops by whom that flock is admoniſhed, nor can they be, what Peter requires the biſhops of the Jewiſh converts to be, *enſamples to the flock*. It is the opinion of Dr. Hammond, who was a very learned divine, and a zealot for epiſcopacy, that the *elders* whom the apoſtle James deſires the ſick to call for, were of the higheſt permanent order of eccleſiaſtical officers; but it is ſelf-evident that thoſe elders cannot have been dioceſan biſhops, otherwiſe the ſick muſt have been often without the reach of the remedy propoſed to them.

There is nothing in ſcripture upon which the Epiſcopalian is more ready to reſt his cauſe than the alleged epiſcopacy of Timothy and Titus; of whom the former is ſaid to have been biſhop of Epheſus, and the latter biſhop of Crete; yet the Preſbyterian thinks it as clear as the noon-day ſun, that the preſbyters of Epheſus were ſupreme governors under Chriſt of the Epheſian churches, at the very time that Timothy is pretended to have been their proper dioceſan.

In Acts xx. 17, &c. we read, that "from Miletus Paul ſent to Epheſus, and called the elders (preſbyters) of the church. And when they were come to him, he ſaid unto them, Ye know, from the firſt day that I came into Aſia, after what manner I have been with you, at all ſeaſons. And now I know that ye all, among whom I have gone preaching the kingdom of God, ſhall ſee my face no more. Wherefore I take you to record this day, that I am pure from the blood of all men. For I have not ſhunned to declare unto you all the counſel of God. Take heed therefore unto yourſelves, and to all the flock over which the Holy Ghoſt hath made you overſeers (επισκοπους *biſhops*), to feed the church of God, which he hath purchaſed with his own blood. For I know this, that after my departure ſhall grievous wolves enter in among you, not ſparing the flock. Alſo of your ownſelves ſhall men ariſe, ſpeaking perverſe things, to draw away diſciples after them. Therefore watch, and remember, that by the ſpace of three years I ceaſed not to warn every one night and day with tears. And now, brethren, I recommend you to God, and to the word of his grace," &c.

From this paſſage it is evident that there was in the city of Epheſus a plurality of paſtors of equal authority, without any ſuperior paſtor or biſhop over them; for the apoſtle directs his diſcourſe to them all in common, and gives them equal power over the whole flock. Dr. Hammond indeed imagines, that the elders whom Paul called to Miletus were the *biſhops* of *Aſia*, and that he ſent for them to Epheſus, becauſe that city was the metropolis of the province. But were this opinion well founded, it is not conceivable that the ſacred writer would have called them the elders of the church of *Epheſus*, but the elders of the *church in general*, or the elders of the *churches in Aſia*. Beſides, it is to be remembered, that the apoſtle was in ſuch haſte to be at Jeruſalem, that the ſacred hiſtorian meaſures his time by *days*; whereas it muſt have required ſeveral months to call together the biſhops or elders of all the cities of Aſia; and he might certainly have gone to meet them at Epheſus in leſs time than would be requiſite for their meeting in that city and proceeding thence to him at Miletus. They muſt therefore have been either the joint paſtors of one congregation, or the paſtors of different congregations in one city: and as it was thus in Epheſus, ſo was it in Philippi; for we find the apoſtle addreſſing his epiſtle "to all the ſaints in Chriſt Jeſus which are at Philippi, with the biſhops and deacons." From the paſſage before us it is likewiſe plain, that the preſbyters of Epheſus had not only the *name* but the whole *power* of biſhops given to them by the Holy Ghoſt; for they are enjoined to do the whole work of biſhops—*ϖοιμαινειν την εκκλησιαν του θεου*—which ſignifies, to *rule* as well as *feed* the church of God. Whence we ſee, that the apoſtle makes the power of *governing* inſeparable from that of *preaching* and *watching*; and that, according to him, all who are preachers of God's word, and watchmen of ſouls, are neceſſary rulers or governors of the church, without being accountable for their management to any prelate, but only to their Lord Chriſt from whom their power is derived.

It appears, therefore, that the apoſtle Paul left in the church of Epheſus, which he had planted, no other ſucceſſors to himſelf than *preſbyter-biſhops* or Preſbyterian miniſters, and that he did not devolve his power upon any prelate. Timothy, whom the Epiſcopalians allege to have been the firſt biſhop of Epheſus, was preſent when this ſettlement was made; and it is ſurely not to be ſuppoſed, that, had he been their biſhop, the apoſtle would have devolved the whole epiſcopal power upon the preſbyters before his face. If ever there was a ſeaſon fitter than another for pointing out the duty of this ſuppoſed biſhop to his dioceſe, and his preſbyters' duty to him, it was ſurely when Paul was taking his final leave of them, and diſcourſing ſo pathetically concerning the duty of *overſeers*, the coming of ravenous wolves, and the conſequent hazard of the flock. In this farewell diſcourſe he tells them, that "he had not ſhunned to declare unto them all the counſel of God." But with what truth could this have been ſaid, if obedience to a dioceſan biſhop had been any part of their duty either at the time of the apoſtle's ſpeaking or at any future period? He foreſaw that ravenous wolves would enter in among them, and that even ſome of themſelves ſhould ariſe ſpeaking perverſe things; and if, as the Epiſcopalians allege, dioceſan epiſcopacy was the remedy provided for thoſe evils, is it not ſtrange, paſſing ſtrange, that the inſpired preacher did not foreſee that Timothy, who was ſtanding beſide him, was deſtined to fill that important office; or, if he did foreſee it, that he omitted to recommend him to his future charge, and to give him proper inſtructions for the diſcharge of his duty?

But if Timothy was not biſhop of Epheſus, what, it may be aſked, was his office in that city? for that he reſided there for ſome time, and was by the apoſtle inveſted with authority to ordain and rebuke preſbyters, are facts about which all parties are agreed, and which indeed cannot be controverted by any reader of Paul's epiſtles. To this the Preſbyterian replies with confidence, that the power which Timothy exerciſed in the church of Epheſus was that of an evangeliſt, and not a fixed prelate. But, according to Euſebius, the work of an evangeliſt was, "to lay the foundations of the faith in barbarous nations, and to conſtitute among them paſtors; after which he paſſed on to other countries." Accordingly we find, that Timothy was reſident for a time at Philippi and Corinth as well as at Epheſus, and that he had as much authority over thoſe churches as over that of which he is ſaid to have been the fixed biſhop. "Now, if Timotheus come, ſee that he may be with you without fear, for he worketh the work of the Lord, as I alſo do. Let no man therefore deſpiſe him." This text might lead us to ſuppoſe, that Timothy was biſhop of Corinth as well as of Epheſus; for it is ſtronger than that upon which his epiſcopacy of the latter church is chiefly built. The apoſtle ſays, "I beſought thee to abide ſtill at Epheſus, when I went into Macedonia, that thou mighteſt charge ſome that they teach no other doctrine." But had Timothy been the fixed biſhop of that city, there would ſurely have been no neceſſity for *beſeeching* him to abide with his flock. It is to be obſerved, too, that the firſt epiſtle to Timothy, which alone was written to him during his reſidence at Epheſus, was of a date prior to Paul's meeting with the elders of that church at Miletus; for in the epiſtle he hopes to come to him ſhortly, whereas he tells the elders at Miletus that they ſhould ſee his face no more. This being the caſe, it is evident that Timothy was left by the apoſtle at Epheſus only to ſupply his place during his temporary abſence at Macedonia, and that he could not poſſibly have been conſtituted fixed biſhop of that church, ſince the epiſcopal powers were afterwards committed to the preſbyters by the Holy Ghoſt in his preſence.

The identity of the office of biſhop and preſbyter being thus clearly eſtabliſhed, it follows, that the preſbyterate is the higheſt permanent office in the church, and that every faithful paſtor of a flock is ſucceſſor to the apoſtles in every thing in which they were to have any ſucceſſors. In the apoſtolic office there were indeed ſome things peculiar and extraordinary; ſuch as, their immediate call by Chriſt, their infallibility, their being witneſſes of our Lord's reſurrection, and their unlimited juriſdiction over the whole world. Theſe powers and privileges could not be conveyed by impoſition of hands to any ſucceſſors, whether called preſbyters or biſhops; but as rulers or office-bearers in particular churches, we have the confeſſion of "the very chiefeſt apoſtles," Peter and John, that they were nothing more than preſbyters or pariſh miniſters. This being the caſe, the diſpute, which in the early part of the paſſing century was ſo warmly agitated concerning the validity of Preſbyterian ordination, may be ſoon decided; for, if the ceremony of ordination be at all eſſential, it is obvious that ſuch a ceremony performed by preſbyters muſt be valid, as there is no higher order of eccleſiaſtics in the church by whom it can be performed. Accordingly we find, that Timothy himſelf, though ſaid to be a biſhop, was ordained by the laying on of the hands of a preſbytery. At that ordination indeed St. Paul preſided, but he could preſide only as *primus in paribus*; for we have ſeen that, as permanent officers in the church of Chriſt, the apoſtles themſelves were no more than preſbyters. If the apoſtles' hands were impoſed for any other purpoſe, it muſt have been to communicate thoſe *chariſmata* or miraculous gifts of the Holy Spirit, which were then ſo frequent; but which no modern preſbyter or biſhop will pretend to give, unleſs his underſtanding be clouded by the groſſeſt ignorance, or perverted by the moſt frantic enthuſiaſm.

But if the office of biſhop and preſbyter was originally the ſame, how, it will be aſked, came diocceſan epiſcopacy to prevail ſo univerſally as it is confeſſed to have done before the converſion of Conſtantine and the civil eſtabliſhment of Chriſtianity in the Roman empire? To give a ſatisfactory anſwer to this queſtion is certainly the moſt arduous taſk which the advocate for preſbytery has to perform; but it is a taſk not inſurmountable.

From many paſſages in the New Teſtament, it is evident, that when the apoſtles planted churches in different cities, they generally ſettled more than one paſtor in the ſame church, to feed and govern it with joint authority. The propriety of this conſtitution is obvious. In thoſe days, when the diſciples of Chriſt were perſecuted for their religion, and often obliged to meet in the "night for fear of the Jews," they could not with any degree of prudence aſſemble in large numbers; and therefore, had there been no more than one paſtor in a city, the Chriſtian converts, though, when aſſembled, they might have amounted but to a ſmall congregation, could not all have enjoyed the benefit of public worſhip on the ſame day; at leaſt it is obvious that they could not poſſibly have aſſembled for this purpoſe ſo often as their want of inſtruction, and the duty of "breaking of bread and of prayer," required them to meet. It was therefore with great wiſdom that the apoſtles ordained ſeveral preſbyters in the ſame church; but as theſe preſbyters would have occaſion to meet frequently, and to deliberate on the ſtate of the flock which it was their duty to feed, and over which they had all equal authority, they would be under the neceſſity of electing one of their own number to be preſident or *moderator* of the preſbytery, that order might be preſerved, and all things done with decency. At firſt there is reaſon to believe that thoſe preſidents held their office no longer than while the preſbyteries ſat in which they were elected. Among the apoſtles themſelves there was no fixed preſident. Peter indeed appears to have been moſt frequently admitted to that honour; but there is one very memorable occaſion on record, when James, the Lord's brother, preſided in an aſſembly of apoſtles, elders, and brethren, held at Jeruſalem, to determine the queſtion concerning the neceſſity of circumciſing the Gentiles, and commanding them to keep the law of Moſes.

Upon this model were the primitive preſbyteries formed. They conſiſted of ſeveral preſbyters poſſeſſed of equal powers, who at their meetings appointed one of their own number to diſcharge the office of moderator or temporary preſident; but to this preſident they gave no prelatical powers or negative voice over the deliberations of his brethren; for, as Jerome informs us, the church was then governed *communi preſbyterorum concilio*, "by a common council of preſbyters." It appears, however, that when an apoſtle, an apoſtolical man, or an evangeliſt, fixed his reſidence in any city, and took upon himſelf the paſtoral care of part of the flock, his co-preſbyters, from reſpect to his ſingular gifts, made him their conſtant and fixed moderator. Hence Timothy, during his abode at Epheſus, was moderator of the preſbytery; and hence too Mark the evangeliſt, who reſided many years in Alexandria, has been called the firſt biſhop of that church, though he appears to have been nothing more than permanent moderator. We advance this upon the authority of Jerome, one of the moſt learned fathers of the Chriſtian church, who informs us, that upon the death of the evangeliſt, the preſbyters of Alexandria, for more than 200 years, choſe their biſhops from their own number, and placed them in the epiſcopal chair without dreaming that they ought to be raiſed to a higher order by a new conſecration:—*Preſbyteri unum ex ſe electum in excelſiori gradu collocatum, epiſcopum nominabant.* As this practice of making the moderator of the preſbytery of Alexandria a permanent officer, was thought a good expedient to guard the infant churches againſt ſchiſms and diviſions, thoſe churches gradually adopted it, For, as Jerome tells us. *Poſtquam unuſquiſque eos quos baptizaverat, ſuos putabat eſſe, non Chriſti, in toto orbe decretum eſt, ut unus de preſbyteris electus, ſuperponeretur cæteris, ad quem omnis eccleſiæ cura pertineret, et ſchiſmatum ſemina tollerentur.*

The advantages which, in diſplaying his talents and authority, the perpetual preſident or ſpeaker of any aſſembly has over his colleagues in office, are ſo obvious, that, when the practice of electing their moderators for life became univerſal among the preſbyteries of the primitive church, it is eaſy to conceive how ambitious men might ſo magnify the difficulties and importance of their ſtation, as to introduce the cuſtom of filling it by a new conſecration of the biſhop elect. But when this was done, dioceſan epiſcopacy, with all its powers and prerogatives, would follow as a thing of courſe, until "by little and little (as Jerome expreſſes himſelf) the whole paſtoral care of the flock was devolved upon one man."

Our limits will not permit us to trace more minutely the riſe and progreſs of this eccleſiaſtical uſurpation, as the Preſbyterian calls it; but the reader who wiſhes for fuller information, after ſtudying the remains of the four firſt centuries of the Chriſtian church, may conſult *An Inquiry into the Conſtitution, Diſcipline, and Worſhip, of the Primitive Church*, ſaid to have been written by Sir Peter King, afterwards lord chancellor of England. As an impartial lover of truth, he will do well to conſult alſo a book entitled *An original Draught of the Primitive Church*, which was publiſhed as an anſwer to the Inquiry; and he may read with much advantage to himſelf *A Letter from a parochial biſhop to a prelatical gentleman*, with *An Apology for the church of Scotland*, both written by Mr. Williſon, ſome time miniſter in Dundee, and both evincing conſiderable learning and great ingenuity in their pious author.

As one of the churches at preſent formed upon this model, we will notice the church of Scotland. Her mode of worſhip is ſimple and ſolemn; her eſtabliſhed faith agreeable to the confeſſions of moſt other Proteſtant churches; her judicatories are calculated to maintain the rights of the people; and her paſtors are men of liberal minds. We cannot therefore more properly conclude this article than with a ſhort view of her conſtitution.

No one is ignorant, that from the firſt dawn of reformation in Scotland, till the era of the revolution, there was a perpetual ſtruggle between the court and the people for the eſtabliſhment of an epiſcopal or a preſbyterian form of church government. The former model of eccleſiaſtical polity was patroniſed by the houſe of Stuart on account of the ſupport which it gave to the prerogatives of the crown; the latter was the favourite of the majority of the people, perhaps not ſo much on account of its ſuperior claim to apoſtolical inſtitution, as becauſe the laity are mixed with the clergy in church judicatories, and the two orders, which under epiſcopacy are kept ſo diſtinct, incorporated, as it were, into one body. In the Scottiſh church, every regulation of public worſhip, every act of diſcipline, and every eccleſiaſtical cenſure, which in other churches flows from the authority of a dioceſan biſhop, or from a convocation of the clergy, is the joint work of a certain number of clergymen and laymen acting together with equal authority, and deciding every queſtion by a plurality of voices. The laymen who thus form an eſſential part of the eccleſiaſtical courts of Scotland, are called *ruling elders*; and hold the ſame office, as well as the ſame name, with thoſe brethren who joined with the apoſtles and elders at Jeruſalem in determining the important queſtion concerning the neceſſity of impoſing upon the Gentile converts the ritual obſervances of the law of Moſes. Theſe lay-elders Paul enjoined Timothy to account worthy of double honour, if they ſhould rule well, and diſcharge the duties for which they were ſeparated from the multitude of their brethren. In the church of Scotland every pariſh has two or three of thoſe lay elders, who are grave and ſerious perſons choſen from among the heads of families, of known orthodoxy and ſteady adherence to the worſhip, diſcipline, and government of the church. Being ſolemnly engaged to uſe their utmoſt endeavours for the ſuppreſſion of vice and the cheriſhing of piety and virtue, and to exerciſe diſcipline faithfully and diligently, the miniſter, in the preſence of the congregation, ſets them apart to their office by ſolemn prayer; and concludes the ceremony, which is ſometimes called ordination, with exhorting both elders and people to their reſpective duties.

The kirk-ſeſſion, which is the loweſt eccleſiaſtical judicatory, conſiſts of the miniſter and thoſe elders of the congregation. The miniſter is *ex officio* moderator, but has no negative voice over the deciſion of the ſeſſion; nor indeed has he a right to vote at all, unleſs when the voices of the elders are equal and oppoſite. He may indeed enter his proteſt againſt their ſentence, if he think it improper, and appeal to the judgment of the preſbytery; but this privilege belongs equally to every elder, as well as to every perſon who may believe himſelf aggrieved by the proceedings of the ſeſſion. The deacons, whoſe proper office it is to take care of the poor, may be preſent in every ſeſſion, and offer their counſel on all queſtions that come before it; but, except in what relates to the diſtribution of alms, they have no deciſive vote with the miniſter and elders.

The next judicatory is the *preſbytery*, which conſiſts of all the paſtors within a certain diſtrict, and one ruling elder from each pariſh commiſſioned by his brethren to repreſent, in conjunction with the miniſter, the ſeſſion of that pariſh. The preſbytery treats of ſuch matters as concern the particular churches within its limits; as the examination, admiſſion, ordination, and cenſuring of miniſters; the licenſing of probationers, rebuking of groſs or contumacious ſinners, the directing of the ſentence of excommunication, the deciding upon references and appeals from kirk-ſeſſions, reſolving caſes of conſcience, explaining difficulties in doctrine or diſcipline; and cenſuring, according to the word of God, any hereſy or erroneous doctrine which hath been either publicly or privately maintained within the bounds of its juriſdiction. One part of the conſtitution of the church of Scotland gives an equal vote, in queſtions of hereſy, to an illiterate mechanic and his enlightened paſtor. This has been the ſource of trouble to many a clergyman; who, from the laudable deſire of explaining the ſcriptures and declaring to his flock all the counſel of God, has employed a variety of expreſſions of the ſame import, to illuſtrate thoſe articles of faith which may be obſcurely expreſſed in the eſtabliſhed ſtandards. The fact however is, that, in preſbyteries, the only prerogatives which the paſtors have over the ruling elders, are the power of ordination by impoſition of hands, and the privilege of having the moderator choſen from their body.

From the judgment of the preſbytery there lies an appeal to the provincial ſynod, which ordinarily meets twice in the year, and exerciſes over the preſbyteries within the province a juriſdiction ſimilar to that which is veſted in each preſbytery over the ſeveral kirk-ſeſſions within its bounds. Of theſe ſynods there are in the church of Scotland fifteen, which are compoſed of the members of the ſeveral preſbyteries within the reſpective provinces which give names to the ſynods.

The higheſt authority in the church of Scotland is the general aſſembly, which conſiſts of a certain number of miniſters and ruling elders delegated from each preſbytery, and of commiſſioners from the univerſities and royal boroughs. A preſbytery in which there are fewer than twelve pariſhes, ſends to the general aſſembly two miniſters and one ruling elder: if it contain between 12 and 18 miniſters, it ſends three of theſe, and one ruling elder: if it contain between 18 and 24 miniſters, it ſends four miniſters and two ruling elders; and of 24 miniſters, when it contains ſo many, it ſends five, with two ruling elders. Every royal borough ſends one ruling elder, and Edinburgh two; whoſe election muſt be atteſted by the kirk ſeſſions of their reſpective boroughs. Every univerſity ſends one commiſſioner from its own body. The commiſſioners are choſen annually ſix weeks before the meeting of the aſſembly; and the ruling elders are often men of the firſt eminence in the kingdom for rank and talents. In this aſſembly, which meets once a year, the king preſides by his commiſſioner, who is always a nobleman; but he has no voice in their deliberations. The order of their proceedings is regular, though ſometimes the number of members creates a confuſion, which the moderator, who is choſen from among the miniſters, to be as it were the ſpeaker of the houſe, has not ſufficient authority to prevent. Appeals are brought from all the other eccleſiaſtical courts in Scotland to the general aſſembly; and in queſtions purely religious no appeal lies from its determinations.—In the ſubordination of theſe aſſemblies, parochial, preſbyterial, provincial, and national, the leſs unto the greater, conſiſt the external order, ſtrength, and ſtedfaſtneſs of the church of Scotland.

PRESCIENCE, in theology, previſion, or foreknowledge; that knowledge which God has of things to come.—The doctrine of predeſtination is founded on the preſcience of God, and on the ſuppoſition of all futurity's being preſent to him. See PREDESTINATION.

PRESCRIPTION, in medicine, is the aſſigning a proper and adequate remedy to the diſeaſe from an examination of its ſymptoms, and an acquaintance with the virtues and effects of the materia medica.

PRESCRIPTION, in law, is a title acquired by uſe and time, and allowed by law; as when a man claims any thing, becauſe he, his anceſtors, or they whoſe eſtate he hath, have had or uſed it all the time whereof no memory is to the contrary: or it is where for continuance of time, *ultra memoriam hominis*, a particular perſon hath a particular right againſt another.

There is a difference between preſcription, cuſtom, and uſage. *Preſcription* hath reſpect to a certain perſon, who *by intendment* may have continuance *for ever*; as for inſtance, he and all they *whoſe eſtate he hath* in ſuch a thing, this is a preſcription: but, *Cuſtom* is *local*, and always applied to a *certain* place; as, *time out of mind there has been ſuch a cuſtom in ſuch a place*, &c. And *preſcription* belongeth to *one* or a *few* only; but *cuſtom* is common to *all*. *Uſage* differs from both, for it may be either to *perſons* or *places*; as to *inhabitants of a town to have a way*, &c.

A cuſtom and preſcription are in the *right*; uſage is in the *poſſeſſion*; and a preſcription that is good for the matter and ſubſtance, may be bad by the manner of ſetting it forth: but where that which is claimed *as a cuſtom*, in or for many, will be good, *that* regularly will be ſo when claimed by *preſcription* for one. *Preſcription* is to be *time out of mind*; though it is not the length of time that begets the right of preſcription, nothing being done by time, although every thing is done in time; *but it is a preſumption in law, that a thing cannot continue ſo long quiet, if it was againſt right or injurious to another.*

PRESCRIPTION, in theology, was a kind of argument pleaded by Tertullian and others in the 3d century againſt erroneous doctors. This mode of arguing has been deſpiſed by ſome, both becauſe it has been uſed by Papiſts, and becauſe they think that truth has no need of ſuch a ſupport. But ſurely in diſputed points, if it can be ſhown that any particular doctrine of Chriſtianity was held in the earlieſt ages, even approaching the apoſtolic, it muſt have very conſiderable weight; and indeed that it has ſo, appears from the univerſal appeals of all parties to thoſe early times in ſupport of their particular opinions. Beſides, the thing is in itſelf natural; for, if a man find a variety of opinions in the world upon important paſſages in ſcripture, where ſhall he be ſo apt to get the true ſenſe as from cotemporary writers, or others who lived very near the apoſtolic age? And if ſuch a man ſhall find any doctrine or interpretation to have been univerſally believed in the firſt ages, or, as Vincentius Lirinenſis words it, *ſemper, ubique, et ab omnibus*, he will unqueſtionably be diſpoſed to think ſuch early and univerſal conſent, or ſuch preſcription, of great weight in determining his opinion.

PRESENCE, a term of relation, uſed in oppoſition to abſence, and ſignifying the exiſtence of a perſon in a certain place.

Present *Tenſe*, in grammar, the firſt tenſe of a verb, expreſſing the preſent time, or that ſomething is now performing; as *ſcribo*, I write, or am writing. See Grammar.

PRESENTATION, in eccleſiaſtical law. See Patronage.

Presentation *of the Virgin*, is a feaſt of the Romiſh church, celebrated on the 21ſt of November, in memory of the Holy Virgin's being preſented by her parents in the temple, to be there educated. Emanuel Comnenus, who began to reign in 1143, makes mention of this feaſt in his Conſtitution. Some imagine it to have been eſtabliſhed among the Greeks in the 11th century; and think they ſee evident proofs of it in ſome homilies of George of Nicomedia, who lived in the time of Photius. Its inſtitution in the Weſt is aſcribed to Gregory XI. in 1372. Some think it was inſtituted in memory of the ceremony practiſed among the Jews for their new-born females; correſponding to the circumciſion on the eighth day for males.

Presentation *of our Lady* alſo gives the title to three orders of nuns. The firſt was projected in 1618, by a maid named Joan of Cambray. The habit of the nuns, according to the viſion ſhe pretended to have, was to be a gray gown of natural wool, &c.; but this project was never accompliſhed. The ſecond was eſtabliſhed in France, about the year 1627, by Nicholas Sanguin, biſhop of Senlis; it was approved by Urban VIII. This order never made any great progreſs. The third was eſtabliſhed in 16^4, when Frederic Borromeo, being apoſtolical viſitor in the Valteline, was entreated by ſome devout maids at Morbegno to allow them to live in community in a retired place; which he granted, and erected them into a congregation, under the title of *Congregation of our Lady*. They live under the rule of St. Auguſtine.

PRESENTMENT, in law. See Prosecution. A preſentment, generally taken, is a very comprehenſive term; including not only *preſentments* properly ſo called, but alſo inquiſitions of office, and indictments by a grand jury. A preſentment, properly ſpeaking, is the notice taken by a grand jury of any offence from their own knowledge or obſervation, without any bill of indictment laid before them at the ſuit of the king: As the preſentment of a nuiſance, a libel, and the like; upon which the officer of the court muſt afterwards frame an indictment, before the party preſented can be put to anſwer it. An inquiſition of office is the act of a jury, ſummoned by the proper officer to inquire of matters relating to the crown, upon evidence laid before them. Some of theſe are in themſelves convictions, and cannot afterwards be traverſed or denied; and therefore the inqueſt, or jury, ought to hear all that can be alleged on both ſides. Of this nature are all inquiſitions of *felo de ſe*; of flight in perſons accuſed of felony; of deodands, and the like; and preſentments of petty offences in the ſheriff's tourn or court leet, whereupon the preſiding officer may ſet a fine. Other inquiſitions may be afterwards traverſed and examined; as particularly the coroner's inquiſition of the death of a man, when it finds any one guilty of homicide; for in ſuch caſes the offender ſo preſented muſt be arraigned upon this inquiſition, and may diſpute the truth of it; which brings it to a kind of indictment, the moſt uſual and effectual means of proſecution. See Indictment.

PRESIDENT, Præses, is an officer created or elected to preſide over a company or aſſembly; ſo called in contradiſtinction to the other members, who are termed *reſidents*.

Lord President *of the Council*, is a great officer of the crown, who has precedence next after the lord chancellor and lord treaſurer; as ancient as the time of king John, when he was ſtiled *conſiliarius capitalis*.—His office is to attend on the king, to propoſe buſineſs at the council-table, and to report to the king the ſeveral tranſactions there. See Privy-*Council*.

PRESIDIAL, was a tribunal, or bench of judges, eſtabliſhed (before the Revolution) in the ſeveral conſiderable cities of France, to judge ultimately, or in the laſt reſort, of the ſeveral cauſes brought before them by way of appeal from the ſubaltern judges. The preſidials made one company with the officers of the bailliages and ſeneſchauſſées, where they were eſtabliſhed.

PRESS (Prelum), in the mechanic arts, a machine made of iron or wood, ſerving to ſqueeze or compreſs any body very cloſe. The ordinary preſſes conſiſt of ſix members, or pieces; viz. two flat ſmooth planks; between which the things to be preſſed are laid; two ſcrews, or worms, faſtened to the lower plank, and paſſing through two holes in the upper; and two nuts, in form of an S, ſerving to drive the upper plank, which is moveable, againſt the lower, which is ſtable, and without motion.

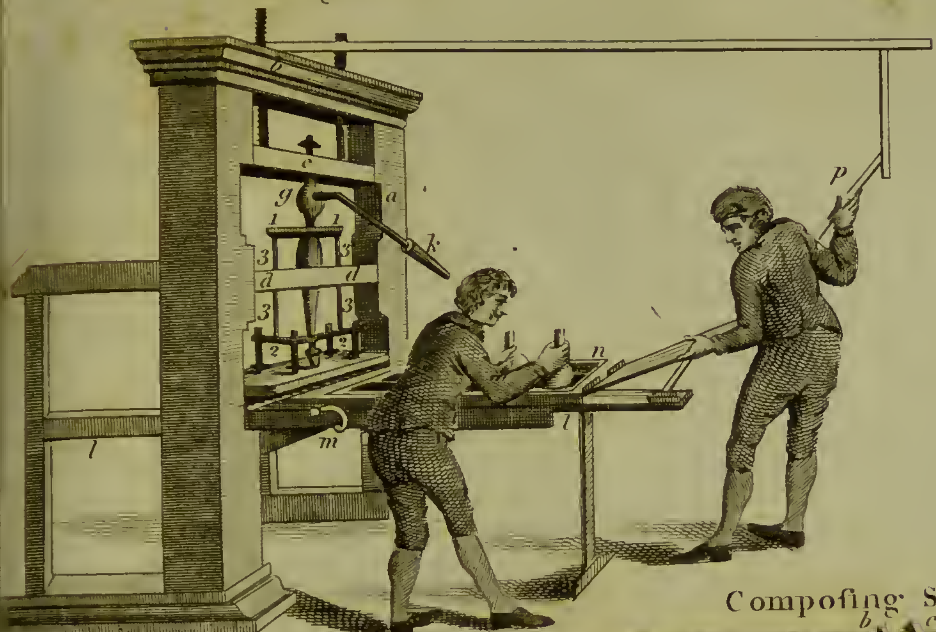
Presses *uſed for expreſſing of Liquors*, are of various kinds; ſome, in moſt reſpects, the ſame with the common preſſes, excepting that the under plank is perforated with a great number of holes, to let the juice expreſſed run through into a tub, or receiver, underneath.

A very uſeful machine for a preſs, in the proceſs of cyder-making, has been lately conſtructed by Mr. Anſtice, who, with his well-known zeal for the improvement of mechanics, permits us to lay before our readers the following deſcription of it. See pl. 20.

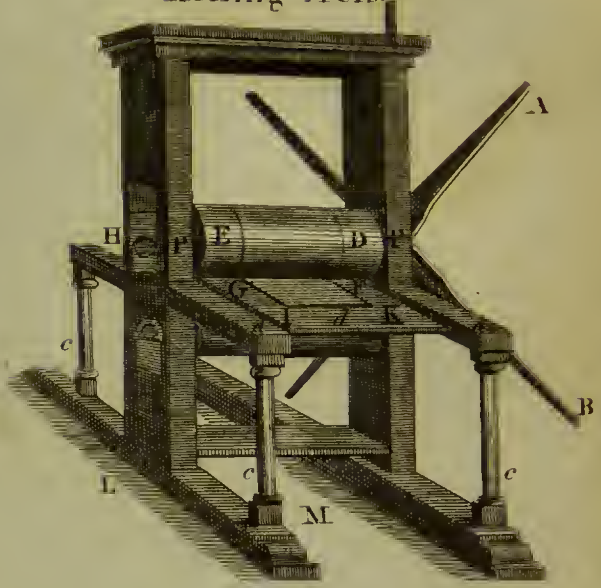
AA, No. 1. two pieces of timber, 21 feet long, 12 by 6 inches, laid ſide by ſide at the diſtance of 12 inches, and ſecured in that ſituation by blocks placed between and bolts paſſing through them; this frame forms the bed of the machine. BB, two uprights, 12 feet long, 6 by 8 inches, morticed upon them, and ſecured in their poſition by pins and iron ſquares. CC, two uprights, five feet long, ſix by 10 inches, morticed near the end of the under frame, and ſecured as before. D, a lever, 17 feet long, 12 by 13 inches, turning on a large bolt which paſſes through the ſhort uprights, alſo through iron ſtraps, which ſecure them to the bed inſide, and a ſtirrup of iron which paſſes over the end of the lever, and which makes the turning point in the line of its lower ſide, and not through its middle. E, a lever 20 feet long, ſix by eight inches at its largeſt part, and tapering towards the other end: this lever turns on a bolt in the uprights BB. F, 1, 2, 3, 4. four pieces of oak (which he calls *needles*, 10 feet long), four inches by two and a half, morticed looſely into the upper lever, and hung thereto by bolts, ſo as to ſwing perpendicularly, and play in a long mortice or channel cut through the large lever to receive them. Theſe needles have inch holes pretty cloſely bored through them (in a direction croſſing the machine), from the lower ends, as far upwards as the great lever will reach, when it is as high as it can go. G, a bed to receive what is to be preſſed. H, a frame to ſupport a winch worked by a handle at I. At the end of the ſmall lever two blocks or pulleys are fixed, one above, and the other below it; a rope of about half an inch diameter is then faſtened to the cieling (or continuation of the uprights of the winch frame if neceſſary) at K; then paſſed through the upper block on the lever, from thence paſſed through a block at L, and then goes with four turns round the winch, from whence it is carried through the block under the lever, and faſtens to the machine at M; by this means, if the winch be

PRESS.

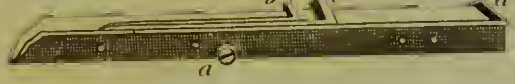
Printing Preſs.



Rolling Preſs.

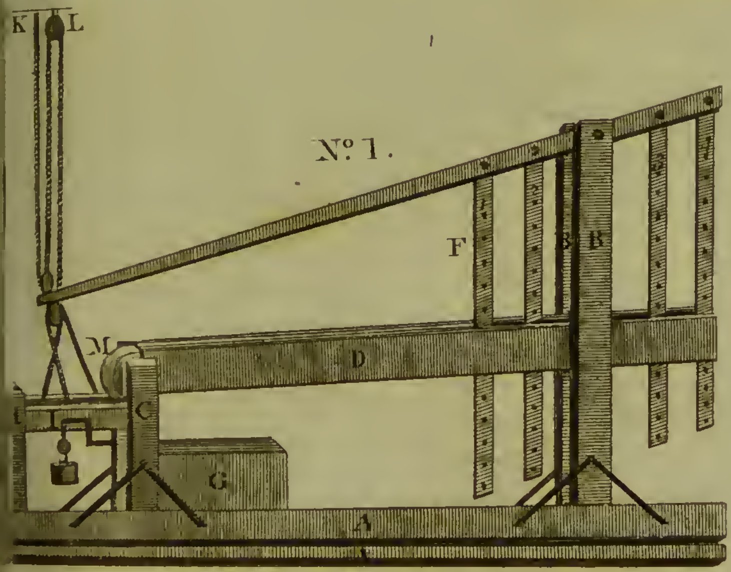


Compoſing Stick.



Cyder Preſs.

No. 1.



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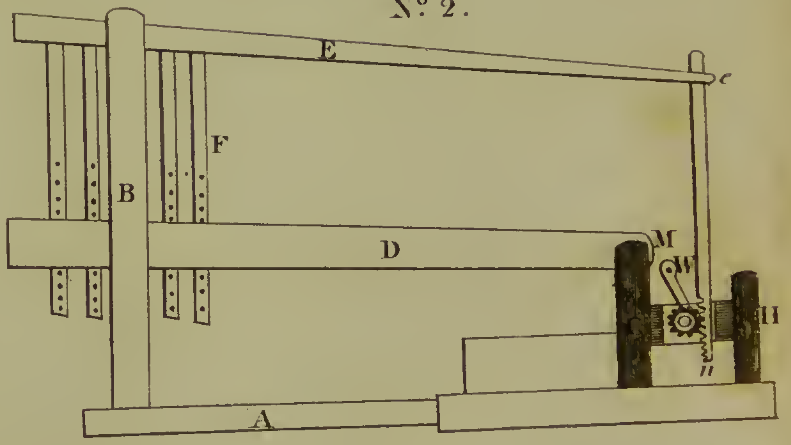


POTASH KILN.

Fig. 1.

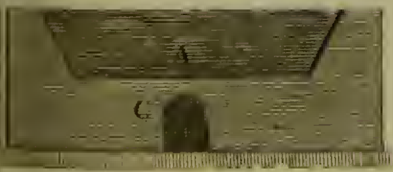


Fig. 4.

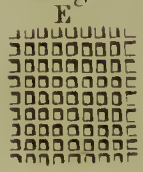


Fig. 5.

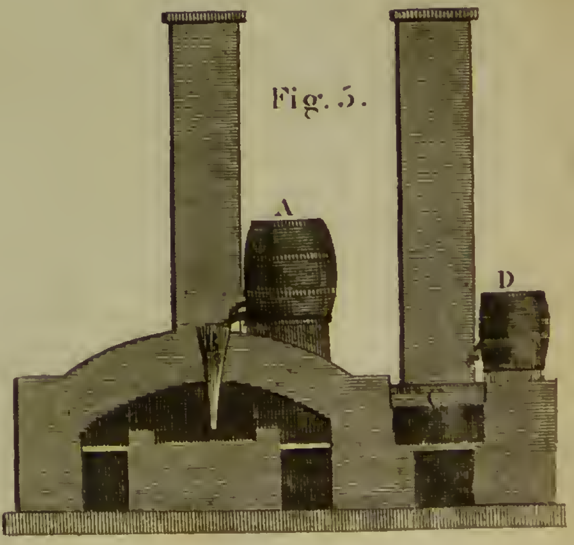


Fig. 2.

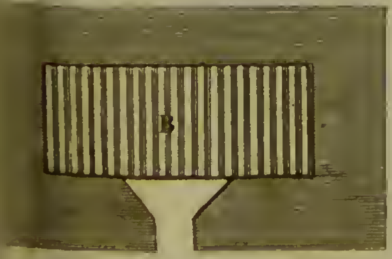
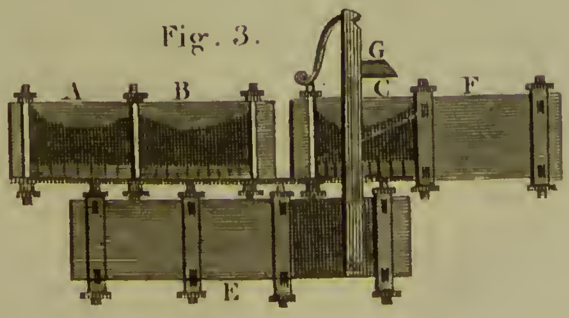


Fig. 3.



turned one way, it raiſes the end of the ſmall lever, if the other, depreſſes it.

To work the machine. If we ſuppoſe the great lever bearing on the matter to be preſſed, an iron pin muſt be put into one of the holes in the needles above the great lever; and when the ſmall lever is worked as far as it will go, either up or down, another bolt is to be put into the hole, which comes neareſt above the great lever on the other ſide of the uprights BB, and the winch then turned the contrary way; by which means the preſſing goes on whether the ſmall lever riſes or falls. Before the reſiſtance is very great, the needles furtheſt from the *fulcrum* of the ſmall lever are uſed; after that the neareſt are employed, which doubles the power of the machine. In raiſing the great lever, or lowering it to its bearing, the needles moſt diſtant from the fulcrum of the ſmall lever are uſed *under* inſtead of *over* it. As the rope is liable to ſtretch and get ſlack, he paſſes it, after taking two turns on the winch, through a pulley, to which is ſuſpended a weight of half a hundred, and then takes two turns more before it is carried through the other block; by which means the ſlack is conſtantly gathered in, and the weight holds on without increaſing the friction, as by hanging under the winch it counteracts the preſſure upwards on its axis.

The power of this machine is very great, being as 1 to 1136 nearly, and capable by a trifling addition of any other proportion. It is applicable to many purpoſes beſide cyder-preſſing, and is more ſimple, and leſs liable to injury, than any other which has fallen under our obſervation. Perhaps, however, it would be an improvement to uſe, inſtead of the ropes and pulleys, by which the lever E is moved, a ſmall wheel or pinion of 10 or 12 teeth, on the axis of the winch W (No. 2), and a ſtiff beam *en* down from the lever, having on its lower end an iron rack, of which the teeth take into thoſe of the pinion. The action of theſe teeth would, in our opinion, be leſs diminiſhed by friction and obliquity, than the pulleys are by friction and the ſtiffneſs of the rope; and the machine would retain all its other advantages.

Press *uſed by Joiners*, to keep cloſe the pieces they have glued, eſpecially panels, &c. of wainſcot, is very ſimple, conſiſting of four members; viz. two ſcrews, and two pieces of wood, four or five inches ſquare, and two or three feet long; whereof the holes at the two ends ſerve for nuts to the ſcrews.

Press *uſed by Inlayers*, reſembles the joiner's preſs, except that the pieces of wood are thicker, and that only one of them is moveable; the other, which is in form of a treſſel, being ſuſtained by two legs or pillars, jointed into it at each end. This preſs ſerves them for ſawing and cleaving the pieces of wood required in marquetry or inlaid work.

Founder's Press, is a ſtrong ſquare frame, conſiſting of four pieces of wood firmly joined together with tenons &c. This preſs is of various ſizes, according to the ſizes of the moulds; two of them are required to each mould, at the two extremes whereof they are placed; ſo as that, by driving wooden wedges between the mould and the ſides of the preſſes, the two parts of the mould wherein the metal is to be run may be preſſed cloſe together.

Printing-Press. See Printing-*Preſs*.

Rolling Press, is a machine uſed for the taking off prints from copper plates. It is much leſs complex than that of the letter printers. See its deſcription and uſe under the article *Rolling preſs* Printing.

Press, in *Coining*, is one of the machines uſed in ſtriking of money; differing from the balance, in that it has only one iron bar to give it motion, and preſs the moulds or coins; is not charged with lead at its extreme, nor drawn by cordage. See Coining.

Binder's Cutting-Press, is a machine uſed equally by bookbinders, ſtationers, and paſteboard-makers; conſiſting of two large pieces of wood, in form of cheeks, connected by two ſtrong wooden ſcrews; which, being turned by an iron bar, draw together, or ſet aſunder, the cheeks, as much as is neceſſary for the putting in the books or paper to be cut. The cheeks are placed lengthwiſe on a wooden ſtand, in the form of a cheſt, into which the cuttings fall. Aſide of the cheeks are two pieces of wood, of the ſame length with the ſcrews, ſerving to direct the cheeks, and prevent their opening unequally. Upon the cheeks the plough moves, to which the cutting-knife is faſtened by a ſcrew; which has its key, to diſmount it, on occaſion, to be ſharpened.

The plough conſiſts of ſeveral parts; among the reſt a wooden ſcrew or worm, which, catching within the nuts of the two feet that ſuſtain it on the cheeks, brings the knife to the book or paper which is faſtened in the preſs between two boards. This ſcrew, which is pretty long, has two directories, which reſemble thoſe of the ſcrews of the preſs. To make the plough ſlide ſquare and even on the cheeks, ſo that the knife may make an equal paring, that foot of the plough where the knife is not fixed, ſlides in a kind of groove, faſtened along one of the cheeks. Laſtly, the knife is a piece of ſteel, ſix or ſeven inches long, flat, thin, and ſharp, terminating at one end in a point, like that of a ſword, and at the other in a ſquare form, which ſerves to faſten it to the plough. See Book-*Binding*.

As the long knives uſed by us in the cutting of books or papers are apt to jump in the cutting thick books, the Dutch are ſaid to uſe circular knives, with an edge all round; which not only cut more ſteadily, but laſt longer without grinding.

Press, in the *Woollen Manufactory*, is a large wooden machine, ſerving to preſs cloths, ſerges, rateens, &c. thereby to render them ſmooth and even, and to give them a gloſs. This machine conſiſts of ſeveral members; the principal whereof are the cheeks, the nut, and the worm or ſcrew, accompanied with its bar, which ſerves to turn it round, and make it deſcend perpendicularly on the middle of a thick wooden plank, under which the ſtuffs to be preſſed are placed. The calender is alſo a kind of preſs, ſerving to preſs or calender linens, ſilks, &c.

Liberty of the Press. See Liberty *of the Preſs*.

PRESSING, in the manufactures, is the violently ſqueezing a cloth, ſtuff, &c. to render it ſmooth and gloſſy. There are two methods of preſſing, viz. cold and hot. As to the former, or *cold* preſſing: After the ſtuff has been ſcoured, fulled, and ſhorn, it is folded ſquare in equal plaits, and a ſkin of vellum or paſteboard put between each plait. Over the whole is laid a ſquare wooden plank, and ſo put into the preſs, which is ſcrewed down tight by means of a lever. After it has lain a ſufficient time in the preſs, they take it out, removing the paſteboards, and lay it up to keep. Some only lay the ſtuff on a firm table after plaiting and paſteboarding, cover the whole with a wooden plank, and load it with a proper weight.

The method of preſſing *hot* is this: When the ſtuff has received the above preparations, it is ſprinkled a little with water, ſometimes gum-water; then plaited equally, and between each two plaits are put leaves of paſteboard; and between every ſixth and ſeventh plait, as well as over the whole, an iron or braſs plate well heated in a kind of furnace. This done, it is laid upon the preſs, and forcibly ſcrewed down. Under this preſs are laid five, ſix, &c. pieces at the ſame time, all furniſhed with their paſteboards and iron-plates. When the plates are well cooled, the ſtuffs are taken out and ſtitched a little together to keep them in the plaits. This manner of preſſing was only invented to cover the defects of the ſtuffs; and, accordingly, it has been frequently prohibited.

Pressing, or *Impreſſing*. See Impressing.

PRESSION, or Pressure, in the Carteſian philoſophy, is a ſuppoſed impulſive kind of motion, or rather an endeavour to move, impreſſed on a fluid medium, and propagated through it.

PRESSURE of air. See Pneumatics.

Pressure *of Fluids*. See Hydrostatics and Pneumatics.

PREST, is uſed for a duty in money, to be paid by the ſheriff on his account, in the exchequer, or for money left or remaining in his hands: 2 & 3 Edw. VI. c. 4.

Prest-*Money*, is ſo called from the French word *preſt*, that is, *promptus expeditus*; for that it binds thoſe who receive it, to be ready at all times appointed, being commonly meant of ſoldiers.

PRESTATION-money, is a ſum of money paid yearly by archdeacons and other dignitaries to their biſhop, *pro exteriori juriſdictione.*

Prestation *(præſtatio)*, was anciently uſed for other payments: *Et quieti ſint de præſtatione muragii.* Chart. Hen. VII. Sometimes alſo for pourveyance.

PRESTEIGN is a town of Radnorſhire, diſtant 149 miles weſt-north-weſt from London, in the direct road to Aberyſtwith, and throughout South Wales, in N. lat. 52° 12′, bounded to the north and north-eaſt by Herefordſhire. It is a neat well built town, with clean and regular ſtreets, and is the reſidence of many genteel families. The neighbourhood abounds with all the comforts and conveniencies of life. It is ſeated on a gravelly ſoil on the banks of the river Lug, and at the head of a very fertile vale; the mountains to the weſt and north-weſt of the town forming, as it were, an amphitheatre round it. The name of it in Welſh is *Slan-Andras*, which is ſuppoſed to be derived from the church, which is dedicated to Saint Andrew. The town is divided into four wards, which have each a ſeparate juriſdiction, ſeparate officers, levies, &c. The curfew-bell of William the Conqueror ſtill remains in this place, and is rung every night. It is a borough by preſcription, and is governed by a bailiff annually elected, and ſworn in by a ſteward appointed by the crown. The living is a rectory and vicarage united, and reported to be worth from 500l. to 600l. *per annum*; the pariſh lying in two counties. Here is an excellent free ſchool well endowed. The county hall, the county gaol, the county bridewell, and houſe of correction, are kept in this place. The markets are held on Saturdays; and there are two fairs in the year. About a century and a half ago Preſteign was conſiderably larger; had a good woollen manufactory, of which the very large buildings now ſtanding (formerly belonging to clothiers) bear ample teſtimony; but a fire, ſucceeded by the plague, in the town, about the year 1636, reduced the ſame, and, with it, its conſequence as a manufacturing town. The healthineſs of its ſituation cannot be better aſcertained than by the regiſter of births and burials. The pariſh embraces at leaſt a circle of 19 miles; and the average of burials for the laſt ſeven years was only 26 perſons *per annum*, and that of births for the ſame time was 42; and of the former upwards of 18 were from 80 to 100 years old.

PRESTER (John, or Jean), an appellation formerly given to an emperor of the Tartars, who was overcome and killed by Jenghiz Khan. Since that time it has been given to the emperor of Abyſſinia or Ethiopia: however, in Ethiopia itſelf this name is utterly unknown, the emperor being there called the *grand negus*.

Prester, a meteor, conſiſting of an exhalation thrown from the clouds downwards with ſuch violence, as that by the colliſion it is ſet on fire. The word is Greek, πρηστηρ, the name of a kind of ſerpent; called alſo *dipſas*, to which this meteor is ſuppoſed to bear a reſemblance. The preſter differs from the thunderbolt in the manner of its inflammation; and in its burning and breaking every thing it touches with greater violence.

Prester, a word uſed by ſome to expreſs the external part of the neck, which is uſually inflated in anger.

PRESTIMONY, in canon law, is derived *a præſtatione quotidiana*; and is, by ſome, defined to be a kind of benefice, ſerved by a ſingle prieſt. Others ſay, it is the incumbency of a chapel, without any title or collation; ſuch as are moſt of thoſe in caſtles, where prayers or maſs are ſaid; and which are mere unendowed oratories. Whence the term is alſo applied, in the Romiſh church, to certain perpetual offices beſtowed on canons, religious, or others, for the ſaying of maſſes, by way of augmentation of their livings. Others think it is a leaſe, or conceſſion of any eccleſiaſtical fund or revenue, belonging to a monaſtery, to be enjoyed during life. Du Moulin calls it a *profane benefice*, which however, has a perpetual title, and an eccleſiaſtical office, with certain revenues attached to it; which the incumbent is allowed to ſell, and which may be poſſeſſed without tonſure; ſuch as the lay church wardens of Notre dame. He adds, that, in propriety, the canonries of chapels are benefices of this nature. The moſt probable opinion ſeems to be, that preſtimony is a fund, or revenue, appropriated by the founder for the ſubſiſtence of a prieſt, without being erected into any title of benefice, chapel, prebend, or priory; and which is not ſubject either to the pope or to the ordinary, but whereof the patron, and thoſe who have a right from him, are the collators, and nominate and confer *pleno jure.*

PRESTO, in the Italian muſic, intimates to perform quick; as *preſtiſſimo* does extremely quick.

PRESTON, a conſiderable town of Lancaſhire, ſeated on the river Ribble, over which there is a handſome ſtone bridge. Here is held a court of chancery, and other offices of juſtice for the county palatine of Lancaſter. It is noted for the defeat of the rebels here in 1715, when they were all made priſoners, and ſent up to London. W. lon. 2. 26. N. lat. 53. 45.

PRESTRE. See Vauban.

PRETENSED or pretended right, in law, is where one is in poſſeſſion of lands and tenements, which another, who is out, claims and ſues for. Here the pretenſed right is in him who ſo claims or ſues.

PRETERITE, in grammar, a tenſe which expreſſes the time paſt, or an action completely finiſhed; as, *Scripſi*, "I have written." See Perfect and Grammar.

PRETERITION, or pretermission, in rhetoric, a figure whereby, in pretending to paſs over a thing untouched, we make a ſummary mention thereof. *I will not ſay he is valiant, he is learned, he is juſt*, &c. The moſt artful praiſes are thoſe given by way of preterition. See Oratory.

PRETEXT, a colour or motive, whether real or feigned, for doing ſomething.

Toga PRETEXTA, among the ancient Romans, a long white gown, with a border of purple round the edges, and worn by children of quality till the age of puberty, *viz.* by the boys till 17, when they changed it for the *toga virilis*: and by the girls till marriage.

PRETIUM sepulchri, in old law books, &c. thoſe goods accruing to the church wherein a corpſe is buried. In the Iriſh canons, lib. xix. cap. 6. it is ordered, that along with every body that is buried, there go his cow, horſe, apparel, and the furniture of his bed; none of which may be diſpoſed of otherwiſe than for the payment of debts, &c. as being familiars and domeſtics of the deceaſed.

PRETOR, a magiſtrate among the ancient Romans, not unlike our lord chief juſtices, or lord chancellor, or both in one; as being veſted with the power of diſtributing juſtice among the citizens. At firſt there was only one pretor; but afterwards, another being created, the firſt or chief one had the title of *prætor urbanus*, or the "city pretor:" the other was called *peregrinus*, as being judge in all matters relating to foreigners. But, beſides theſe, there were afterwards created many provincial pretors; who were not only judges, but alſo aſſiſted the conſuls in the government of the provinces, and even were inveſted with the government of provinces themſelves.

PRETORIAN GUARDS, in Roman antiquity, were the emperor's guards, who at length were increaſed to 10,000: they had this denomination, according to ſome, from their being ſtationed at a place called *Prætorium*: their commander was ſtyled *præfectus prætorii*.

PRETORIUM, or PRÆTORIUM, among the Romans, denoted the hall or court wherein the pretor lived, and wherein he adminiſtered juſtice. It likewiſe denoted the tent of the Roman general, wherein councils of war, &c. were held: alſo a place in Rome where the Pretorian guards were lodged.

PREVARICATION, in the civil law, is where the informer colludes with the defendants, and ſo makes only a ſham proſecution.

PREVARICATION, in our laws, is when a man falſely ſeems to undertake a thing, with intention that he may deſtroy it; where a lawyer pleads booty, or acts by colluſion, &c. It alſo denotes a ſecret abuſe committed in the exerciſe of a public office, or of a commiſſion given by a private perſon.

PRIAM, king of Troy, was the ſon of Laomedon. He was carried into Greece after the taking of that city by Hercules; but was afterwards ranſomed, on which he obtained the name of *Priam*, a Greek word ſignifying "ranſomed." At his return he rebuilt Ilium, and extended the bounds of the kingdom of Troy, which became very flouriſhing under his reign. He married Hecuba, the daughter of Ciſſeus king of Thrace, by whom he had 19 children; and among the reſt Paris, who carried off Helen, and occaſioned the ruin of Troy, which is ſuppoſed to have been ſacked by the Greeks about 1184 B. C. when Priam was killed by Pyrrhus the ſon of Achilles at the foot of an altar where he had taken refuge, after a reign of 52 years. See TROY.

PRIAPISMUS, or PRIAPISM, is an erection of the penis without any concomitant pain, or the conſent of other parts. It is thus called, becauſe the perſon in this ſtate reſembles the lewd god Priapus. Cœlius Aurelianus ſays it is a palſy of the ſeminal veſſels and other nerves diſtributed to the parts about the penis, by the diſtenſion of which this diſorder is produced. It is of the ſame nature as the ſatyriaſis.

PRIAPUS, in Pagan worſhip, the ſon of Bacchus and Venus, who preſided over gardens and the moſt indecent actions. He was particularly adored at Lampſacus, a city at the mouth of the Helleſpont, ſaid to be the place of his birth; and his image was placed in gardens to defend them from thieves and birds deſtructive to fruit. He was uſually repreſented naked, with a ſtern countenance, matted hair, and holding either a wooden ſword or ſickle in his hand, and with a monſtrous privity; from whence downward his body ended in a ſhapeleſs trunk. The ſacrifice offered to this obſcene deity was the aſs; either on account of the natural uncomelineſs of this animal, and its propenſity to venery, or from the diſappointment which Priapus met with on his attempting the chaſtity of Veſta, while that goddeſs was aſleep, when ſhe eſcaped the injury deſigned her by her being awaked by the braying of old Silenus's aſs.

PRICE (Rev. RICHARD), D. D. LL. D. Fellow of the Royal Society of London, and of the Academy of Sciences, New England, was born at Tynton in Glamorganſhire, February 22, 1723. His father was a diſſenting miniſter at Bridgend in that county, and died in 1739. At eight years old he was placed under a Mr. Simmons of Neath; and in four years removed to Pentwyn in Caermarthenſhire under the Rev. Samuel Jones, whom he repreſented as a man of a very enlarged mind, and who firſt inſpired him with liberal ſentiments of religion. Having lived as long with him as with Mr. Simmons, he was ſent to Mr. Griffith's academy at Talgarth in Breconſhire. In 1740 he loſt his mother; and on this he quitted the academy and came to London. Here he was ſettled at that academy of which Mr. Eames was the principal tutor, under the patronage of his uncle the Rev. S. Price, who was co-paſtor with Dr. Watts upwards of 40 years. At the end of four years he left this academy, and reſided with Mr. Streatfield of Stoke Newington in the quality of domeſtic chaplain, while at the ſame time he regularly aſſiſted Dr. Chandler at the Old Jewry, and occaſionally aſſiſted others. Having lived with Mr. Streatfield near 13 years, on his death and his uncle's he was induced to change his ſituation, and in 1757 married Miſs S. Blundell of Leiceſterſhire. He then ſettled at Hackney; but being ſhortly after choſen miniſter at Newington Green, he lived there until the death of his wife, which was in 1786, when he returned to Hackney. He was next choſen afternoon-preacher at the meeting-houſe in Poor Jewry-ſtreet; but this he reſigned on being elected paſtor of the Gravel-pit meeting, Hackney, and afternoon-preacher at Newington Green. Theſe he reſigned with a farewell-ſermon in February 1791. Shortly after he was attacked with a nervous fever; which diſappearing was ſucceeded by a diſorder in his bladder, which reduced him to ſuch a degree that, worn out with agony and diſeaſe, he died without a groan on the 19th of April 1791. He left his property to a ſiſter and two nephews.

Dr. Kippis, ſpeaking of his learning and purſuits, obſerves, that "his chief aim was to lay a foundation for ſolid knowledge, by an application to ſciences of the nobleſt kind. It was on the great and fundamental principles and obligations of morality, on the higher ſpecies of mathematics, on the ſublimer parts of natural philoſophy, on the true baſis of government, and on the queſtions which relate to the eſſential welfare and dignity of man, that his ſtudies were employed; and in the proſecution of theſe ſtudies he not only enriched his own mind, but was enabled to become of eminent ſervice to his country and to the world. In his moral writings he has laboured with diſtinguiſhed ability to build the ſcience of ethics on an immutable baſis; and what he has advanced will always ſtand high in eſtimation, as one of the ſtrongeſt efforts of human reaſon in favour of the ſyſtem he has adopted. For myſelf (adds Dr. Kippis), I ſcruple not to ſay, that I regard the treatiſe referred to as a rich treaſure of valuable information, and as deſerving to be ranked among the firſt productions of its kind. With reſpect to his other ethical works, every one muſt admire the zeal, earneſtneſs, and ſtrength, with which he endeavours to lead men into pious views of God, of providence and prayer; and to promote the exerciſe of devout and amiable diſpoſitions. In conſequence of his profound knowledge in mathematical calculations, he was qualified at a particular criſis for being of ſingular utility to his fellow-citizens. A number of ſchemes for inſurance for lives, and the benefit of ſurvivorſhip, promiſing mighty advantages, were riſing up in the metropolis. Theſe ruinous ſchemes would have been carried to great exceſs, had not Dr. Price ſtepped forward and diſpelled the deluſion. Gratitude will not allow us to forget the ability and ſpirit with which he awakened the attention of his countrymen to the reduction of the national debt. With him it was that the ſcheme of the preſent miniſter for that purpoſe is underſtood to have originated. What crowned the whole of his character was, its being an aſſemblage of the moſt amiable and excellent private virtues. His piety was ſincere, humble, and fervent; his ſoul pure and elevated. In his views diſintereſted and noble, and in his manners mild and gentle, the applauſe of his talents and virtues will be tranſmitted to future ages, and he will be united in the catalogue with the moſt eminent benefactors of mankind."

This is the panegyric of a friend; but with few abatements it will be admitted by every candid reader. In morals Dr. Price's principles were thoſe of Cudworth and Clarke; and by many who have themſelves adopted a very different theory, he is allowed to have defended thoſe principles with greater ability than any other writer in the Engliſh language (ſee Moral *Philoſophy*). In metaphyſics he was perhaps too great an admirer of Plato, from whom he has borrowed a doctrine concerning ideas which we confeſs ourſelves unable to comprehend. He was a firm believer in the immateriality of the ſoul; but, with Dr. Law, the late learned biſhop of Carliſle, he thought, that from death to the reſurrection of the body it remains in a dormant or quieſcent ſtate. He contended for its indiviſibility, but maintained at the ſame time its extenſion; which furniſhed Dr. Prieſtley with ſome advantages in their celebrated controverſy, which his own acuteneſs would never have obtained. In propagating his political principles, which were republican, he ſometimes expreſſed himſelf with undue vehemence; and he was a zealous enemy to all religious eſtabliſhments, which, in his opinion, encroach upon that liberty wherewith Chriſt has made us free. His faith reſpecting the Son of God was what has been called ſometimes *low Arianiſm* and ſometimes *Semi-arianiſm*. From a very early age he claimed the privilege of thinking for himſelf on every ſubject. His father was a rigid Calviniſt, and ſpared no pains to inſtil his own theological dogmas into the tender mind of his ſon; but young Richard would often ſtart his doubts and difficulties, and ſometimes incur the old man's diſpleaſure by arguing againſt his favourite ſyſtem with an ingenuity that perplexed, and a ſolidity that could not be eaſily overturned. He had once the misfortune to be caught reading a volume of Clarke's ſermons, which his father in great wrath ſnatched from him and threw into the fire. Perhaps he could not have taken a more effectual method to make the book a favourite, or to excite the young man's curioſity after the other works of the ſame author; and it is by no means improbable that this orthodox bigotry contributed more than any other circumſtance to lay the foundation of his ſon's Arianiſm.

But whatever may be thought of Dr. Price's ſpeculative opinions, whether political or religious, his virtues in private life have never been called in queſtion. Of his practical religion it is impoſſible to ſpeak in terms too high. There was a fervour even in his public prayers which indicated the ſtrongeſt ſenſibility as well as ſincerity in himſelf, and communicated its warmth to thoſe who joined with him. But in his family devotions he gave ſtill fuller ſcope to the pious emotions of his ſoul, and proved to thoſe friends who were occaſionally preſent at them how deeply he felt religious impreſſions, and how happily he blended in this as well as in other things the cool deciſions of the underſtanding with the amiable and exalted ſenſibilities of the heart.

But it was not in devotion only that theſe ſenſibilities were diſplayed. He was as exemplary in affection to his relatives as in love to his Maker. Of this he gave a ſtriking though private inſtance before he firſt quitted his native place to try his fortune in London. His father had left to an elder brother by a former marriage a very conſiderable fortune; to Richard he left a mere trifle; and to each of two ſiſters ſtill leſs. Our author divided his ſhare between his ſiſters, reſerving to himſelf only a few pounds to defray the expences of his journey, and truſting for his future ſupport to the bleſſing of God upon his talents and his induſtry. As in early life he was an affectionate and generous brother, in old age he was a loving and attentive huſband. His wife, who for a conſiderable time before her death was almoſt wholly helpleſs, found during the laſt years of her life hardly any enjoyment except in a game at whiſt; and though our Doctor diſliked cards as a waſte of time, and never touched them on any other occaſion, to amuſe her he would ſit down every evening to the card-table, and play till it was late, with a cheerfulneſs and good humour which charmed every perſon who had the happineſs of viewing him in that endearing ſituation.

Yet, though thus attentive to the obligations of domeſtic life, he did not ſuffer his private affections to encroach upon his ſocial duties. His talents and his labours were ever ready at the call of friendſhip; nay, ſo much did his nature abound with the milk of human kindneſs, that he could not reſiſt without extreme reluctance even troubleſome and unreaſonable ſolicitations. His hours of ſtudy and retirement were frequently broken in upon by applications for aſſiſtance and advice, eſpecially in matters relating to annuities and life-inſurances; and in this way he ſacrificed much of his perſonal convenience to individuals of whom he knew but little, and from whom he would accept of no pecuniary recompenſe. His good nature in this reſpect amounted almoſt to a foible; and ſubjected him to importunities and loſs of time, of which he would ſometimes complain as interfering materially with more important and more generally uſeful ſtudies.

Whilſt he thus obliged the rich by his mental talents, he ſuccoured the poor with his earthly ſubſtance. A fifth part of his annual income was regularly devoted to charitable purpoſes; and he was laudably anxious to diſtribute it in ſuch a way as might produce the greateſt good. In the practice of this, and indeed of all his virtues, he was utterly devoid of oſtentation. Simplicity and humility were among the ſtrong features of his character. No man was ever leſs ſenſible of his own excellence, or leſs elated by his own celebrity; and in no man was the dignity of artleſs manners and unaffected modeſty more happily diſplayed.

His face was the true index of his mind. It beamed with philanthropy, and, when lighted up in converſation with his friends, aſſumed an aſpect peculiarly pleaſing. His perſon was ſlender, and rather below the common ſize, but poſſeſſed of great muſcular ſtrength and remarkable activity. A habit of deep thought had given a ſtoop to his figure, and he generally walked a briſk pace with his eyes on the ground, his coat buttoned, one hand in his pocket, and the other ſwinging by his ſide.

It is natural to ſuppoſe that ſuch a man as Dr. Price, ſome of whoſe writings were tranſlated into foreign languages, would be very generally reſpected in the republic of letters, and have many correſpondents. The ſuppoſition is well founded. In 1763 or 1764 he was choſen a fellow of the Royal Society, and contributed largely to the Tranſactions of that learned body; in 1769 he received from Aberdeen a diploma creating him D.D.; and in 1783 the degree of LL.D. was conferred upon him by the college of Yale in Connecticut. As in 1770 he had refuſed an American degree which had been conveyed to him by Dr. Franklin, his acceptance of one 13 years afterwards can be attributed only to his extravagant attachment to a republican form of government; which was the greateſt defect in his character, and ſhows what prejudices the moſt vigorous mind will imbibe by thinking always on the ſame ſubjects, and in the ſame track. Among his correſpondents, the moſt eminent in his own country were the late lord Chatham, lord Stanhope, lord Lanſdowne, the late biſhops of Carliſle and St. Aſaph, and the preſent biſhop of Landaff; Mr. Hume, Mr. Harris of Saliſbury, Dr. Gregory of Edinburgh, and the celebrated Mr. Howard, who lived with him on terms of the greateſt intimacy; in America he correſponded with Dr. Franklin, Dr. Chauncey, Mr. Adams, and others; and in France with the celebrated Turgot, the duke de Rochefoucault, and ſeveral of the firſt national aſſembly. One of his female correſpondents ſketched his character with great juſtneſs many years ago under the fictitious but well applied name of *Simplicius;* and with this character we ſhall cloſe theſe memoirs.

“While the vain man is painfully ſtriving to outſhine the company and to attract the admiration by falſe wit, forced compliments, and ſtudied graces, he muſt ſurely be mortified to obſerve how conſtantly Simplicius engages their attention, reſpect, and complacency, without having once thought of himſelf as a perſon of any conſequence among them. Simplicius imparts his ſuperior knowledge, when called upon, as eaſily and naturally as he would tell you what it is o'clock; and with the ſame readineſs and good will informs the moſt ignorant or confers with the moſt learned. He is as willing to receive information as to give it, and to join the company, as far as he is able, in the moſt trifling converſation into which they may happen to fall, as in the moſt ſerious and ſublime. If he diſputes, it is with as much candour on the moſt important and intereſting as on the moſt inſignificant ſubjects; and he is not leſs patient in hearing than in anſwering his antagoniſt. If you talk to him of himſelf or his works, he accepts praiſe or acknowledges defects with equal meekneſs, and it is impoſſible to ſuſpect him of affectation in either. We are more obliged by the plain unexaggerated expreſſions of his regard, than by the compliments and attention of the moſt accompliſhed pattern of high breeding; becauſe his benevolence and ſincerity are ſo ſtrongly marked in every look, word, and action, that we are convinced his civilities are offered for our ſakes, not for his own, and are the natural effects of real kindneſs, not the ſtudied ornaments of behaviour. Every one is deſirous to ſhow him kindneſs in return, which we know will be accepted juſt as it is meant. All are ready to pay him that deference which he does not deſire, and to give him credit for more than he aſſumes, or even more than he poſſeſſes. With a perſon ungraceful, and with manners unpoliſhed by the world, his behaviour is always proper, eaſy and reſpectable; as free from conſtraint and ſervility in the higheſt company, as from haughtineſs and inſolence in the loweſt. His dignity ariſes from his humility; and the ſweetneſs, gentleneſs, and frankneſs of his manners, from the real goodneſs and rectitude of his heart, which lies open to inſpection in all the fearleſſneſs of truth, without any need of diſguiſe or ornament."

Such was Dr. Price.—Of his public principles men will think differently; of his private worth there can be but one opinion. He will live in the memory of his friends till memory has loſt her power. To poſterity his works will be his monument. They are: A Review of the principal Queſtions and Difficulties in Morals, 8vo. 1758; Diſſertations on Providence, &c. 8vo. 1767; Obſervations on Reverſionary Payments, &c. 8vo. 1771; Appeal on the National Debt, &c. 8vo. 1773; Obſervations on the Nature of Civil Liberty, 1776; on Materialiſm and Neceſſity, in a correſpondence between Dr. Price and Dr. Prieſtley, 1779; on Annuities, Aſſurances, Population, &c. 8vo. 1779; on the Population of England, 1780; on the Public Debts, Finances, Loans, &c. 8vo. 1783; on Reverſionary Payments, 2 vols. 1783; on the Importance of the American Revolution, 1784: beſides Sermons, and a variety of papers in the Philoſophical Tranſactions on aſtronomical and other philoſophical ſubjects.

PRIDE, inordinate and unreaſonable ſelf-eſteem, attended with inſolence and rude treatment of others. It is frequently confounded with vanity, and ſometimes with dignity; but to the former paſſion it has no reſemblance, and in many circumſtances it differs from the latter. Vanity is the parent of loquacious boaſting; and the perſon ſubject to it, if his pretences be admitted, has no inclination to inſult the company. The proud man, on the other hand, is naturally ſilent, and, wrapt up in his own importance, he ſeldom ſpeaks but to make his audience feel their inferiority. It is this circumſtance which diſtinguiſhes pride from dignity, and conſtitutes its ſinfulneſs. Every man poſſeſſed of great powers of mind is conſcious of them, and feels that he holds a higher rank in the ſcale of exiſtence than he whoſe powers are leſs. If he recollect, at the ſame time, that he has nothing which he did not receive, and that his ſuperiority is owing to the good pleaſure of him who forms his creatures differently, as the potter forms his clay; he will be ſo far from inſulting his inferiors, that, when neceſſarily in company with them, he will bear with their foibles, and, as far as is proper, make them loſe ſight of the diſtance which the laws of God and man have for ever placed between them and him. This condeſcenſion, however, if he be a man of dignity, will never lead him to join with them in any mean or dirty action. He will even excuſe in them many things which he would condemn in himſelf. and give them his good wiſhes, after they have forfeited his eſteem. Such a character is amiable and reſpectable, and what every man ſhould labour to obtain. From the weakneſs of human nature, however, it is too apt to degenerate into pride.

To a man of great intellectual powers and various erudition, the converſation of ordinary perſons affords neither inſtruction nor amuſement; and ſuch converſation, when often repeated, muſt, from the nature of things, become tedious and irkſome. But it requires great command of temper and of manners to prevent uneaſineſs long felt from ſometimes betraying itſelf by external ſymptoms, ſuch as peeviſh expreſſions, a forbidding look, or abſence of mind; and theſe are the infallible indications of contempt for the company, the very worſt ingredient in the paſſion of pride. If this contempt be often excited, it will be formed into a habit; and the proud man will be ſo much under its influence, as to inſult his inferiors, and ſometimes his equals, without forming the reſolution to inſult either the one or the other. Such a character is hateful to every company, and is ſo far from indicating true dignity of mind in him to whom it belongs, that it is obviouſly aſſociated with meanneſs, and indicates a conſciouſneſs of ſome radical defect. He who poſſeſſes real and conſpicuous merit has no occaſion to depreſs others for the purpoſe of raiſing himſelf; his ſuperiority will be cheerfully acknowledged: but when a man of undoubted eminence in one reſpect, is ſo ſwollen with pride as to make him wiſh to appear great in all reſpects, he has no other means of enforcing his ill-founded claim, than diſplaying his acknowledged ſuperiority, with ſuch inſolence as may drive at a diſtance from him every perſon by whom he is conſcious that in many inſtances he might be more than rivalled. Whoever is proud of knowledge, would do well to conſider how much knowledge he wants.

The ſame obſervations which we have made on pride of parts will apply to every other ſpecies of pride, ſuch as pride of birth, office, or riches, &c. The peace and order of ſociety require difference of rank, accompanied with different degrees of authority; and he who inherits a title or office from his anceſtors, may without pride be conſcious of his ſuperiority, provided he forget not that ſuch ſuperiority is conferred on families and individuals, not for their own ſakes, but for the good of the community. The peer who keeps this circumſtance in mind may maintain his ſtation, and repreſs the forward petulance of the plebeian, without giving offence to any thinking man; but if he dwell upon his rank with too much complacency, he will in proceſs of time be apt to conſider himſelf and his family as ſuperior by nature to thoſe upon whom no title has been conferred, and then his pride will become intolerable. If we could trace our deſcents, ſays Seneca, we ſhould find all ſlaves to come from princes, and all princes from ſlaves. To be proud of knowledge, is to be blind in the light; to be proud of virtue, is to poiſon ourſelves with the antidote; to be proud of authority, is to make our riſe our downfall. The beſt way to humble a proud man is to neglect him.

PRIDEAUX (Humphry) was born at Padſtow in Cornwall in 1648, and was honourably deſcended by both parents. Three years he ſtudied at Weſtminſter under Dr. Buſby; and then was removed to Chriſt-church, Oxford. Here he publiſhed, in 1676, his *Marmora Oxonienſia ex Arundelianis, Seldenianis, aliiſque conflata, cum perpetuo Commentario.* This introduced him to the lord chancellor Finch, afterward earl of Nottingham, who in 1679 preſented him to the rectory of St. Clement near Oxford, and in 1681 beſtowed on him a prebend of Norwich. Some years after he was engaged in a controverſy with the Papiſts at Norwich, concerning the validity of the orders of the church of England, which produced his book upon that ſubject. In 1688 he was inſtalled in the archdeaconry of Suffolk; to which he was collated by Dr. Lloyd, then biſhop of Norwich. In 1691, upon the death of Dr. Edward Pococke, the Hebrew profeſſorſhip at Oxford, being vacant, was offered to Dr. Prideaux; but he refuſed it. In 1697 he publiſhed his Life of Mahomet, and in 1702 was inſtalled dean of Norwich. In 1710 he was cut for the ſtone; which interrupted his ſtudies for more than a year. Some time after his return to London, he proceeded with his Connection of the Hiſtory of the Old and New Teſtament; which he had begun when he laid aſide the deſign of writing the Hiſtory of Appropriations. He died in 1724.

PRIENE, an ancient town of Aſia Minor. It is now called *Samſun*, and *Samſun-kateſi*, which do not however appear to be very recent. It was taken in 1391 by Bajazet, who ſubdued Ionia. It had formerly, without including the citadel, three gateways; one of which was towards Kelibeſh, an adjoining village; and without it are vaults of ſepulchres. The entrance was not wide. A part of the arch, conſiſting of a ſingle row of maſſive ſtones, ſtill remains; but thoſe on which it reſts are ſo corroded by age, broken, or diſtorted, as to ſeem every moment ready to yield and let down their load. A rugged way leads to a ſecond opening in the wall oppoſite to this, and about a mile from it; beyond which are likewiſe vaults of ſepulchres. Between theſe was a gate facing to the plain; and on the left hand going out of it is a hole, reſembling the mouth of an oven, in the ſide of a ſquare tower; and over it an inſcription in ſmall characters, exceedingly difficult to be read. It ſignifies, that a certain Cyprian in his ſleep had beheld Ceres and Proſerpine arrayed in white; and that in three viſions they had enjoined the worſhip of a hero, the guardian of the city, and pointed out the place where, in obedience to them, he had erected the god. This was probably ſome local hero, whoſe little image was ſet in the wall, and whoſe name and memory have periſhed.

PRIEST, a perſon ſet apart for the performance of ſacrifice, and other offices and ceremonies of religion. Before the promulgation of the law of Moſes, the firſt-born of every family, the fathers, the princes, and the kings, were prieſts. Thus Cain and Abel, Noah, Abraham, Melchizedec, Job, Iſaac, and Jacob, offered themſelves their own ſacrifices. Among the Iſraelites, after their exod from Egypt, the prieſthood was confined to one tribe, and it conſiſted of three orders, the *high-prieſt*, *prieſts*, and *Levites*. The prieſthood was made hereditary in the family of Aaron, and the firſt born of the oldeſt branch of that family, if he had no legal blemiſh, was always the high-prieſt. This divine appointment was obſerved with conſiderable accuracy till the Jews fell under the dominion of the Romans, and had their faith corrupted by a falſe philoſophy. Then, indeed, the high-prieſthood was ſometimes ſet up to ſale; and inſtead of continuing for life, as it ought to have done, it ſeems, from ſome paſſages in the New Teſtament, to have been nothing more than an annual office. There is ſufficient reaſon, however, to believe, that it was never diſpoſed of but to ſome deſcendant of Aaron, capable of filling it, had the older branches been extinct. (For the conſecration and offices of the Jewiſh prieſthood, we refer our readers to the books of Moſes.) In the time of David, the inferior prieſts were divided into 24 companies, who were to ſerve in rotation, each company by itſelf, for a week. The order in which the ſeveral courſes were to ſerve was determined by lot; and each courſe was in all ſucceeding ages called by the name of its original chief. All nations have had their *prieſts*. The Pagans had *prieſts* of Jupiter, Mars, Bacchus, Hercules, Oſiris, and Iſis, &c.; and ſome deities had *prieſteſſes*. The Mahometans have prieſts of different orders, called *ſchiek*, and *mufti*; and the Indians and Chineſe have their *bramins* and *bonzes*.

It has been much diſputed, whether in the Chriſtian church there be any ſuch officer as a *prieſt*, in the proper ſenſe of the word. The church of Rome, which holds the *propitiatory* ſacrifice of the *maſs*, has of courſe her proper *prieſthood*. In the church of England, the word *prieſt* is retained to denote the ſecond order in her hierarchy, but, we believe, with very different ſignifications, according to the different opinions entertained of the Lord's ſupper. Some few of her divines, of great learning, and of undoubted proteſtantiſm, maintain that the Lord's ſupper is a *commemorative* and *euchariſtical ſacrifice*. Theſe conſider all who are authoriſed to adminiſter that ſacrament as in the ſtricteſt ſenſe *prieſts*. Others hold the Lord's ſupper to be a *feaſt* upon the *one* ſacrifice, once offered on the croſs; and theſe too muſt conſider themſelves as clothed with ſome kind of prieſthood. Great numbers, however, of the Engliſh clergy, perhaps the majority, agree with the church of Scotland, in maintaining that the Lord's ſupper is a rite of no other moral import, than the mere commemoration of the death of Chriſt. Theſe cannot conſider themſelves as *prieſts* in the rigid ſenſe of the word, but only as *preſbyters*, of which the word *prieſt* is a contraction of the ſame import with *elder*. See SUPPER *of the Lord*.

PRIMÆ VIÆ, among phyſicians, denote the whole alimentary duct; including the œſophagus, ſtomach, and inteſtines, with their appendages.

PRIMAGE, in commerce, a ſmall duty at the water-ſide, uſually about 12d. *per* ton, or 6d. *per* bale, due to the maſter and mariners of a ſhip.

PRIMARY, firſt in dignity, chief, or principal.

PRIMARY *Qualities of Bodies.* See METAPHYSICS.

PRIMATE, in church-polity, an archbiſhop, who is inveſted with a juriſdiction over other biſhops.

PRIME, PRIMUS, an appellation given to whatever is firſt in order, degree, or dignity, among ſeveral things of the ſame or like kind: thus we ſay, the prime miniſter, prime coſt, &c. Prime is ſometimes uſed to denote the ſame with decimal, or the tenth part of an unit.

PRIME-*Figure*, in geometry, one which cannot be divided into any other figures more ſimple than itſelf, as a triangle among planes, and the pyramid among ſolids.

PRIME-*Numbers*, in arithmetic, ſee the article NUMBER.

PRIME *of the Moon*, is the new moon when ſhe firſt appears, which is about three days after the change.

PRIME *Vertical*, is that vertical circle which paſſes through the poles of the meridian, or the eaſt and weſt points of the horizon; whence dials projected on the plane of this circle are called *prime vertical*, or *north-and-ſouth dials*.

PRIME, in the Romiſh church, is the firſt of the canonical hours, ſucceeding to lauds.

PRIME, in fencing, is the firſt of the chief guards. See GUARD.

PRIMER SEASIN, in feodal law, was a feodal burden, only incident to the king's tenants *in capite*, and not to thoſe who held of inferior or meſne lords. It was a right which the king had, when any of his tenants *in capite* died ſeiſed of a knight's fee, to receive of the heir (provided he were of full age) one whole year's profits of the lands if they were in immediate poſſeſſion, and half a year's profits if the lands were in reverſion expectant on an eſtate for life. This ſeems to be little more than an additional relief, (ſee Relief;) but grounded upon this feodal reaſon, That, by the ancient law of feods, immediately upon the death of a vaſſal the ſuperior was entitled to enter and take ſeiſin or poſſeſſion of the land, by way of protection againſt intruders, till the heir appeared to claim it, and receive inveſtiture: and for the time the lord ſo held it, he was entitled to take the profits; and unleſs the heir claimed within a year and day, it was by the ſtrict law a forfeiture. This practice however ſeems not to have long obtained in England, if ever, with regard to tenures under inferior lords; but, as to the king's tenures *in capite*, this *prima ſeiſina* was expreſsly declared, under Hen. III. and Ed. II. to belong to the king by prerogative, in contradiſtinction to other lords. And the king was entitled to enter and receive the whole profits of the land, till livery was ſued; which ſuit being commonly within a year and day next after the death of the tenant, therefore the king uſed to take at an average the *firſt-fruits*, that is to ſay, one year's profits of the land. And this afterwards gave a handle to the popes, who claimed to be feodal lords of the church, to claim in like manner from every clergyman in England the firſt year's profits of his benefice, by way of *primitiæ*, or firſt-fruits.—All the charges ariſing by primer ſeiſin were taken away by 12 Car. II. c. 24.

PRIMING, in gunnery, the train of powder that is laid, from the opening of the vent, along the gutter or channel on the upper part of the breech of the gun; which, when fired, conveys the flame to the vent, by which it is further communicated to the charge, in order to fire the piece. This operation is only uſed on ſhipboard at the proof, and ſometimes in garriſon; for, on all other occaſions, tubes are uſed for that purpoſe.

Priming-*Wire*, in gunnery, a ſort of iron needle employed to penetrate the vent or touch-hole of a piece of ordnance, when it is loaded; in order to diſcover whether the powder contained therein is thoroughly dry and fit for immediate ſervice; as likewiſe to ſearch the vent and penetrate the cartridge, when the guns are not loaded with the looſe powder.

Priming, among painters, ſignifies the laying on of the firſt coat of colour.

PRIMIPILUS, in antiquity, the centurion of the firſt cohort of a legion, who had the charge of the Roman eagle.

PRIMITIÆ, the firſt-fruits gathered of the earth, whereof the ancients made preſents to the gods.

PRIMITIVE, in grammar, is a root or original word in a language, in contradiſtinction to *derivative*: thus, *God* is a primitive; *godly*, a derivative; and *godlike*, a compound.

PRIMOGENITURE, the right of the firſt-born, has among moſt nations been very conſiderable. The firſt-born ſon in the patriarchal ages had a ſuperiority over his brethren, and, in the abſence of his father, was prieſt to the family. Among the Jews, he was conſecrated to the Lord, had a double portion of the inheritance, and ſucceeded in the government of the family or kingdom. It is, however, remarkable, and unqueſtionably ſhows the connection between this inſtitution and the birth and office of our Saviour, that, if a woman's firſt child was a girl, neither ſhe nor the children that came after her were conſecrated.

In every nation of Europe, the right of primogeniture prevails in ſome degree at preſent, but it did not prevail always. The law which calls the elder born to the crown, preferably to others, was not introduced into France till very late; it was unknown to the firſt race of kings, and even to the ſecond. The four ſons of Clovis ſhared the kingdom equally among themſelves; and Louis le Debonnaire did the ſame: it was not till the race of Hugh Capet that the prerogative of ſucceſſion to the crown was appropriated to the firſt born.

By the ancient cuſtom of *Gavel kind*, ſtill preſerved in ſome parts of our iſland, primogeniture is of no account; the paternal eſtate being equally ſhared by all the ſons. And it has been a matter of violent and learned diſpute, whether, at the death of Alexander III. Baliol or Bruce was, by the law as it then ſtood, heir to the crown of Scotland. The former had undoubtedly the right of primogeniture, but the latter ſtood in one degree of nearer relation to the deceaſed ſovereign; and the Scottiſh barons, not being able to determine whoſe claim was beſt founded, referred the queſtion to Edward I. of England, and thereby involved their country in a long and ruinous war.

PRIMORIE, is a name given by the Slavi to that tract of ſea-coaſt which lies between the two rivers Cettina and Narenta, the firſt of which is the Neſtus and Tiluras, and the ſecond the Narus, of the ancients; compriſing what was properly called Dalmatia two ages before our era, and which was known to the Greeks of the low times under the name of *Paratalaſſia*. Appian informs us that the Ardei or Vardei poſſeſſed many cities there, part of which they ſeized before the invaſion of the Romans, and part they built themſelves. We learn alſo from the *Tabula Peutingeriana*, that after the conqueſt many of thoſe cities remained, and were inhabited by the conquerors, who alſo founded new ſettlements. And indeed were theſe proofs wanting, the numerous inſcriptions found near the ſea, and ſometimes among the hills, would render it at leaſt probable. The coaſt is extremely pleaſant, the ſoil fertile, and the ſituation moſt convenient for commerce with the inland provinces. By bad management, however, much ground has been loſt near the ſea, by its being covered with gravel; and by imprudent cultivation of the hills, the impetuous fury of the mountain torrents has rendered a part of it uninhabitable. Macarſka is now the only town in the territory, and it appears to have riſen out of the ruins of the ancient Rataneum of Pliny. It formed a part of the Narentan ſtate for ſeveral ages, and afterwards, together with the reſt of Primorie, paſſed under the obedience of various Chriſtian princes. It afterwards became ſubject to the Ottoman Porte, and at laſt voluntarily ſubjected itſelf to the Venetian republic. See Dalmatia and Macarska. See alſo Fortis's *Travels into Dalmatia*, p. 265—318.

PRIMULA, the Primrose: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 21ſt order, *Preciæ*. The involucrum lies under a ſimple umbel; the tube of the corolla cylindrical; with the mouth or limb patulous. This genus, including alſo the polyanthus and auricula, furniſhes an excellent collection of low, fibrous-rooted, herbaceous, flowery perennials.

1. The *primula veris*, or ſpring primroſe, has thick and very fibrous roots, crowned by a cluſter of large oblong indented rough leaves, and numerous flower-ſtalks, from about three or four, to five or ſix inches high; each terminated commonly by one flower.—The varieties are, common yellow-flowered primroſe of the woods—white primroſe—paper-white—red—double red—double yellow, and double white.—All theſe flower abundantly in March and April, and continue for a month or ſix weeks.

The cowſlip primroſe, or cowſlip, has very thick fibrous roots, crowned by a cluſter of oblong, indented, round leaves, and upright, firm flower ſtalks five or ſix inches high, terminated each by a cluſter of ſmall flowers. The varieties are, common ſingle yellow cowſlip of the meadows—double yellow cowſlip—ſcarlet cowſlip—hoſe and-hoſe cowſlip; one flower growing out of the boſom of another, the lowermoſt ſerving as a calyx; all of which varieties have the flower ſtalks crowned by many flowers in branches.—They flower in April and May, continuing in ſucceſſion a month or ſix weeks.

2. The *polyanthus*, has thick fibrous roots, increaſing into large bunches, crowned with a cluſter of large oblong indented rough leaves; amidſt them upright flower ſtalks ſix or eight

inches high, terminated moſtly by a cluſter of ſeveral ſpreading flowers of many different colours in the varieties. The principal are, purple, red, gold, orange-coloured, &c. They all flower beautifully in April and May, and frequently again in autumn; and ſometimes even in winter, if the ſeaſon is mild. The polyanthus is one of the noted prize-flowers among the floriſts; many of whom are remarkably induſtrious in raiſing a conſiderable variety of different ſorts, as well as in uſing every art to blow them with all requiſite perfection; for, among the virtuoſi, a polyanthus muſt poſſeſs ſeveral peculiar properties in order to be admitted in their collections. The chief properties required in a floriſt's polyanthus are, 1. The ſtem or flower-ſtalk ſhall be upright, moderately tall, with ſtrength in proportion, and crowned by a good regular bunch of flowers on ſhort pedicles, ſtrong enough to ſupport them nearly in an upright poſition, 2. The florets of each branch ſhould be equally large, ſpreading open flat, with the colours exquiſite, and the ſtripes and variegations lively and regular. 3. The eye in the centre of each floret ſhould be large, regular, and bright; and the antheræ, by the floriſts called the *thrum*, ſhould riſe high enough to cover the mouth of the tube or hollow part in the middle of the florets, and render them what they call *thrum-eyed*; but when the ſtyle elevates the ſtigma above the antheræ, the eye of the tube generally appears hollow, ſhowing the ſtigma in the middle, like the head of a pin, and is rejected as an incomplete flower, though its other properties ſhould be ever ſo perfect. This pin-eyed polyanthus, however, though rejected by the floriſts, is the flower in its moſt perfect ſtate, and great numbers of them are of as beautiful forms and colours as the thrum-eyed varieties.

3. The *auricula* has a thick fibrous root, crowned by a cluſter of oblong, fleſhy, broad, ſerrated, ſmooth leaves, reſembling the ſhape of a bear's ear; and amidſt them upright flower-ſtalks from about three or four to ſix or eight inches high, terminated by an umbellate cluſter of beautiful flowers, of many different colours in the varieties. All of theſe have a circular eye in the middle of each flower, and of which there are different colours; whence the auriculas are diſtinguiſhed into yellow-eyed, white-eyed, &c. The petals of moſt of the kinds are powdered with an exceeding fine farina or mealy powder, which contributes greatly to the beauty of the flower. They all flower in April or May, continuing a month or ſix weeks in beauty, and ripening plenty of ſeeds in June.

All the varieties of the common ſpring primroſe multiply ſo faſt by the roots, that it is ſcarce worth while to raiſe them from ſeeds. However, though many ſingle kinds may be raiſed from ſeed, yet parting the roots is the only method by which the double kind can be preſerved; and the ſame thing is to be obſerved of all the reſt.

PRIMUM MOBILE, in the Ptolemaic aſtronomy, the ninth or higheſt ſphere of the heavens, whoſe centre is that of the world, and in compariſon of which the earth is but a point. This they will have to contain all other ſpheres within it, and to give motion to them, turning itſelf, and all them, quite round in 24 hours.

PRINCE, PRINCEPS, in polity, a perſon inveſted with the ſupreme command of a ſtate, independent of any ſuperior.

PRINCE alſo denotes a perſon who is a ſovereign in his own territories, yet holds of ſome other as his ſuperior; ſuch are the princes of Germany, who, though abſolute in their reſpective principalities, are bound to the emperor in certain ſervices.

PRINCE alſo denotes the iſſue of princes, or thoſe of the royal family. In France, before the revolution, they were called *princes of the blood*, and during the ſhort continuance of the conſtitution of 1791, *French princes*. In England the king's children are called *ſons and daughters of England*; the eldeſt ſon is created prince of Wales; the cadets are created dukes or earls as the king pleaſes, and the title of all the children is *royal highneſs*: all ſubjects are to kneel when admitted to kiſs their hand, and at table out of the king's preſence they are ſerved on the knee. See ROYAL *family*.

PRINCE *of the Senate*, in old Rome, the perſon who was called over firſt in the roll of ſenators, whenever it was renewed by the cenſors: he was always of conſular and cenſorian dignity. See the article SENATE.

PRINCE'S *Metal*, a mixture of copper and zinc, in imitation of gold.

PRINCETOWN. See *New* JERSEY.

PRINCE *of Wales's Iſland*, or *Pulo Penany*, is ſituated in the entrance of the ſtraits of Malacca, in 100 degrees of eaſt longitude, and in five degrees of north latitude. It is about ſeven leagues in length and three in breadth. Its northern extremity runs nearly parallel with the main land at a diſtance of about two miles, by which a fine channel is formed, where the greateſt fleets might ride in perfect ſafety, the height of the ſurrounding mountains acting as a barrier againſt the force of the prevailing winds. The climate, conſidering its vicinity to the equator, is remarkably mild. Eighty degrees is about the mean height of the thermometer at noon, which, during the night, is ſeldom above 70. Its healthfulneſs is certainly not ſurpaſſed by that of any European ſettlement on the coaſt. Out of a garriſon of 300 troops (natives of Hindoſtan), not one died for the ſpace of 14 months; a ſingular fact to be experienced by a new ſettlement in an uncleared country. This great ſalubrity is perhaps the effect of a conſtant ventilation, ſupported by almoſt continued but gentle breezes, added to the dryneſs of the ſoil, the uniform but gradual elevation from the ſea to the foot of the hills preventing thoſe ſtagnations of water which, in tropical latitudes, are ſo highly prejudicial to the health of man.

A ridge of beautiful mountains, deeply indented with valleys, and covered with evergreens, divides the iſland longitudinally. Innumerable rivulets receive their origin from theſe mountains, and are remarkable for the tranſparency and coolneſs of their waters. The ſoil, which is light and ſandy near the ſea, gradually changes to a rich clay as it approaches to the high lands. There the ſugar-cane grows with the utmoſt luxuriance, and the moſt plentiful crops of rice are every where produced. The gardens have already furniſhed the inhabitants with cabbages and potatoes; and when induſtry ſhall have reached the tops of the mountains, it will be no ſurpriſe to ſee in the plantations moſt of the productions of Europe in their utmoſt perfection. In decorating the landſcapes of this little iſland, nature has been peculiarly laviſh. An aſſemblage of flowering trees and ſhrubs in perpetual bloſſom, and endleſs in the variety of their ſpecies, form the firſt ſhade. Theſe are overtopped by foreſt trees of an immenſe height, which ſpread their vaſt branches on every ſide, and are covered with the richeſt foliage. Here ſtrangers feel with rapture the effect of the breezes, which, from whatſoever quarter they blow, are ſtrongly impregnated with the fragrance of the groves.

The original animal productions of this iſland are very limited. Of quadrupeds, the wild hog, deer, and ſquirrel, nearly comprehend the whole; but the abſence of the tiger and leopard, whoſe numbers and ferocity almoſt render the oppoſite ſhores uninhabitable, amply compenſates for this deficiency. The flying fox and ſquirrel are natives of this iſland; the former a nondeſcript, and a great natural curioſity. Of birds there are alſo but a few, and only one which is remarkable for the melody of its notes. The crow and ſparrow, the never-failing attendants on population, have but lately made their appearance. They are now, however, rapidly increaſing and multiplying. All the domeſtic animals arrive here at great perfection.

The ſea which ſurrounds the iſland affords a vaſt variety of fiſh of the moſt delicious flavour, and its ſhores abundance of the fineſt turtle and oyſters. In no ſituation indeed are the conveniencies and luxuries of life enjoyed in greater profuſion. The advantages of the iſland in a political and commercial view, are too obvious to require to be pointed out.

Prince *William's Sound*, ſituated on the north-weſt coaſt of America, and ſo named by Captain Cook in 1778. The men, women and children of this ſound are all clothed in the ſame manner. Their ordinary dreſs is a ſort of cloſe frock, or rather robe, which ſometimes reaches only to the knees, but generally down to the ancles. Theſe frocks are compoſed of the ſkins of various animals, and are commonly worn with the hairy ſide outwards. The men often paint their faces of a black colour, and of a bright red, and ſometimes of a blueiſh or leaden hue; but not in any regular figure. The women puncture or ſtain the chin with black, that comes to a point in each of their cheeks. Their canoes are of two ſorts; the one large and open, the other ſmall and covered. The framing conſiſts of ſlender pieces of wood, and the outſide is compoſed of the ſkins of ſeals, or other ſea animals, ſtretched over the wood. Their weapons, and implements for hunting and fiſhing, are the ſame as thoſe uſed by the Greenlanders and Eſquimaux. Many of their ſpears are headed with iron, and their arrows are generally pointed with bone. The food they were ſeen to eat was the fleſh of ſome animal, either roaſted or broiled, and dried fiſh. Some of the former that was purchaſed had the appearance of bear's fleſh. They alſo eat a large ſort of fern-root, either baked or dreſſed in ſome other method. Their drink, in all probability, is water; for, in their canoes, they brought in wooden veſſels ſnow, which they ſwallowed by mouthfuls. Our knowledge of the animals of this part of the American continent is entirely derived from the ſkins that were brought by the natives for ſale. Theſe were principally of bears, common and pine martins, ſea-otters, ſeals, racoons, ſmall ermines, foxes, and the whitiſh cat or lynx. The birds found here were the halcyon, or great king's-fiſher, which had fine bright colours; the white-headed eagle, and the humming-bird. The fiſh that were principally brought to market for ſale were torſk and halibut. The rocks were almoſt deſtitute of ſhell-fiſh; and the only other animal of this tribe that was obſerved was a reddiſh crab, covered with very large ſpines. Few vegetables of any kind were obſerved; and the trees that chiefly grew about this ſound were the Canadian ſpruce pine, ſome of which were of a conſiderable ſize. E. lon. 115. 21. N. lat. 59. 33.

PRINCIPAL, the chief and moſt neceſſary part of a thing. The principal of a college or hall is the maſter thereof. In commerce, principal is the capital of a ſum due or lent; ſo called in oppoſition to intereſt. See Interest. It alſo denotes the firſt fund put by partners into a common ſtock, by which it is diſtinguiſhed from the calls or acceſſions afterwards required.

Principal, in muſic. See Fundamental, in muſic, and Generator, in muſic.

Principal, in law, is either the actor or abſolute perpetrator of the crime, who is called a *principal* in the firſt degree; or he who is preſent, aiding and abetting the fact to be done, who is denominated a *principal* in the ſecond degree. The preſence of a principal need not always be an actual immediate ſtanding by, within ſight or hearing of the fact; but there may be alſo a conſtructive preſence, as when one commits a robbery or murder, and another keeps watch or guard at ſome convenient diſtance. And this rule has alſo other exceptions; for, in caſe of murder by poiſoning, a man may be a principal felon by preparing and laying the poiſon, or giving it to another (who is ignorant of its poiſonous quality) for that purpoſe; and yet not adminiſter it himſelf, nor be preſent when the very deed of poiſoning is committed. And the ſame reaſoning will hold, with regard to other murders committed in the abſence of the murderer by means which he had prepared before-hand, and which probably could not fail of their miſchievous effect. As by laying a trap or pit-fall for another, whereby he is killed; letting out a wild beaſt, with an intent to do miſchief; or exciting a madman to commit murder, ſo that death thereupon enſues: in every one of theſe caſes the party offending is guilty of murder as a principal, in the firſt degree. For he cannot be called an acceſſory, that neceſſarily pre-ſuppoſing a principal; and the poiſon, the pit-fall, the beaſt, or the madman, cannot be held principals, being only the inſtruments of death. As therefore he muſt be certainly guilty, either as principal or acceſſory, and cannot be ſo as acceſſory, it follows that he muſt be guilty as principal; and if principal, then in the firſt degree; for there is no other criminal, much leſs a ſuperior in the guilt, whom he could aid, abet, or aſſiſt.

Principal *Point*, in perſpective, is a point in the perſpective plane, upon which a line is drawn from the eye, perpendicular to which the plane falls. This point is in the interſection of the horizontal and vertical plane; and is alſo called the *point of ſight*, and *point of the eye*. See Perspective.

Principal *Ray*, in perſpective, is that which paſſes perpendicularly from the ſpectator's eye to the perſpective plane, or picture. Whence the point where this ray falls on the plane, is by ſome alſo called the *principal point*, which other writers call *the centre of the picture*, and *the point of concurrence*.

PRINCIPATO, the name of a province of Italy, in the kingdom of Naples, which is divided into two parts, called by the Italians the *Principato Ultra* and the *Principato Citra*, that is, the Hither and Further Principato. The Hither Principato is bounded on the north by the Further Principato and part of the Terra-di-Lavoro, on the weſt and ſouth by the Tuſcan Sea, and on the eaſt by the Baſilicata. It is about 60 miles in length, and 30 in breadth; the ſoil is fertile in wine, corn, oil, and ſaffron; and they have a great deal of ſilk, beſides ſeveral mineral ſprings. The capital town is Salerno. The Further Principato is bounded on the north by the county of Moleſe and the Terra-di-Lavoro, on the weſt by the Tuſcan Sea, on the ſouth by the Hither Principato, and on the eaſt by the Capitanata. It is about 37 miles in length, and 30 in breadth. The Apennine mountains render the air cold; and the ſoil is not very fertile either in corn or wine, but it produces cheſnuts, and paſtures in great plenty. Benevento is the capital town.

PRINCIPLE, principium, in general, is uſed for the cauſe, ſource, or origin of any thing.

Principle, in human nature. See Disposition.

Principle, in ſcience, is a truth, admitted without proof, from which other truths are inferred by a chain of reaſoning. Principles are of two kinds, *primary* and *general*; and to the laſt the name of *axioms* is uſually given on account of their importance and *dignity*. An axiom or *general* principle, when the terms in which it is expreſſed are underſtood, muſt be a ſelf-evident truth; but from its very nature it cannot be a *firſt* truth. Our firſt truths are all *particular*. A child knows that two *particular* lines, each an inch long, are equal to one another, before he has formed any *general* notions of length and equality. "Things equal to one and the ſame thing are equal to one another," is the firſt of Euclid's axioms; and an axiom it undoubtedly is, but to no man has it been a *firſt* truth. It is, if we may uſe the expreſſion, a *genus* or *claſs* of truths comprehending under it numberleſs individuals. Were a full-grown man introduced into the world, without a ſingle idea in his mind, as we may ſuppoſe Adam to have been, he would inſtantly perceive, upon laying together three pieces of wood each a foot long, that they were all equal in length; and if he were to cut another of the ſame length with *any one* of them, he would find upon trial, that it was of the ſame length with them all. After a few ſimple experiments of this kind, he would, by a law of human thought, infer that all things equal in length or in any other dimenſion, to any *one* thing, are in that dimenſion equal to one another.

It was not therefore with ſuch weakneſs as ſome have imagined, that Hobbes affirmed thoſe propoſitions commonly called axioms, not to be primary but ſecondary principles. A primary principle deſerves not the name of an axiom, as it is only a particular truth including in it no other truth. There is not one of Euclid's axioms which has not been the reſult of induction, though we remember not the time at which the induction was made. That the whole is greater than any of its parts is a general truth no man of common ſenſe can controvert; but every one diſcovered that truth by obſerving that his body was larger than his head, his foot, or his hand; that a mountain is larger than a mole-hill in the middle of it; and that a piece of timber meaſuring what is called a yard is longer than any one of the diviſions marked upon it, and termed inches. The particular obſervations are made through the ſenſes, and treaſured up in the memory; and the intellect, by its conſtitution, compares them together, marks in what they agree and diſagree, and thence draws its *axioms* or *general* principles. He, therefore, who ſhould admit the truth of an axiom, and deny the evidence of ſenſe and perception, would act as abſurdly as he who accepts payment in a bank-bill, and refuſes it in the individual pieces of gold or ſilver which that bill repreſents. General axioms are of infinite uſe in the purſuits of ſcience: but it is not becauſe they create new truths; they only ſhorten the proceſs in the diſcovery of ſuch as might be found, with labour, through the medium of particular propoſitions. See *Campbell's Philoſophy of Rhetoric* and *Tatham's Chart and Scale of Truth*.

Principles, in phyſics, are often confounded with elements, or the firſt and ſimpleſt parts whereof natural bodies are compounded, and into which they are again reſolvable by the force of fire.

PRINGLE (Sir John), an eminent phyſician and philoſopher, was a younger ſon of Sir John Pringle of Stitchel, in the ſhire of Roxburgh, Baronet; took the degree of M. D. at Leyden, 1730; and publiſhed there *Diſſertatio Inauguralis de Marcore Senili*, 4to. After having been ſome years profeſſor of moral philoſophy at Edinburgh, he was in June 1745 appointed phyſician to the duke of Cumberland, and phyſician-general to the hoſpital of the forces in Flanders, where the earl of Stair appears to have been his patron. In February 1746 Dr. Pringle, Dr. Armſtrong, and Dr. Barker, were nominated phyſicians to the hoſpital for lame, maimed, and ſick ſoldiers, behind Buckingham houſe; and in April 1749 Dr. Pringle was appointed phyſician in ordinary to the king. In 1750 he publiſhed "Obſervations on the Nature and Cure of Hoſpital and Gaol Fevers, in a letter to Dr. Mead," 8vo. (reprinted in 1755); and in 1752 he favoured the public with the reſult of his long experience in an admirable treatiſe under the title of "Obſervations on the Diſorders of the Army in Camp and Garriſon," 8vo. On the 14th of April 1752 he married Charlotte, ſecond daughter of Dr. Oliver, an eminent phyſician at Bath. In 1756 he was appointed jointly with Dr. Wintringham (afterwards Sir Clifton Wintringham, Bart.) phyſician to the hoſpital for the ſervice of the forces of Great Britain. After the acceſſion of his preſent majeſty, Dr. Pringle was appointed phyſician to the queen's houſehold, 1761; phyſician in ordinary to the queen in 1763, in which year he was admitted of the college of phyſicians in London; and on the 5th of June 1765 he was advanced to the dignity of a baronet of Great Britain. In 1772 he was elected preſident of the Royal Society, where his ſpeeches for five ſucceſſive years, on delivering the prize-medal of Sir Godfrey Copley, gave the greateſt ſatisfaction. Sir John Pringle in 1777 was appointed phyſician extraordinary to the king. He was alſo a fellow of the College of Phyſicians at Edinburgh, and of the Royal Medical Society at Paris; member of the Royal Academies at Paris, Stockholm, Gottingen, and of the Philoſophical Societies at Edinburgh and Haerlem; and continued preſident of the Royal Society till November 1778; after which period he gradually withdrew from the world, and in 1781 quitted his elegant houſe in Pall Mall (where he had long diſtinguiſhed himſelf as the warm friend and patron of literary men of every nation and profeſſion), and made an excurſion to his native country. He returned to London in the latter end of that year; died greatly beloved and reſpected, January 18, 1782; and, having no children, was ſucceeded in eſtate, and alſo (agreeably to the limitation of the patent) in title, by his nephew, now Sir James Pringle, Bart. Among this worthy phyſician's communications to the Royal Society, the following are the principal: 1. "Some Experiments on Subſtances reſiſting Putrefaction," Phil. Tranſ. N° 495, p. 580; and N° 496, p. 525, 550; reprinted, with additions, in Martin's Abridgment, vol. xi. p. 1365. 2. "Account of ſome Perſons ſeized with the Gaol Fever by working in Newgate, and of the manner by which the Infection was communicated to one entire Family," vol. xlviii. p. 42. At the requeſt of Dr. Hales, a copy of this uſeful paper was inſerted in the Gentleman's Magazine, 1753, p. 71, before its appearance in the Tranſactions. 3. "A remarkable Caſe of Fragility, Flexibility, and Diſſolution of the Bones," ib. p. 297. 4. "Account of the Earthquakes felt at Bruſſels," vol. xlix. p. 546. 5. Account of ſinking of a River near Pontypool, in Monmouthſhire," ib. p. 547. 6. "Account of an Earthquake felt Feb. 18, 1756, along the coaſt of England, between Margate and Dover," ib. p. 579. 7. "Account of the Earthquake felt at Glaſgow and Dumbarton; alſo of a Shower of Duſt falling on a Ship between Shetland and Iceland," ib. p. 509. 8. "Several Accounts of the Fiery Meteor which appeared on Sunday, November 26, 1758, between eight and nine at night," vol. l. p. 218. 9. "Account of the Virtues of Soap in diſſolving the Stone, in the Caſe of the Reverend Mr. Matthew Simſon," ib. p. 221. 10. "Account of the Effects of Electricity in Paralytic Caſes," ib. p. 481. And ſee a letter to him on that ſubject from Profeſſor Winthorp. "Some Account of the Succeſs of the *Vitrum Ceratum Antimonii*," was printed in the Edinburgh Medical Eſſays, vol. v.

PRINOS, in botany: A genus of the monogynia order, belonging to the hexandria claſs of plants; and in the natural method ranking under the 43d order, *Dumoſæ*. The calyx is ſexfid; the corolla monopetalous, and rotaceous; the belly hexaſpermous.

PRINTER, a perſon who compoſes and takes impreſſions from moveable characters ranged in order, by means of ink, and a preſs.

PRINTING, the art of taking impreſſions from characters or figures, moveable and immoveable, on paper, linen, ſilk, &c. There are three kinds of printing: the one from moveable letters, for books; another from copper-plates, for pictures; and the laſt from blocks, in which the repreſentations of birds, flowers, &c. are cut, for printing calicoes, linen, &c. The firſt is called *common* or *letter-preſs* printing; the ſecond *rolling-preſs* printing; and the laſt, *calico*, &c. printing. The principal difference between the three conſiſts in this, that the firſt is caſt in relievo, in diſtinct pieces; the ſecond engraven in creux; and the third cut in relievo, and generally ſtamped, by placing the block upon the materials to be printed, and ſtriking upon the back of it.

Of the above branches, Letter-press PRINTING is the moſt curious, and deſerves the moſt particular notice: for to it are owing chiefly our deliverance from ignorance and error, the progreſs of learning, the revival of the ſciences, and numberleſs improvements in arts, which, without this noble invention, would have been either loſt to mankind, or confined to the knowledge of a few. "To the art of printing (ſays Dr. Knox), it is acknowledged we owe the reformation. It has been juſtly remarked, that if the books of Luther had been multiplied only by the ſlow proceſs of the hand-writing, they muſt have been few, and would have been eaſily ſuppreſſed by the combination of wealth and power: but, poured forth in abundance from the preſs, they ſpread over the land with the rapidity of an inundation, which acquires additional force from the efforts uſed to obſtruct its progreſs. He who undertook to prevent the diſperſion of the books once iſſued from the preſs, attempted a taſk no leſs arduous than the deſtruction of the hydra. Reſiſtance was vain, and religion was reformed: and we who are chiefly intereſted in this happy revolution muſt remember, amidſt the praiſes beſtowed on Luther, that his endeavours had been ineffectual, unaſſiſted by the invention of Fauſtus.

"How greatly the cauſe of religion has been promoted by the art, muſt appear, when it is conſidered, that it has placed thoſe ſacred books in the hand of every individual, which, beſides that they were once locked up in a dead language, could not be procured without great difficulty. The numerous comments on them of every kind, which tend to promote piety, and to form the Chriſtian philoſopher, would probably never have been compoſed, and certainly would not have extended their beneficial influence, if typography had ſtill been unknown. By that art, the light, which is to illuminate a dark world, has been placed in a ſituation more advantageous to the emiſſion of its rays: but if it has been the means of illuſtrating the doctrines, and enforcing the practice of religion, it has alſo, particularly in the preſent age, ſtruck at the root of piety and moral virtue, by propagating opinions favourable to the ſceptic and the voluptuary. It has enabled modern authors wantonly to gratify their avarice, their vanity, and their miſanthropy, in diſſeminating novel ſyſtems ſubverſive of the dignity and happineſs of human nature: but though the perverſion of the art is lamentably remarkable in thoſe volumes which iſſue, with offenſive profuſion, from the vain, the wicked, and the hungry, yet this good reſults from the evil, that as truth is great and will prevail, ſhe muſt derive freſh luſtre, by diſplaying the ſuperiority of her ſtrength in the conflict with ſophiſtry.

"Thus the art of printing, in whatever light it is viewed, has deſerved reſpect and attention. From the ingenuity of the contrivance, it has ever excited mechanical curioſity; from its intimate connection with learning, it has juſtly claimed hiſtorical notice; and from its extenſive influence on morality, politics, and religion, it is now become a ſubject of very important ſpeculation.

"But however we may felicitate mankind on the invention, there are perhaps thoſe who wiſh, that, together with its compatriot art of manufacturing gun-powder, it had not yet been brought to light. Of its effects on literature, they aſſert, that it has increaſed the number of books, till they diſtract rather than improve the mind; and of its malignant influence on morals, they complain, that it has often introduced a falſe refinement, incompatible with the ſimplicity of primitive piety and genuine virtue. With reſpect to its literary ill-conſequences, it may be ſaid, that though it produces to the world an infinite number of worthleſs publications, yet true wit and fine compoſition will ſtill retain their value, and it will be an eaſy taſk for critical diſcernment to ſelect theſe from the ſurrounding maſs of abſurdity: and though, with reſpect to its moral effects, a regard to truth extorts the confeſſion, that it has diffuſed immorality and irreligion, divulged with cruel impertinence the ſecrets of private life, and ſpread the tale of ſcandal through an empire; yet theſe are evils which will either ſhrink away unobſerved in the triumphs of time and truth over falſehood, or which may, at any time, be ſuppreſſed by legiſlative interpoſition."

Some writers have aſcribed the origin of this art to the Eaſt, and affixed a very early period to its invention; particularly P. Jovius, (*Hiſt.* lib. xiv. p. 226. ed. Florent. 1550), from whom Oſorius and many others have embraced the ſame opinion. But theſe have evidently confounded the European mode of printing with the *engraved tablets* which to this day are uſed in China. The invention of theſe tablets has been aſcribed by many writers even to an earlier period than the commencement of the Chriſtian æra; but it is with more probability aſſigned, by the very accurate Phil Couplet, to the year 930. The *Hiſtoria Sinenſis* of Abdalla, written in Perſic in 1317, ſpeaks of it as an art in very common uſe. Meerman, vol. i. p. 16: 218, 219, vol. ii. p. 186 N. Trigault aſſerts that the Chineſe practiſed the art of printing five centuries before. Count Ferre Rezzonico found at Lyons plates with words and names engraven by a Nuremberger 1380.

The honour of having given riſe to the European method has been claimed by the cities of *Harlem*, *Mentz*, and *Straſburg*. And to each of theſe it may be aſcribed in a qualified ſenſe, as they made improvements upon one another.

I. The firſt teſtimony of the inventor is that recorded by Hadrian Junius, in his *Batavia*, p 253, ed. Lugd. Bat. 1588; which, though it hath been rejected by many, is of undoubted authority. Junius had the relation from two reputable men; Nicolaus Galius*, who was his ſchoolmaſter; and Quirinius Taleſius, his intimate and correſpondent. He aſcribes it to Laurentius, the ſon of John (Æditiuus, or Cuſtos, of the cathedral at HARLEM, at that time a reſpectable office), upon the teſtimony of Cornelius, ſome time a ſervant to Laurentius, and afterwards bookbinder to the cathedral, an office which had before been performed by Franciſcan friars. His narrative was thus: "That, walking in a wood near the city (as the citizens of opulence uſe to do), he began at firſt to cut ſome letters upon the rind of a beech tree; which, for fancy's ſake, being impreſſed on paper, he printed one or two lines, as a ſpecimen for his grand-children (the ſons of his daughter) to follow. This having happily ſucceeded, he meditated greater things (as he was a man of ingenuity and judgment); and firſt of all, with his ſon-in-law Thomas Peter (who, by the way, left three ſons, who all attained the conſular dignity, invented a more glutinous writing-ink, becauſe he found the common ink ſunk and ſpread; and then formed whole pages of wood, with letters cut upon them; of which ſort I have ſeen ſome eſſays, in an anonymous work, printed only on one ſide, entitled, *Speculum noſtræ ſalutis*; in which it is remarkable, that in the infancy of printing (as nothing is complete at its firſt invention), the back ſides of the pages were paſted together, that they might not by their nakedneſs betray their deformity. Theſe beechen letters he afterwards changed for leaden ones, and theſe again for a mixture of tin and lead [*ſtanneas*] as a leſs flexible and more ſolid and durable ſubſtance. Of the remains of which types, when they were turned to waſte metal, thoſe old wine-pots were caſt, that are ſtill preſerved in the family-houſe, which looks into the market-place, inhabited afterwards by his great-grandſon Gerard Thomas, a gentleman of reputation; whom I mention for the honour of the family, and who died old a few years ſince. A new invention never fails to engage curioſity. And when a commodity never before ſeen excited purchaſers, to the advantage of the inventor, the admiration of the art increaſed, dependents were enlarged, and workmen multiplied; the firſt calamitous incident! Among theſe was one John, whether, as we ſuſpect, he had ominouſly the name of *Fauſtus**, unfaithful and unlucky to his maſter, or whether it was really a perſon of that name, I ſhall not much inquire; being unwilling to moleſt the ſilent ſhades, who ſuffer from a conſciouſneſs of their paſt actions in this life. This man bound by oath to keep the ſecret of printing, when he thought he had learned the art of joining the letters, the method of caſting the types, and other things of that nature, taking the moſt convenient time that was poſſible, on Chriſtmas eve, when every one was cuſtomarily employed in luſtral ſacrifices, ſeizes the collection of types, and all the implements his maſter had got together, and, with one accomplice, marches off to Amſterdam, thence to Cologne, and at laſt ſettled at Mentz, as at an aſylum of ſecurity, where he might go to work with the tools he had ſtolen. It is certain, that in a year's time viz. in 1442, the *Doctrinale* of Alexander Galius, which was a grammar much uſed at that time, together with the *Tracts* of Peter of Spain, came forth there, from the ſame types as Laurentius had made uſe of at Harlem."

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* Galius ſeems to be the ſame who is called *Claes Lottynſz. Gael*, Scabinus Harlemi, as it is in the Faſti of that city, in the years 1531, 1533, and 1535. Quirinius in the ſame Faſti is called *Mr. Quiryn Dirkſzoon.* He was many years amanuenſis to the great Eraſmus, as appears from his epiſtle, 23d July 1529 tom. iii. Oper. p. 1222. He was afterwards Scabinus in 1537 & ſeq. and Conſul in 1552 & ſeq. But in the troubles of Holland he was cruelly killed by the Spaniſh ſoldiers, May 23, 1573. There are ſome letters of Hadrian Junius to this Taleſius, in the *Epiſtolæ Junianæ*, p. 198.

Thus far the narrative of Junius, which he had frequently heard from Nicolaus Galius; to whom it was related by Cornelius himſelf, who lived to a great age, and uſed to burſt into tears upon reflecting on the loſs his maſter had ſuſtained, not only in his ſubſtance but in his honour, by the roguery of his ſervant, his former aſſociate and bedſellow. Cornelius, as appears by the regiſters of Harlem cathedral, died either in 1515, or the beginning of the following year; ſo that he might very well give this information to Nicolaus Galius, who was ſchoolmaſter to Hadrian Junius.

Though this circumſtance is probable as to the main fact, yet we muſt ſet aſide the evidence of it in ſome particulars. 1. The firſt obvious difficulty is noticed by Scriverius; "that the types are ſaid to be made of the *rind* of beach, which could not be ſtrong enough to bear the impreſſion of the preſs:" though this is removed, if, inſtead of the *bark*, we ſubſtitute a *bough* of the beach. The idea of the *bark*, when Junius wrote this, was perhaps ſtrong in his mind, from what Virgil tells us (Ecl. v. 13.) of its being uſual to cut words on the *bark* of a beech; and thence he was eaſily led to make a wrong application of it here.

2. The letters were at firſt *wooden*, and are ſaid to have been afterwards exchanged for *metal* types; from which the wine-pots were formed, remaining in the time of Junius. According to tradition, printing was carried on in the ſame houſe long after the time of Laurentius: theſe pots might therefore be formed from the waſte metal of the printing houſe, after the uſe of *fuſile types* became univerſal.—But Laurentius ſeems to have carried the art no further than *ſeparate wooden types.* What is a remarkable confirmation of this, Henry Spiechel, who wrote, in the 16th century, a Dutch poem entitled *Herſpiegel*, expreſſes himſelf thus: "Thou firſt, Laurentius, to ſupply the defect of wooden tablets, adaptedſt *wooden types*, and afterwards didſt connect them with a thread, to imitate writing. A treacherous ſervant ſurreptitiouſly obtained the honour of the diſcovery. But truth itſelf, though deſtitute of common and wide-ſpread fame; truth, I ſay, ſtill remains." No mention in the poem of *metal types*; a circumſtance which, had he been robbed of ſuch, as well as of *wooden* ones, would ſcarcely have been paſſed over in ſilence.

When Laurentius firſt deviſed his rough ſpecimen of the art, can only be gueſſed at. He died in 1440, after having publiſhed the *Speculum Belgicum* and two editions of *Donatus*, all with different *wooden types*; which it is probable (conſidering the difficulties he had to encounter, and the many artiſts whom he muſt neceſſarily have had occaſion to conſult) coſt him ſome years to execute; ſo that the firſt eſſay might be about 1430, which nearly agrees with Petrus Scriverius, who ſays the invention was 10 or 12 years before 1440. See LAURENTIUS.

3. What was the ſpecimen he firſt diverted himſelf with in cutting, at the diſtance of three centuries one would think impoſſible to be diſcovered. And yet Joh. Enſchedius, a printer, thinks he was ſo happy as to find it, being an old parchment *Horarium*, printed on both ſides, in eight pages, containing the Letters of the Alphabet, the Lord's Prayer, the Apoſtles Creed, and three ſhort prayers. And Mr. Meerman having ſhown this to proper artiſts who were judges of theſe matters, they gave it as their opinion that it agreed exactly with the deſcription of Junius. It is conformable to the firſt edition of the Dutch *Speculum Salvationis*, and the fragments of both *Donatuses* of Holland, both which are the works of the ſame Laurentius, and were preceded by this. In theſe types, which are certainly moveable, cut, and uneven, there is a rudeneſs which Mr. Meerman has not obſerved in any other inſtances. There are no numbers to the pages, no ſignatures, no *direction-words*, no diviſions at the end of the lines; on the contrary, a ſyllable divided in the middle is ſeen, thus, *Sp iritū*, in p. 8. l. 2, 3. There are neither diſtinctions nor points which are ſeen in the other works of Laurentius; and the letter *í* is not marked with an accent, but with a dot at the top. The lines throughout are uneven. The ſhape of the pages not always the ſame; not (as they ſhould be) rectangular, but ſometimes rhomb-like, ſometimes an *iſoſcele trapezium*; and the performance ſeems to be left as a ſpecimen both of his piety, and of his ingenuity in this eſſay of a new invented art. Mr. Meerman has given an exact engraving of this ſingular curioſity.

But, whatever elſe may appear doubtful in the narrative of Junius, it is very clear, that the firſt eſſays of the art are to be attributed to Laurentius, who uſed only *ſeparate wooden types.* See the article LAURENTIUS.

II. Some of Laurentius's types were ſtolen from him by one of his ſervants†, JOHN GEINSFLEICH ſenior; who fled therewith to MENTZ. Having introduced the art from Harlem into this his native city, he ſet with all diligence to carry it on; and publiſhed, in 1442, ALEXANDRI GALLI *Doctrinale*, and PETRI HISPANI *Tractatus*; two works, which being ſmall, beſt ſuited his circumſtances; and for which, being much uſed in the ſchools, he might reaſonably expect a profitable ſale. They were executed with *wooden types*, cut after the model of thoſe he had ſtolen.

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* *John Fauſt*, or *Fuſt*, is by many ſuppoſed to have derived his name from *fauſtus*, "happy;" and Dr. Fauſtus ſeems to carry an air of grandeur in the appellation: but very erroneouſly. *John Fauſt*, or *Fuſt*, is no more than *John Hand*, whence our name *Fiſt*.

† Authors differ as to the perſon who committed this robbery. It is clear from all accounts that his name was *John*; but what his ſurname was is the diſputed point. Junius, after ſome heſitation, aſcribes it to John Fuſt; but with injuſtice: for he was a wealthy man, who aſſiſted the firſt printers at Mentz with money; and though he afterwards was proprietor of a printing-office, yet he never, as far as appears, performed any part of the buſineſs with his own hands, and conſequently he could never have been a ſervant to Laurentius. Nor is the conjecture of Scriverius better founded, which fixes it upon John Gutenberg, who (as appears by authentic teſtimonies) reſided at Straſburg from 1436 to 1444, and during all that period employed much fruitleſs labour and expenſe in endeavouring to attain this art. Mr. Meerman once thought, "it might be either John Meiden-

In 1443 he hired the houſe Zum Jungen; and was aſſiſted with money by FUST, a wealthy perſon, who in return had a ſhare of the buſineſs: and about the ſame time *John Meidenbachius* was admitted a partner, as were ſome others whoſe names are not tranſmitted to our times; and in 1444 they were joined by GUTENBERG, who for that purpoſe quitted Straſburg. Wooden types being found not ſufficiently durable, and not anſwering expectation in other reſpects, the two brothers firſt invented *cut metal types*. But while theſe were preparing, which muſt have been a work of time, ſeveral works were printed, both on *wooden ſeparate types* and on *wooden blocks*; which were well adapted to ſmall books of frequent uſe, ſuch as the *Tabula Alphabetica*, the *Catholicon Donati Grammatica*, and the *Confeſſionalia*.

From the above-mentioned printers in conjunction, after many ſmaller eſſays, the Bible was publiſhed in 1450, with *large cut metal types**. And it is no wonder, conſidering the immenſe labour this work coſt, that it ſhould be ſeven or eight years in completing. In this ſame year the partnerſhip was diſſolved, and a new one entered into, in Auguſt, between *Fuſt and Gutenberg*; the former ſupplying the money, the latter ſkill, for their common benefit. Various difficulties ariſing occaſioned a law-ſuit for the money which Fuſt had advanced; which was determined againſt Gutenberg. A diſſolution of this partnerſhip enſued in 1455; and in 1457 a magnificent edition of the Pſalter was publiſhed by *Fuſt and Schoeffer*, with a remarkable commendation, in which they aſſumed to themſelves the merit of a new invention, (viz. of *metal types), ad inventionem artificioſam imprimendi ac characterizandi*. This book was uncommonly elegant, and in ſome meaſure the work of Gutenberg; as it was four years in the preſs, and came out but 18 months after the partnerſhip was diſſolved between him and Fuſt.

The latter continued in poſſeſſion of the printing-office;

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bachius, (who, we are told by Seb. Munſter and the author of *Chronographia Moguntinenſis*, was an aſſiſtant to the firſt Mentz printers); or John Peterſheimius (who was ſome time a ſervant to Fuſt and Schoeffer, and ſet up a printing-houſe at Francfort, in 1459): or, laſtly, ſome other perſon, who, being unable through poverty to carry on the buſineſs, diſcovered it to *Geinsfleich* at Mentz." But more authentic intelligence afterwards convinced him there were two perſons of this name; and that John Geinsfleich ſenior (*a*) was the diſhoneſt ſervant, who was born at Mentz, and who in the papers publiſhed by Kohlerus, we find there in the year 1441, and not before: for though he was of a good family, yet he was poor, and ſeems to have been obliged, as well as his brother, to ſeek his livelihood in a foreign country; and perhaps was content to be under Laurentius, in order that when he had learned the art, he might follow it in his own. But, to leave conjecture, we may produce ſome certain teſtimonies.

1. It is what Junius himſelf ſays, that the perſon who ſtole the types did it with ſome view to ſet up elſewhere; nor is it likely that he would either make no uſe of an art he had ſeen ſo profitable to Laurentius, or that he would teach it to another and ſubmit to be again a ſervant.

2. The Lambeth Record (which is annexed, from Mr. Atkyns) tells us, that "Mentz gained the art by the brother of one of the workmen of Harlem, who learned it at home of his brother, who after ſet up for himſelf at Mentz."—By the ſtricteſt examination of the beſt authorities, it is plain that by theſe *two brothers* the two Geinsfleiches muſt be meant. But as the younger (*Gutenberg*) was never a ſervant to Laurentius, it muſt be the ſenior who carried off the types, and inſtructed his brother in the art; who firſt applied himſelf to the buſineſs at Straſburg, and afterwards joined his elder brother, who had in the mean time ſettled at Mentz.

What is ſtill ſtronger, two chronologers of Straſburg, the one named *Dan Specklinus*, the other anonymous (in Meerman's *Documenta*, No. lxxxv. lxxxvi.), tells us expreſsly, that John Geinsfleich (viz. the ſenior, whom they diſtinguiſhed from Gutenberg), having learned the art by being ſervant to its *firſt inventor*, carried it by theft into Mentz his native country. They are right in the fact, though miſtaken in the application of it; for they make Straſburg the place of invention, and Mentelius the inventor, from whom the types were ſtolen. But this is plainly an error: for Geinsfleich lived at Mentz in 1441, as appears from undoubted teſtimonies; and could not be a ſervant to Mentelius, to whom the before-mentioned writers aſcribe the invention in 1440, though more ancient ones do not attempt to prove that he began to print before 1444 or 1447. Nor will the narrative agree better with Gutenberg, who was an earlier printer than Mentelius; ſince, among the evidences produced by him in his law-ſuit, 1439, no Geinsfleich ſenior appears, nor any other ſervant but Laurentius Beildck. The narration therefore of the theft of Geinsfleich, being ſpread by various reports through the world, and ſubſiſting in the time of theſe chronologers, was applied by them (to ſerve the cauſe they wrote for) to Straſburg; but ſerves to confirm the truth, ſince no writer derives the printing ſpoils from any other country than Holland or Alſatia. The chronologers have likewiſe, inſtead of Fuſt, called Gutenberg the wealthy man; who, from all circumſtances, appears to have been poor. They alſo call Schoeffer the ſon-in-law of Mentelius; when it is clear that he married the daughter of Fuſt.

* Many writers have ſuppoſed that this was the edition of which ſome copies were ſold in France, by Fuſt, as manuſcripts, for the great price of 500 or 600 crowns, which he afterwards lowered to 60, and at laſt to leſs than 40. But it was the ſecond and more expenſive edition of 1462, that was thus diſpoſed of, when Fuſt went to Paris in 1466, and which had coſt 4000 florins before the third *quaternion* (or quire of four ſheets) was printed. MEERMAN, vol. I. p. 6. 151, 152.

(*a*) He was called *Geinsfleich* κατ' ἐξοχην; the other was diſtinguiſhed by the name of *Gutenberg*. They were both poor; though of a family diſtinguiſhed by knighthood. They were both married men; and were moſt probably brothers, as it was not uncommon in that age for two brothers to have the ſame Chriſtian name. Theſe both appear in a diſreputable light. The eldeſt robbed his maſter, with many aggravating circumſtances. The youngeſt was remarkably contentious; and after entering into a contract of marriage with Anna, a noble girl of *The Iron Gate*, refuſed to marry her till compelled by a judicial decree; and afterwards cared not what became of the lady, but left her behind at Straſburg when he removed to Mentz. He had not only frequent quarrels with his wife; but with *Andrew Dritzehen*, *Andrew Heilmann*, and *John Riff*, all of whom were aſſociated with him at Straſburg in his different employments of making of looking-glaſſes, poliſhing of precious ſtones, and endeavouring to attain the art of printing; and with theſe he involved himſelf in three law-ſuits. See *Meerman*, vol. i. p. 163, &c. N.

and *Gutenberg*, by the pecuniary aſſiſtance of Conrad Humery ſyndic of Mentz[*], and others, opened another office in the ſame city; whence appeared, in 1460, without the printer's name, the *Catholicon Jo. de Janua*, with a pompous colophon in praiſe of its beauty, and aſcribing the honour of the invention to the city of Mentz. It was a very handſome book, though inferior to the Pſalter which had been publiſhed in 1457 by Fuſt and Schoeffer. Both the Pſalter and *Catholicon* were printed on *cut metal types*[†]. It may not be improper to obſerve here, that as the Pſalter is the earlieſt book which is known to have a genuine date, it became a common practice, after that publication, for printers to claim their own performances by adding their names to them.

III. The progreſs of the art has been thus traced through its *ſecond* period, the invention of *cut metal types*. But the honour of completing the diſcovery is due to PETER SCHOEFFER[‡] de Gernſheim.

A very clear account of this final completion of the types is preſerved by Trithemius[§]. *Poſt hæc inventis ſucceſſerunt ſubtiliora, inveneruntque modum* fundendi formas *omnium Latini alphabeti literarum, quas ipſi* matrices *nominabant: ex quibus rurſum æneos ſive ſtanneos characteres fundebant, ad omnem preſſuram ſufficientes, quos prius manibus ſculpebant. Et revera ſicuti* ante *xxx* ferme annos *ex ore Petri Opilionis de Gernſheim, civis Moguntini, qui gener erat primi artis inventoris, audivi, magnam a primo inventionis ſuæ hæc ars impreſſoria habuit difficultatem.—Petrus autem memoratus Opilio, tunc famulus poſtea gener, ſicut diximus, inventoris primi, Johannis Fuſt, homo ingenioſus et prudens, faciliorem modum* fundendi characteres *excogitavit, et artem, ut nunc eſt, complevit.*

Another ample teſtimony in favour of Schoeffer is given by Jo. Frid. Fauſtus of Aſchaffenburg, from papers preſerved in his family: "Peter Schoeffer of Gernſheim, perceiving his maſter Fuſt's deſign, and being himſelf ardently deſirous to improve the art, found out (by the good providence of God) the method of cutting *(incidendi)* the characters in a *matrix*, that the letters might eaſily be ſingly *caſt*, inſtead of being *cut*. He privately *cut matrices* for the whole alphabet; and when he ſhowed his maſter the letters caſt from theſe matrices, Fuſt was ſo pleaſed with the contrivance, that he promiſed Peter to give him his only daughter Chriſtina in marriage, a promiſe which he ſoon after performed. But there were as many difficulties at firſt with theſe letters, as there had been before with *wooden* ones; the metal being too ſoft to ſupport the force of the impreſſion: but this defect was ſoon remedied, by mixing the metal with a ſubſtance which ſufficiently hardened it[||]."

Fuſt and Schoeffer concealed this new improvement, by adminiſtering an oath of ſecrecy to all whom they intruſted, till the year 1462; when, by the diſperſion of their ſervants into different countries, at the ſacking of Mentz by the archbiſhop Adolphus, the invention was publicly divulged.

The firſt book printed with theſe *improved types* was *Durandi Rationale*, in 1459; at which time, however, they ſeem to have had only *one ſize* of *caſt* letters, all the larger characters which occur being *cut types*, as appears plainly by an inſpection of the book. From this time to 1466, Fuſt and Schoeffer continued to print a conſiderable number of books; particularly two famous editions of *Tully's Offices*. In their earlieſt books, they printed more copies on *vellum* than on *paper*, which was the caſe both of their *Bibles* and *Tully's Offices*. This, however, was ſoon inverted; and *paper* introduced for the greateſt part of their impreſſions; a few only being printed on *vellum* for curioſities, and for the purpoſe of being *illuminated*. How long Fuſt lived, is uncertain: but in 1471 we find Schoeffer was in partnerſhip with *Conrad Henlif* and a kinſman of his maſter Fuſt. He publiſhed many books after the death of his father-in-law; the laſt of which that can be diſcovered is a third edition of the *Pſalter* in 1490, in which the old *cut* types of the firſt edition were uſed.

IV. With regard to the claim of STRASBURG: It has been already mentioned, that Gutenberg was engaged in that city in different employments; and, among others, in endeavouring to attain the art of printing. That theſe endeavours were unſucceſsful, is plain from an authentic judicial decree of the ſenate of Straſburg in 1439, after the death of Andrew Drizehen[¶].

But there are many other proofs that Gutenberg and his partners were never able to bring the art to perfection.

1. Wimphelingius, the oldeſt writer in favour of Straſburg, tells us, that Gutenberg was the inventor of "a new art of writing," *ars impreſſoria*, which might alſo be called a *divine benefit*, and which he happily completed at Mentz; but does not mention one book of his printing: though he adds, that Mentelius printed many volumes correctly and beautifully, and ac-

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[*] At the death of Gutenberg, Conrad Humery took poſſeſſion of all his printing materials; and engaged to the archbiſhop Adolphus, that he never would ſell them to any one but a citizen of Mentz. They were however ſoon diſpoſed of to Nicholas Bechtermuntze of Altavilla, who, in 1469, publiſhed *Vocabularium Latino Teutonicum*, which was printed with the ſame types which had been uſed in the *Catholicon*. This very curious and ſcarce *Vocabulary* was ſhown to Mr. Meerman, by Mr. Bryant, in the duke of Marlborough's valuable library at Blenheim. It is in quarto, 35 lines long, contains many extracts from the *Catholicon*, and is called *Ex quo*, from the preface beginning with thoſe words. MEERMAN, vol. ii. p. 96.

[†] Gutenberg never uſed any other than either *wooden* or *cut metal types* till the year 1462. In 1465 he was admitted *inter Aulicos* by the elector Adolphus, with an annual penſion; and died in February 1468. His elder brother Geinsfleich died in 1462. Their epitaphs are printed by Mr. Meerman, vol. ii. p. 154, 295.

[‡] In German, Schoeffer; in Latin, *Opilio*; in Engliſh, *Shepherd*.——He is ſuppoſed by Mr. Meerman to have been the firſt engraver on copper-plates.

[§] *Annales Hirſaugienſes*, tom. ii. ad ann. 1450.—As this book was finiſhed in 1514, and Trithemius tells us he had the narrative from Schoeffer himſelf about 30 years before; this will bring us back to 1484, when Schoeffer muſt have been advanced in years, and Trithemius about 22 years old, who died in 1516. See *Voſſ.* Hiſt. Lat. l. 1. c. 10 *Fabr.* Med. & Infim. Æt. l. 9.

[||] See *Meerman*, vol. i. 9. 183. who copied this teſtimony from Wolfius, *Monument. Typograph.* vol. i. p. 468. ſeq.

[¶] Their firſt attempts were made about 1436 with *wooden types*. Mr. Meerman is of opinion that Geinsfleich junior (who was of an enterpriſing genius, and had already engaged in a variety of projects) gained ſome little inſight into the buſineſs by viſiting his brother who was employed by Laurentius at Harlem, but not ſufficient to enable him to practiſe it. It is certain that, at the time of the law-ſuit in 1439, much money had been expended, without any profit having ariſen; and the unfortunate Drizehen, in 1438, on his death bed, lamented to his confeſſor, that he had been at great expenſe, without having been reimburſed a ſingle *obolus*. Nor did Gutenberg (who perſiſted in his fruitleſs endeavours) reap any advantage from them; for, when he quitted Straſburg, he was overwhelmed in debt, and under a neceſſity of ſelling every thing he was in poſſeſſion of. [MEERMAN, vol. i. p. 198—202] All the depoſitions in the law-ſuit above mentioned (with the judicial decree) are printed by Mr. Meerman, vol. ii. p. 58—88. N.

quired great wealth; whence we may conclude that he perfected what Gutenberg had in vain eſſayed.

2. Wimphelingius, in another book, tells us, the art of printing was found out by Gutenberg *incomplete*; which implies, not that he practiſed the art in an imperfect manner (as Laurentius had done at Harlem), but rather that he had not been able to accompliſh what he aimed at.

3. Gutenberg, when he left Straſburg in 1444 or the following year, and entered into partnerſhip with Geinsfleich ſenior and others, had occaſion for his brother's aſſiſtance to enable him to complete the art; which ſhows that his former attempts at Straſburg had been unſucceſsful.

4. Theſe particulars are remarkably confirmed by Trithemius, who tells us, in two different places, that Gutenberg ſpent all his ſubſtance in queſt of this art; and met with ſuch inſuperable difficulties, that, in deſpair, he had nearly given up all hopes of attaining it, till he was aſſiſted by the liberality of Fuſt, and by his brother's ſkill, in the city of Mentz.

5. Ulric Zell ſays the art was completed at Mentz; but that ſome books had been publiſhed in Holland earlier than in that city. Is it likely that Zell, who was a German, would have omitted to mention Straſburg, if it had preceded Mentz in printing?

There is little doubt, therefore, that all Gutenberg's labours at Straſburg amounted to no more than a fruitleſs attempt, which he was at laſt under the neceſſity of relinquiſhing: and there is no certain proof of a ſingle book having been printed in that city till after the diſperſion of the printers in 1462, when Mentelius and Eggeſtenius ſucceſsfully purſued the buſineſs.

In fine, the pretenſions of *Straſburg* fall evidently to be ſet aſide. And as to the other two cities, *Harlem* and *Mentz*, the diſputes between them ſeem eaſily cleared up, from the twofold invention of printing above mentioned: the firſt with *ſeparate* WOODEN *types* at Harlem, by Laurentius, about 1430, and after continued by his family; the other with METAL *types*, firſt *cut*, and afterwards *caſt*, invented at Mentz, but not uſed in Holland till brought thither by Theodoric Martens at Aloſt about 1472.

From this period printing made a rapid progreſs in moſt of the principal towns of Europe. In 1490, it reached Conſtantinople; and, according to Mr. Palmer, p. 281, &c. it was extended, by the middle of the next century, to Africa and America. It was introduced into Ruſſia about 1560: but, from motives either of policy or ſuperſtition, it was ſpeedily ſuppreſſed by the ruling powers; and even at preſent has ſcarcely emerged from its obſcurity.—That it was early practiſed in the inhoſpitable regions of Iceland, we have the reſpectable authority of Mr. Bryant: "Arngrim Jonas was born amidſt the ſnows of Iceland; yet as much prejudiced in favour of his country as thoſe who are natives of a happier climate. This is viſible in his *Crymogæa*; but more particularly in his *Anatome Bleſkiniana*. I have in my poſſeſſion this curious little treatiſe, written in Latin by him in his own country, and printed *Typis Holenſibus in Iſlandia Boreali, anno* 1612. *Hola* is placed in ſome maps within the Arctic circle, and is certainly not far removed from it. I believe it is the furtheſt north of any place where arts and ſciences have ever reſided." *Obſervations and Inquiries relating to various parts of Ancient Hiſtory*, 1767, p. 277.

It was a conſtant opinion, delivered down by our hiſtorians, as hath been obſerved by Dr. Middleton, that the Art of Printing was introduced and firſt practiſed in England by *William Caxton*, a mercer and citizen of London; who, by his travels abroad, and a reſidence of many years in Holland, Flanders, and Germany, in the affairs of trade, had an opportunity of informing himſelf of the whole method and proceſs of the art; and by the encouragement of the great, and particularly of the abbot of Weſtminſter, firſt ſet up a preſs in that abbey, and began to print books ſoon after the year 1471.

This was the tradition of our writers; till a book, which had ſcarce been obſerved before the Reſtoration, was then taken notice of by the curious, with a date of its impreſſion from Oxford, anno 1468, and was conſidered immediately as a clear proof and monument of the exerciſe of printing in that univerſity ſeveral years before Caxton began to deal in it.

This book, which is in the public library at Cambridge, is a ſmall volume of 41 leaves in 4to, with this title: *Expoſitio Sancti Jeronimi in Simbolum Apoſtolorum ad Papam Laurentium*: and at the end, *Explicit expoſitio, &c. Impreſſ. Oxonie, & finita Anno Domini* M.CCCC.LXVIII. XVII. *die Decembris*.

The appearance of this book has robbed Caxton of a glory that he had long poſſeſſed, of being the author of printing in this kingdom; and Oxford has ever ſince carried the honour of the firſt preſs. The only difficulty was, to account for the ſilence of hiſtory in an event ſo memorable, and the want of any memorial in the univerſity itſelf concerning the eſtabliſhment of a new art amongſt them of ſuch uſe and benefit to learning. But this likewiſe has been cleared up by the diſcovery of a record, which had lain obſcure and unknown at Lambeth-palace, in the Regiſter of the See of Canterbury; and gives a narrative of the whole tranſaction, drawn up at the very time.

An account of this record was firſt publiſhed in a thin quarto volume in Engliſh, with this title: "The Original and Growth of Printing, collected out of Hiſtory and the Records of this Kingdome: wherein is alſo demonſtrated, that Printing appertaineth to the Prerogative Royal, and is a Flower of the Crown of England. By Richard Atkyns, eſq.—Whitehall, April the 25. 1664. By order and appointment of the right honourable Mr. Secretary Morrice, let this be printed. Tho. Rycaut. London: Printed by John Streater, for the Author. 1664." Quarto.

It ſets forth in ſhort, "That as ſoon as the art of printing made ſome noiſe in Europe, Thomas Bourchier, archbiſhop of Canterbury, moved the then king (Henry VI.) to uſe all poſſible means for procuring a printing-mould (for ſo it was then called) to be brought into this kingdom. The king, (a good man, and much given to works of this nature) readily hearkened to the motion; and taking private advice how to effect his deſign, concluded it could not be brought about without great ſecrecy, and a conſiderable ſum of money given to ſuch perſon or perſons as would draw off ſome of the workmen of Harlem in Holland, where John Gutenberg had newly invented it, and was himſelf perſonally at work. It was reſolved, that leſs than 1000 merks would not produce the deſired effect; towards which ſum the ſaid archbiſhop preſented the king 300 merks. The money being now prepared, the management of the deſign was committed to Mr. Robert Turnour; who then was maſter of the robes to the king, and a perſon moſt in favour with him of any of his condition. Mr. Turnour took to his aſſiſtance Mr. Caxton, a citizen of good abilities, who traded much into Holland; which was a creditable pretence, as well for his going, as ſtay in the Low Countries. Mr. Turnour was in diſguiſe (his beard and hair ſhaven quite off); but Mr. Caxton appeared known and public. They, having received the ſaid ſum of 1000 merks, went firſt to Amſterdam, then to Leyden, not daring to enter Harlem itſelf; for the town was very jealous, having impriſoned and apprehended divers perſons who came from other parts for the ſame purpoſe. They ſtaid till they had ſpent the whole thouſand merks in gifts and expenſes: ſo as the king was fain to ſend 500 merks more, Mr. Turnour having written to the king that he had almoſt done his work; a bargain, as he ſaid, being ſtruck betwixt him and two Hollanders, for bringing off one of the under workmen, whoſe name was Frederick Corſells (or rather Corſellis), who late one night ſtole from his fellows in diſguiſe into a veſſel prepared before for that purpoſe; and ſo, the wind favouring the deſign, brought him ſafe to London. It was not thought ſo prudent to ſet him on work in London: but by the archbiſhop's means (who had been vice-chancellor and afterwards chancellor of the univerſity of Oxon) Corſellis was carried with a guard to Oxon; which guard conſtantly watched, to prevent Corſellis from any poſſible eſcape, till he had made good his promiſe in teaching them how to print. So that at Oxford printing was firſt ſet up in England, which was before there was any printing-preſs or printer in France, Spain, Italy, or Germany (except the city of Mentz), which claims ſeniority, as to printing, even of Harlem itſelf, calling her city, *Urbem Moguntinam artis typographicæ inventricem primam*; though it is known to be otherwiſe, that city gaining the art by the brother of one of the workmen of Harlem, who had learnt it at home of his brother, and after ſet up for himſelf at Mentz. This preſs at Oxon was at leaſt ten years before there was any printing in Europe, except at Harlem and Mentz, where it was but new-born. This preſs at Oxford was afterwards found inconvenient to be the ſole printing-place of England, as being too far from London and the ſea; wherefore the king ſet up a preſs at St. Alban's, and another in the city of Weſtminſter, where they printed ſeveral books of *divinity* and *phyſic: for the king* (for reaſons beſt known to himſelf and council) *permitted then no law-books to be printed;* nor did any printer exerciſe that art, but only ſuch as were the king's ſworn ſervants; *the king himſelf having the price and emolument for printing books.* By this means the art grew ſo famous, that anno primo Richard III. c. 9. when an act of parliament was made for reſtraint of aliens for uſing any handicrafts here except as ſervants to natives), a ſpecial proviſo was inſerted, that ſtrangers might bring in printed or written books to ſell at their pleaſure, and exerciſe the art of printing here, notwithſtanding that act: ſo that in the ſpace of 40 or 50 years, by the indulgence of Edward IV. Edward V. Richard III. Henry VII. and Hen. VIII. the Engliſh proved ſo good proficients in printing, and grew ſo numerous, as to furniſh the kingdom with books; and ſo ſkilful, as to print them as well as any beyond the ſeas; as appears by the act 25 Hen. VIII. c. 15. which abrogates the ſaid proviſo for that reaſon. And it was further enacted in the ſame ſtatute, that if any perſon bought foreign books bound, he ſhould pay 6s. 8d. per book. And it was further provided and enacted, that in caſe the ſaid printers and ſellers of books were unreaſonable in their prices, they ſhould be moderated by the lord chancellor, lord treaſurer, the two lords chief juſtices, or any two of them; who alſo had power to fine them 3s. 4d. for every book whoſe price ſhould be enhanced.—But when they were by charter corporated with *bookbinders*, *bookſellers*, and *founders of letters*, 3 and 4 Philip and Mary, and called *The Company of Stationers*—they kick'd againſt the power that gave them life, &c.—Queen Elizabeth, the firſt year of her reign, grants by patent *the privilege of ſole printing all books that touch or concern the common laws of England*, to Tottel a ſervant to her majeſty, who kept it entire to his death; after him, to one Yeſt Weirt, another ſervant to her majeſty; after him, to Weight and Norton; and after them, king James grants the ſame privilege to More, one of the ſignet; which grant continues to this day, &c."

From the authority of this record, all our later writers declare Corſellis to be the firſt printer in England; Mr. Anthony Wood, the learned Mr. Maittaire, Palmer, and one John Bagford, an induſtrious man, who had publiſhed propoſals for Hiſtory of Printing, (Phil. Tranſ. for April 1707). But Dr. Middleton has called in queſtion the authenticity of this account, and has urged ſeveral objections to it, with the view of ſupporting Caxton's title to the precedency with reſpect to the introduction of the art into this country; of which we ſhall quote one or two, with the anſwers that have been made to them.

Objection 1.—"The ſilence of Caxton concerning a fact in which he is ſaid to be a principal actor, is a ſufficient confutation of it: for it was a conſtant cuſtom with him, in the prefaces or concluſions of his works, to give a hiſtorical account of all his labours and tranſactions, as far as they concerned the publiſhing and printing of books. And what is ſtill ſtronger, in the continuation of the Polychronicon, compiled by himſelf, and carried down to the end of Henry the ſixth's reign, he makes no mention of the expedition in queſt of a printer: which he could not have omitted, had it been true; whilſt in the ſame book he takes notice of the invention and beginning of printing in the city of Mentz."

Anſwer.—As Caxton makes no mention in his Polychronicon of his *expedition in queſt of a printer*; ſo neither does he of his *bringing the art into England*, which it is as much a wonder he ſhould omit as the other. And as to his ſaying that *the invention of printing was at Mentz*, he means, of printing on *fuſile* ſeparate types. In this he copies, as many others have, from the *Faſciculus Temporum*, a work written in 1470, by Wernerus Rolevinch de Laer, a Carthuſian monk, a MS. copy of which was in the library of Gerard Jo. Voſſius (ſee lib. iii. *de Hiſtor. Latin.* c. 6.); and afterwards continued to the year 1474, when it was firſt printed at Cologne *typis Arnoldi ter Huernen*. It was republiſhed in 1481 by Heinricus Wirczburgh de Vach, a Cluniac monk, without mentioning the name either of the printer or of the place of publication. It is plain that Caxton had one at leaſt, or more probably both, of theſe editions before him, when he wrote his continuation of Polychronicon, as he mentions this work in his preface, and adopts the ſentiments of its editor. (See Meerman, vol. ii. p. 37, and his *Documenta*, No. VII. XXIV. and XXV.)

Obj. 2.—"There is a further circumſtance in Caxton's hiſtory, that it ſeems inconſiſtent with the record; for we find him ſtill beyond ſea, about twelve years after the ſuppoſed tranſactions, "learning with great charge and trouble the art of printing" (*Recule of the Hiſtories of Troye*, in the end of the 2d and 3d books); which he might have done with eaſe at home, if he had got Corſellis into his hands, as the record imports, ſo many years before: but he probably learnt it at Cologne, where he reſided in 1471, (*Recule*, &c. ibid.), and whence books had been firſt printed with date the year before."

Anſ.—Caxton tells us, in the preface to *The Hiſtory of Troye*, that he began that tranſlation March 1. 1468, at Bruges; that he proceeded on with it at Ghent; that he finiſhed it at Cologne in 1471; and printed it, probably, in that city with his own types. He was 30 years abroad, chiefly in Holland; and lived in the court of Margaret ducheſs of Burgundy, ſiſter of Edward IV. It was therefore much eaſier to print his book at Cologne, than to croſs the ſea to learn the art at Oxford. But further, there was a ſpecial occaſion for his printing it abroad. Corſellis had brought over ſo far the art of printing as he had learned it at Harlem, which was the method of printing on *wooden ſeparate* types, having the face of the letter cut upon them. But the art of *caſting* metal types being divulged in 1462 by the workmen of Mentz, Caxton thought proper to learn that advantageous branch before he returned to England. This method of caſting the types was ſuch an improvement, that they looked on it as the *original* of printing; and Caxton, as moſt others do, aſcribes that to Mentz.—Caxton was an aſſiſtant with Turnour in getting off Corſellis; but it is nowhere ſuppoſed that he came with him into England. (See Meerman, vol. ii. p. 34. B.)

Obj. 3.—"As the Lambeth record was *never heard of before the publication of Atkyns' book*, ſo it has never ſince been ſeen or produced by any man; though the regiſters of Canterbury have on many occaſions been diligently and particularly ſearched for it. They were examined, without doubt, very carefully by archbiſhop Parker, for the compiling his *Antiquities of the Britiſh Church*; where, in the life of Thomas Bourchier, though he congratulates that age on the noble and uſeful invention of printing, yet he is ſilent as to the introduction of it into England by the endeavours of that archbiſhop: nay, his giving the honour of the invention to Straſburg clearly ſhows that he knew nothing of the ſtory of Corſellis conveyed from Harlem, and that the record was not in being in his time. Palmer himſelf owns, "That it is not to be found there now; for that the late earl of Pembroke aſſured him, that he had employed a perſon for ſome time to ſearch for it, but in vain:" (*Hiſt. of Printing*, p. 314.) On theſe grounds we may pronounce the record to be a forgery; though all the writers above-mentioned take pains to ſupport its credit, and call it an *authentic piece*.

Atkyns, who by his manner of writing ſeems to have been *a bold and vain man*, might poſſibly be *the inventor*: for he had an intereſt in impoſing it upon the world, in order to confirm the argument of his book, that *printing was of the prerogative royal*; in oppoſition to the *company of ſtationers*, with whom he was engaged in an expenſive ſuit of law, in defence of the *king's patents*, under which he claimed *ſome excluſive powers of printing*. For he tells us, p. 3. 'That, upon conſidering the thing, he could not but think that a public perſon, more eminent than a mercer, and a public purſe, muſt needs be concerned in ſo public a good: and the more he conſidered, the more inquiſitive he was to find out the truth. So that he had formed his hypotheſis before he had found his record; which he publiſhed, he ſays, as a friend to truth; not to ſuffer one man to be intitled to the worthy atchievements of another; and as a friend to himſelf, not to loſe one of his beſt arguments of intitling the king to this art.' But, if Atkyns was not himſelf the contriver, he was impoſed upon at leaſt by ſome more crafty man; who imagined that his intereſt in the cauſe, and the warmth that he ſhowed in proſecuting it, would induce him to ſwallow for genuine whatever was offered of the kind."

Anſ.—On the other hand, is it likely that Mr. Atkyns would dare to *forge* a record, to be laid before the king and council, and which his adverſaries, with whom he was at law, could diſprove?—(2.) He ſays he received this hiſtory from a perſon of honour, who was ſome time keeper of the Lambeth library. It was eaſy to have confuted this evidence, if it was falſe, when he publiſhed it, April 25. 1664.—(3.) John Bagford (who was born in England 1651, and might know Mr. Atkyns, who died in 1677), in his Hiſtory of Printing at Oxford, blames thoſe who doubted of the authenticity of the Lambeth MS.; and tells us that he knew Sir John Birkenhead had an authentic copy of it, when in 1665 [which Bagford by ſome miſtake calls 1664, and is followed in it by Meerman] he was appointed by the houſe of commons to draw up a bill relating to the exerciſe of that art. This is confirmed by the Journals of that houſe, Friday Oct. 27. 1665. vol. VIII. p. 626. where it is ordered, that this Sir John Birkenhead ſhould carry the bill on that head to the houſe of lords for their conſent.—The act was agreed to in the upper houſe on Tueſday Oct. 31. and received the royal aſſent on the ſame day; immediately after which the parliament was prorogued. See *Journals of the Houſe of Lords*, Vol. XI. p. 700.—It is probable, then, that after Mr. Atkyns had publiſhed his book in April 1664, the parliament thought proper, the next year, to enquire into *the right of the king's prerogative*; and that Sir John Birkenhead took care to inſpect the original, then in the cuſtody of archbiſhop Sheldon: and, finding it not ſufficient to prove what Mr. Atkyns had cited it for, made no report of the MS. to the houſe; but only moved, that the former law ſhould be renewed. The MS. was probably never returned to the proper keeper of it; but was afterwards burnt in the fire of London, Sept. 13. 1666.—(4.) That printing was practiſed at Oxford, was a prevailing opinion long before Atkyns. Bryan Twyne, in his *Apologia pro Antiquitate Academiæ Oxonienſis*, publiſhed 1608, tells us, it is ſo delivered down in *ancient writings*; having heard, probably, of this Lambeth MS. And king Charles I. in his letters patent to the Univerſity of Oxford, March 5. in the eleventh of his reign, 1635, mentions printing as brought to *Oxford* from abroad. As to what is objected, "that it is not likely that the preſs ſhould undergo a ten or eleven years ſleep, viz. from 1468 to 1479," it is probably urged without foundation. Corſellis might print ſeveral books without date or name of the place, as Ulric Zell did at Cologne, from 1467 to 1473, and from that time to 1494. Corſellis's name, it may be ſaid, appears not in any of his publications; but neither does that of Joannes Peterſhemius. [See Meerman, vol. I. p. 34; vol. II. p. 21—27, &c.

Further, the famous Shakeſpeare, who was born in 1564, and died 1616, in the Second Part of Henry VI. act iv. ſc. 7. introduces the rebel John Cade thus upbraiding Lord Treaſurer Say: "Thou haſt moſt traiterouſly corrupted the youth of the realm, in creating a grammar-ſchool: and whereas, before, our forefathers had no other book but the ſcore and the tally, thou haſt cauſed *Printing* to be uſed; and, contrary to the king, his crown, and dignity, thou haſt built a paper-mill."—Whence now had Shakeſpeare this accuſation againſt lord Say? We are told in the Poetical Regiſter, vol. II. p. 231. ed. Lond. 1724, that it was from Fabian, Pol. Virgil, Hall, Hollingſhed, Grafton, Stow, Speed, &c. But not one of theſe aſcribes printing to the reign of Henry VI. On the contrary, Stow, in his Annals, printed at London 1560, p. 686, gives it expreſsly to William Caxton, 1471. "The noble ſcience of printing was about this time found out in Germany at Magunce, by one John Guthumburgus a knight. One Conradus an Almaine brought it into Rome: William Caxton of London mercer, brought it into England about the year 1471, and firſt practiſed the ſame in the Abbie of St Peter at Weſtminſter; after which time it was likewiſe practiſed in the Abbies of St Auguſtine at Canterburie, Saint Albons, and other monaſteries of England." What then ſhall we ſay, that the above is an anachroniſm arbitrarily put into the mouth of an ignorant fellow out of Shakeſpeare's head? We might believe ſo, but that we have the record of Mr Atkyns confirming the ſame in king Charles II.'s time. Shall we ſay, that Mr Atkyns borrowed the ſtory from Shakeſpeare, and publiſhed it with ſome improvements of money laid out by Henry VI. from whence it might be received by Charles II. as a prerogative of the crown? But this is improbable, ſince Shakeſpeare makes Lord Treaſurer Say the inſtrument of importing it, of whom Mr Atkyns mentions not a word. Another difference there will ſtill be between Shakeſpeare and the Lambeth MS.; the poet placing it before 1449, in which year Lord Say was beheaded; the MS. between 1454 and 1459, when Bourchier was archbiſhop. We muſt ſay, then, that lord Say firſt laid the ſcheme, and ſent ſome one to Harlem, though without ſucceſs; but after ſome years it was attempted happily by Bourchier. And we muſt conclude, that as the generality of writers have overlooked the invention of printing at Harlem with *wooden* types, and have aſcribed it to Mentz where *metal* types were firſt made uſe of; ſo in England they have paſſed by Corſellis (or the firſt *Oxford Printer*, whoever he was, who printed with *wooden* types at Oxford), and only mentioned Caxton as the original artiſt who printed with *metal* types at Weſtminſter. [See Meerman, vol. ii. 7, 8.] It is ſtrange, that the learned commentators on our great dramatic poet, who are ſo minutely particular upon leſs important occaſions, ſhould every one of them, Dr. Johnſon excepted, paſs by this curious paſſage, leaving it entirely unnoticed. And how has Dr. Johnſon trifled, by ſlightly remarking, "that Shakeſpeare is a little *too early* with this accuſation!"—The great critic had undertaken to decipher obſolete words, and inveſtigate unintelligible phraſes; but never, perhaps, beſtowed a thought on Caxton or Corſellis, on Mr. Atkyns or the authenticity of the Lambeth Record.

But, independent of the record altogether, the book ſtands firm as a monument of the exerciſe of printing in Oxford ſix years older than any book of Caxton's with a date. In order to get clear of this ſtrong fact, Dr. Middleton

1. Suppoſes the date in queſtion to have been falſified originally by the printer, either by deſign or miſtake; and an X to have been dropped or omitted in the age of its impreſſion. Examples of this kind, he ſays, are common in the hiſtory of printing. And, "whilſt I am now writing, an unexpected inſtance is fallen into my hands, to the ſupport of my opinion; an *Inauguration Speech of the Woodwardian Profeſſor, Mr. Maſon,* juſt freſh from the preſs, with its date given 10 years earlier than it ſhould have been, by the omiſſion of an x, viz. MDCCXXIV; and the very blunder exemplified in the laſt piece printed at Cambridge, which I ſuppoſe to have happened in the firſt from Oxford."——To this it has been very properly anſwered, That we ſhould not pretend to ſet aſide the authority of *a plain date,* without very ſtrong and cogent reaſons; and what the Doctor has in this caſe advanced will not appear, on examination, to carry that weight with it that he ſeems to imagine. There may be, and have been, miſtakes and forgeries in the date both of books and of records too; but this is never allowed as a reaſon for ſuſpecting ſuch as bear no mark of either. We cannot from a blunder in the laſt book printed at Cambridge, infer a like blunder in the firſt book printed at Oxford. Beſides, the *type* uſed in this our Oxford edition ſeems to be no ſmall proof of its antiquity. It is the German letter, and very nearly the ſame with that uſed by Fuſt [who has been ſuppoſed to be] the firſt printer; whereas Caxton and Rood uſe a quite different letter, ſomething between this German and our old Engliſh letter, which was ſoon after introduced by De Worde and Bynſon.

2. "For the probability of his opinion (he ſays), the book itſelf affords ſufficient proof: for, not to inſiſt on what is leſs material, the *neatneſs of the letter, and regularity of the page,* &c. above thoſe of Caxton, it has one mark, that ſeems to have carried the matter beyond probable, and to make it even certain, viz. *the uſe of ſignatures,* or letters of the alphabet placed at the bottom of the page, to ſhow the ſequel of the pages and leaves of each book; an improvement contrived for the direction of the bookbinders; which yet was not practiſed or invented at the time when this book is ſuppoſed to be printed; for we find no ſignatures in the books of Fauſt or Schoeffer at Mentz, nor in the improved or beautiful impreſſions of John de Spira and Jenſon at Venice, till ſeveral years later. We have a book in our library, that ſeems to fix the very time of their invention, at leaſt in Venice; the place where the art itſelf received the greateſt improvements: *Baldi lectura ſuper Codic. &c.* printed by *John de Colonia* and *Jo. Manthem de Gherretzem, anno* MCCCCLXXIIII. It is a large and fair volume in folio, *without ſignatures,* till about the middle of the book, in which they are firſt introduced, and ſo continued forward: which makes it probable, that the firſt thought of them was ſuggeſted during the impreſſion; for we have likewiſe *Lectura Bartholi ſuper Codic.* &c. in two noble and beautiful volumes in folio, printed the year before at the ſame place, by Vindelin de Spira, without them: yet from this time forward they are generally found in all the works of the Venetian printers, and from them propagated to the other printers of Europe. They were uſed at[*] Cologne, in 1475; at Paris, 1476; by Caxton, not before 1480: but if the diſcovery had been brought into England, and practiſed at Oxford 12 years before, it is not probable that he would have printed ſo long at Weſtminſter without them. Mr. Palmer indeed tells us, p. 54, 180, that Anthony Zarot was eſteemed the inventor of ſignatures; and that they are found in a Terence printed by him at Milan in the year 1470, in which he firſt printed. I have not ſeen that Terence; and can only ſay, that I have obſerved the want of them in ſome later works of this, as well as of other excellent printers of the ſame place. But, allowing them to be in the Terence, and Zarot the inventor, it confutes the date of our Oxford book as effectually as if they were of later origin at Venice; as I had reaſon to imagine, from the teſtimony of all the books that I have hitherto met with."——As to theſe proofs, firſt, the neatneſs of the letter, and the regularity of the page, prove, if any thing, the very reverſe of what the Doctor aſſerts. The art of printing was almoſt in its infancy brought to perfection; but afterwards debaſed by later printers, who conſulted rather the cheapneſs than the neatneſs of their work. Our learned diſſertator cannot be unacquainted with the labours of Fuſt and Jenſon. He muſt know, that though other printers may have printed more correctly, yet ſcarce any excel them, either in the neatneſs of the letter, or the regularity of the page. The ſame may be obſerved in our Engliſh printers. Caxton and Rood were indifferently good printers; De Worde and Pynſon were worſe; and thoſe that follow them moſt abominable. This our *anonymous Oxford printer* excells them all; and for this very reaſon we ſhould judge him to be the moſt ancient of all. Our diſſertator lays great ſtreſs on the uſe of ſignatures. But no certain concluſion can be drawn either from the uſe or non-uſe of theſe leſſer improvements of printing. They have in different places come in uſe at different times, and have not been continued regularly even at the ſame places. If Anthony Zarot uſed them at Milan in 1470, it is certain later printers there did not follow his example; and the like might happen alſo in England. But, what is more full to our purpoſe, we have in the Bodleian library an Æſop's Fables printed by Caxton. This is, it is believed, the firſt book which has *the leaves numbered.* But yet this improvement, though more uſeful than that of the ſignatures, was diſuſed both by Caxton, himſelf and other later printers in England. It is therefore not at all ſurpriſing (if true) that the ſignatures, though invented by our Oxford printer, might not immediately come into general uſe. And conſequently, this particular carries with it no ſuch certain or effectual confutation as our diſſertator boaſts of.

3. What the Doctor thinks further confirms his opinion is, "That, from the time of the pretended date of this book, *anno* 1468, we have no other fruit or production from the preſs at Oxford for 11 years next following; and it cannot be imagined that a preſs, eſtabliſhed with ſo much pains and expenſe, could be ſuffered to be ſo long idle and uſeleſs."—To this it may be anſwered, in the words of Oxonides, 1ſt, That his books may have been loſt. Our firſt printers, in thoſe days of ignorance, met with but ſmall encouragement; they printed but

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[*] Dr. Middleton is miſtaken in the time and place of the invention of ſignatures. They are to be found even in very ancient MSS. which the earlieſt printers very ſtudiouſly imitated; and they were even uſed in ſome editions from the office of Lawrence Coſter (whence Corſellis came), which conſiſted of wooden cuts, as in *Figuræ typicæ et antitypicæ Novi Teſtamenti*; and in ſome editions with metal types, as in *Gaſp. Pergamenſis epiſtolæ,* publiſhed at Paris, without a date, but printed A. D. 1470, (Maittaire, Annal. vol. i. p. 25.); and in *Mammetrectus,* printed by Helias de Llouffen, at Bern in Switzerland, 1470; and in *De Tondeli viſione,* at Antwerp, 1472. Venice, therefore, was not the place where they were firſt introduced.—They began to be uſed in *Baldus,* it ſeems, when the book was half finiſhed. The printer of that book might not know, or did not think, of the uſe of them before. See *Meerman,* vol. ii. p. 18.; and *Phil. Tranſ.* vol. xxiii. nº 208. p. 1509.

few books, and but few copies of thoſe books. In after times, when the ſame books were reprinted more correctly, thoſe firſt editions, which were not as yet become curioſities, were put to common uſes. This is the reaſon that we have ſo few remains of our firſt printers. We have only four books of Theoderic Rood, who ſeems by his own verſes to have been a very celebrated printer. Of John Lettou-William de Machlinia, and the ſchoolmaſter of St. Alban's, we have ſcarce any remains. If this be conſidered, it will not appear *impoſſible* that our printer ſhould have followed his buſineſs from 1468 to 1479, and yet time have deſtroyed his intermediate works. But, 2dly, We may account ſtill another way for this diſtance of time without altering the date. The Civil Wars broke out in 1469: this might probably oblige our Oxford printer to ſhut up his preſs; and both himſelf and his readers be otherwiſe engaged. If this were the caſe, he might not return to his work again till 1479; and the next year, not meeting with that encouragement he deſerved, he might remove to ſome other country with his types.

Dr. Middleton concludes with apologizing for his "ſpending ſo much pains on an argument ſo inconſiderable, to which he was led by his zeal to do a piece of juſtice to the memory of our worthy countryman William Caxton; nor ſuffer him to be robbed of the glory ſo clearly due to him, of having *firſt imported into this kingdom* an art of great uſe and benefit to mankind: a kind of merit that, in the ſenſe of all nations, gives the beſt title to true praiſe, and the beſt claim to be commemorated with honour to poſterity."

The fact, however, againſt which he contends, but which it ſeems impoſſible to overturn, does by no means derogate from the honour of Caxton, who, as has been ſhown, was the firſt perſon in England that practiſed the art of printing with *fuſile types*, and conſequently the firſt who brought it to perfection; whereas Corſellis printed with *ſeparate cut types in wood*, being the only method which he had learned at Harlem. Into this detail, therefore, we have been led, not ſo much by the importance of the queſtion, as on account of ſeveral anecdotes connected with it, which ſeemed equally calculated to ſatisfy curioſity and afford entertainment.

Caxton had been bred very reputably in the way of trade, and ſerved an apprenticeſhip to one Robert Large a mercer; who, after having been ſheriff and lord mayor of London, died in the year 1441, and left by will, as may be ſeen in the prerogative-office, XXIIII merks to his apprentice William Caxton: a conſiderable legacy in thoſe days, and an early teſtimonial of his good character and integrity.

From the time of his maſter's death, he ſpent the following thirty years beyond ſea in the buſineſs of merchandiſe: where, in the year 1464, we find him employed by Edward IV, in a public and honourable negotiation, jointly with one Richard Whitehill, eſq to tranſact and conclude a treaty of commerce between the king and his brother-in-law the duke of Burgundy, to whom Flanders belonged. The commiſſion ſtyles them, *ambaſſiatores, procuratores, nuncios, & deputatos ſpeciales*; and gives to both or either of them full powers to treat, &c.

Whoever turns over his printed works, muſt contract a reſpect for him, and be convinced that he preſerved the ſame character through life, of an honeſt, modeſt man; greatly induſtrious to do good to his country to the beſt of his abilities, by ſpreading among the people ſuch books as he thought uſeful to religion and good manners, which were chiefly tranſlated from the French. The novelty and uſefulneſs of his art recommended him to the ſpecial notice and ſavour of the great; under whoſe protection, and at whoſe expenſe, the greateſt part of his works were publiſhed. Some of them are addreſſed to king Edward IV. his brother the duke of Clarence, and their ſiſter the ducheſs of Burgundy; in whoſe ſervice and pay he lived many years before he began to print, as he often acknowledges with great gratitude. He printed likewiſe for the uſe, and by the expreſs order of Henry VII. his ſon prince Arthur, and many of the principal nobility and gentry of that age.

It has been generally aſſerted and believed, that all his books were printed in the abbey of Weſtminſter; yet we have no aſſurance of it from himſelf, nor any mention of the place before the year 1477: ſo that he had been printing ſeveral years without telling us where.

There is no clear account left of Caxton's age: but he was certainly very old, and probably above fourſcore at the time of his death. In the year 1471 he complained of the infirmities of age creeping upon him, and feebling his body: yet he lived 23 years after, and purſued his buſineſs, with extraordinary diligence, in the abbey of Weſtminſter, till the year 1494, in which he died; not in the year following, as all who write of him affirm. This appears from ſome verſes at the end of a book, called "Hilton's Scale of Perfection," printed in the ſame year:

> Infynite laud with thankynges many folde
> I yield to God me ſocouryng with his grace
> This boke to finyſhe which that ye beholde
> Scale of Perfection calde in every place
> Whereof th' auctor Walter Hilton was
> And Wynkyn de Worde this hath ſett in print
> In William Caxſtons hows ſo fyll the caſe,
> God reſt his ſoule. In joy ther mot it ſtynt.
> Impreſſus anno ſalutis MCCCCLXXXXIIII.

Though he had printed for the uſe of Edward IV. and Henry VII. yet there appears no ground for the notion which Palmer takes up, that the firſt printers, and particularly Caxton, were ſworn ſervants and printers to the crown; for Caxton, as far as can be obſerved, gives not the leaſt hint of any ſuch character or title; though it ſeems to have been inſtituted not long after his death; for of his two principal workmen, Richard Pynſon and Wynkyn de Worde, the one was made printer to the king, the other to the king's mother the Lady Margaret. Pynſon gives himſelf the firſt title, in *The Imitation of the Life of Chriſt*; printed by him at the commandment of the Lady Margaret, who had tranſlated the fourth book of it from the French, in the year 1504: and Wynkyn de Worde aſſumes the ſecond, in *The ſeven Penitential Pſalms*, expounded by Biſhop Fiſher, and printed in the year 1509. But there is the title of a book given by Palmer, that ſeems to contradict what is here ſaid of Pynſon: viz. *Pſalterium ex mandato victorioſiſſimi Angliæ Regis Henrici Septimi, per Gulielmum Fanque, impreſſorem regium*, anno MDIIII; which being the only work that has ever been found of this printer, makes it probable that he died in the very year of its impreſſion, and was ſucceeded immediately by Richard Pynſon. No book hath yet been diſcovered printed in Scotland in this period, though the Engliſh printers were able to tranſport ſome of their works to other countries. See *Henry's Hiſtory of Great Britain*, vol. v. p. 471.

Before 1465, the uniform character was the old *Gothic* or *German*; whence our *Black* was afterwards formed. But in that year an edition of Lactantius was printed in a kind of Semi-Gothic, of great elegance, and approaching nearly to the preſent *Roman* type; which laſt was firſt uſed at Rome in 1467, and ſoon after brought to great perfection in Italy, particularly by Jenſon.

Towards the end of the 15th century, Aldus invented the *Italic* character which is now in uſe, called, from his name, *Aldine* or *curſivus*. This ſort of letter he contrived, to prevent the great number of abbreviations that were then in uſe.

The firſt eſſays in Greek that can be diſcovered are a few ſentences which occur in the edition of Tully's *Offices*, 1465, at Mentz; but theſe were miſerably incorrect and barbarous, if we may judge from the ſpecimens Mr. Maittaire has given us, of which the following is one:

Οτιcαταaxaρτμaxaτa καὶ τατωτωκa.

In the ſame year, 1465, was publiſhed an edition of Lactantius's *Inſtitutes*, printed *in monaſterio Sublacenſi*, in the kingdom of Naples, in which the quotations from the Greek authors are printed in a very neat Greek letter. They ſeem to have had but *a very ſmall quantity* of Greek types in the monaſtery; for, in the firſt part of the work, whenever a long ſentence occurred, a blank was left, that it might be written in with a pen: after the middle of the work, however, all the Greek that occurs is printed.

The firſt printers who ſettled at Rome were Conrad Sweynheim and Arnold Pannartz, who introduced the preſent *Roman* type, in 1466, in Cicero's *Epiſtolæ Familiares:* in 1469 they printed a beautiful edition of *Aulus Gellius*, with the Greek quotations in a fair character, without accents or ſpirits, and with very few abbreviations.

The firſt whole Greek book that is yet known is the Greek Grammar of Conſtantine Laſcaris, in quarto, reviſed by Demetrius Cretenſis, and printed by Dionyſius Palaviſinus, at Milan, 1476. In 1481, the Greek *Pſalter* was printed here, with a Latin tranſlation, in folio; as was Æſop's Fables in quarto.

Venice ſoon followed the example of Milan; and in 1486 were publiſhed in that city the *Greek Pſalter* and the *Batrachomyomachia;* the former by Alexander, and the latter by Laonicus, both natives of Crete. They were printed in a very uncommon character; the latter of them with *accents* and *ſpirits*, and alſo with *ſcholia*.

In 1 88, however, all former publications in this language were eclipſed by a fine edition of *Homer's Works* at Florence, in folio, printed by Demetrius, a native of Crete. Thus printing (ſays Mr. Maittaire, p. 185.) ſeems to have attained its acme of perfection, after having exhibited moſt beautiful ſpecimens of Latin, Greek, and Hebrew.

In 1493, a fine edition of *Iſocrates* was printed at Milan, in folio, by Henry German and Sebaſtian ex Pantremulo.

All the above works are prior in time to thoſe of Aldus, who has been erroneouſly ſuppoſed to be the *firſt* Greek printer: the beauty, however, correctneſs, and number of his editions, place him in a much higher rank than his predeceſſors; and his characters in general were more elegant than any before uſed. He was born in 1445, and died in 1515.

Though the noble Greek books of Aldus had raiſed an univerſal deſire of reviving that tongue, the French were backward in introducing it. The only pieces printed by them were ſome quotations, ſo wretchedly performed, that they were rather to be gueſſed at than read; in a character very rude and uncouth, and without accents. But Francis Tiſſard introduced the ſtudy of this language at Paris, by his Βιϐλος η γνωμαγυρικη, in 1507; and that branch of printing was afterwards ſucceſsfully practiſed by Henry, Robert, and Henry Stephens. See the article STEPHENS.

The earlieſt edition of the *whole Bible* was, ſtrictly ſpeaking, the Complutenſian Polyglott of cardinal Ximenes; but as that edition, though finiſhed in 1517, was not publiſhed till 1522, the *Venetian* Septuagint of 1518 may properly be called the firſt edition of the *whole* Greek Bible; Eraſmus having publiſhed the New Teſtament *only* at Baſil in 1516.

A very ſatisfactory account of Hebrew printing is thus given by Dr. Kennicott in his *Annual Accounts of the Collation of Hebrew MSS.* p. 112. "The method which ſeems to have been originally obſerved in printing the Hebrew Bible was juſt what might have been expected: 1. The Pentateuch, in 1482. 2. The Prior Prophets, in 1484. 3. The Poſterior Prophets, in 1486. 4. The Hagiographa, in 1487. And, after the four great parts had been thus printed ſeparately (each with a comment), the whole text (without a comment) was printed in one volume in 1488; and the text continued to be printed, as in theſe firſt editions, ſo in ſeveral others for 20 or 30 years, without marginal *Keri* or *Maſora*, and with greater arguments to the more ancient MSS. till about the year 1520 ſome of the Jews adopted later MSS. and the *Maſora*; which abſurd preference has obtained ever ſince."

Thus much for the ancient editions given by Jews.

In 1642 a Hebrew Bible was printed at Mantua under the care of the moſt learned Jews in Italy. This Bible had not been heard of among the Chriſtians in this country, nor perhaps in any other; though the nature of it is very extraordinary. The text indeed is nearly the ſame with that in other modern editions; but at the bottom of each page are various readings, amounting in the whole to above 2000, and many of them of great conſequence, collected from manuſcripts, printed editions, copies of the Talmud, and the works of the moſt renowned Rabbies. And in one of the notes is this remark:—"That in ſeveral paſſages of the Hebrew Bible the differences are ſo many and ſo great, that they know not which to fix upon as the true readings."

We cannot quit this ſubject without obſerving, on Dr. Kennicott's authority, that as the firſt printed Bibles are more correct than the latter ones; ſo the variations between the firſt edition, printed in 1488, and the edition of Vander Hooght, in 1705, at Amſterdam, in 2 vols. 8vo amount, upon the whole, to above 1200! See further *Bowyer and Nichols*, p. 112—117.

When the art of printing was firſt diſcovered, they only made uſe of one ſide of a page: they had not yet found out the expedient of impreſſing the other. When their editions were intended to be curious, they omitted to print the firſt letter of a chapter, for which they left a blank ſpace, that it might be painted or illuminated at the option of the purchaſer. Several ancient volumes of theſe early times have been found, where theſe letters are wanting, as they neglected to have them painted.

When the art of printing was firſt eſtabliſhed, it was the glory of the learned to be correctors of the preſs to the eminent printers. Phyſicians, lawyers, and biſhops themſelves, occupied this department. The printers then added frequently to their names thoſe of the correctors of the preſs; and editions were then valued according to the abilities of the corrector.

In the productions of early printing may be diſtinguiſhed the various ſplendid editions they made of *Primers* or *Prayer-books.* They were embelliſhed with cuts finiſhed in a moſt elegant taſte: many of them were ludicrous, and ſeveral were obſcene. In one of them an angel is repreſented crowning the Virgin Mary, and God the Father himſelf aſſiſting at the ceremony. We have ſeen in a book of natural hiſtory the Supreme Being repreſented as *reading* on the ſeventh day, when he reſted from all his works. Sometimes St Michael is ſeen overcoming Satan; and ſometimes St. Anthony appears attacked by various devils of moſt hideous forms. The *Prymer of Saliſbury*, 1533, is full of cuts: at the bottom of the title page there is the following remarkable prayer:

God be in my Hede,
And in my Underſtandynge.
God be in my Eyen,
And in my Lokynge.
God be in my Mouthe,
And in my Spekynge.
God be in my Herte,
And in my thinkinge.
God be at myn ende,
And at my departynge.

The workmen employed in the art of printing are of two kinds: *compoſitors*, who range and diſpoſe the letters into words, lines, pages &c. according to the copy delivered them by the author; and *preſſmen*, who apply ink upon the ſame, and take off the impreſſion. The types being caſt, the compoſitor diſtributes each kind by itſelf among the diviſions of two wooden frames, an upper and an under one, called *caſes*; each of which is divided into little cells or boxes. Thoſe of the upper caſe are in number 98: theſe are all of the ſame ſize; and in them are diſpoſed the capitals, ſmall capitals, accented letters, figures, &c. the capitals being placed in alphabetical order. In the cells of the lower caſe, which are 54, are placed the ſmall letters, with the points, ſpaces, &c. The boxes are here of different ſizes, the largeſt being for the letters moſt uſed; and theſe boxes are not in alphabetical order, but the cells which contain the letter ofteneſt wanted are neareſt the compoſitor's hand. Each caſe is placed a little aſlope, that the compoſitor may the more eaſily reach the upper boxes. The inſtrument in which the letters are ſet is called a *compoſing ſtick* (ſee pl. 20.), which conſiſts of a long and narrow plate of braſs or iron, &c. on the right ſide of which ariſes a ledge, which runs the whole length of the plate, and ſerves to ſuſtain the letters, the ſides of which are to reſt againſt it; along this ledge is a row of holes, which ſerve for introducing the ſcrew *a*, in order to lengthen or ſhorten the extent of the line, by moving the ſliders *b c* further from or nearer to the ſhorter ledge at the end *d*. Where marginal notes are required in a work, the two ſliding pieces *b c* are opened to a proper diſtance from each other in ſuch a manner as that while the diſtance between *d c* forms the length of the line in the text, the diſtance between the two ſliding-pieces forms the length of the lines for the notes on the ſide of the page. Before the compoſitor proceeds to compoſe, he puts a rule or thin ſlip of braſs-plate, cut to the length of the line, and of the ſame height as the letter, in the compoſing-ſtick, againſt the ledge, for the letter to bear againſt. Things thus prepared, the compoſitor having the copy lying before him, and his ſtick in his left-hand, his thumb being over the ſlider *c*; with the right he takes up the letters, ſpaces, &c. one by one, and places them againſt the rule, while he ſupports them with his left thumb by preſſing them to the end of the ſlider *c*, the other hand being conſtantly employed in ſetting in other letters: the whole being performed with a degree of expedition and addreſs not eaſy to be imagined.

A little being thus compoſed, if it end with a word or ſyllable, and exactly fill the meaſure, there needs no further care; otherwiſe, more ſpaces are to be put in, or elſe the diſtances leſſened, between the ſeveral words, in order to make the meaſure quite full, ſo that every line may end even. The ſpaces here uſed are pieces of metal exactly ſhaped like the ſhanks of the letters: they are of various thickneſſes, and ſerve to ſupport the letters, and to preſerve a proper diſtance between the words; but not reaching ſo high as the letters, they make no impreſſion when the work is printed. The firſt line being thus finiſhed, the compoſitor proceeds to the next; in order to which he moves the braſs-rule from behind the former, and places it before it, and thus compoſes another line againſt it after the ſame manner as before; going on thus till his ſtick be full, when he empties all the lines contained in it into the gally.

The compoſitor then fills and empties his compoſing-ſtick as before, till a complete page be formed; when he ties it up with a cord or pack-thread; and, ſetting it by, proceeds to the next, till the number of pages to be contained in a ſheet is completed; which done, he carries them to the impoſing ſtone, there to be ranged in order, and faſtened together in a frame called a *chaſe*; and this is termed *impoſing*. The chaſe is a rectangular iron frame, of different dimenſions according to the ſize of the paper to be printed, having two croſs pieces of the ſame metal, called a *long* and *ſhort croſs*, mortiſed at each end ſo as to be taken out occaſionally. By the different ſituations of theſe croſſes the chaſe is fitted for different volumes: for quartos and octavos, one traverſes the middle lengthwiſe, the other broadwiſe, ſo as to interſect each other in the centre: for twelves and twenty-fours, the ſhort croſs is ſhifted nearer to one end of the chaſe; for folios, the long croſs is left entirely out, and the ſhort one left in the middle; and for broadſides, both croſſes are ſet aſide. To dreſs the chaſe, or range and fix the pages therein, the compoſitor makes uſe of a ſet of furniture, conſiſting of ſlips of wood of different dimenſions, and about half an inch high, that they may be lower than the letters: ſome of theſe are placed at the top of the pages, and called *head-ſticks*; others between them to form the inner margin; others on the ſides of the croſſes, to form the outer margin, where the paper is to be doubled; and others in the form of wedges to the ſides and bottoms of the pages. Thus all the pages being placed at their proper diſtances, and ſecured from being injured by the chaſe and furniture placed about them, they are all untied, and faſtened together by driving ſmall pieces of wood called *quoins*, cut in the wedge form, up between the ſlanting ſide of the foot and the ſide ſticks and the chaſe, by means of a piece of hard wood and a mallet; and all being thus bound faſt together, ſo that none of the letters will fall out, it is ready to be committed to the preſſmen. In this condition the work is called a *form*; and as there are two of theſe forms required for every ſheet, when both ſides are to be printed, it is neceſſary the diſtances between the pages in each form ſhould be placed with ſuch exactneſs, that the impreſſion of the pages in one form ſhall fall exactly on the back of the pages of the other, which is called *regiſter*.

As it is impoſſible but that there muſt be ſome miſtakes in the work, either through the overſight of the compoſitor, or by the caſual tranſpoſition of letters in the caſes, a ſheet is printed off, which is called a *proof*, and given to the corrector; who reading it over, and rectifying it by the copy, making the alterations in the margin, it is delivered back to the compoſitor to be corrected.

The compoſitor then unlocking the form upon the correcting-ſtone, by looſening the quoins or wedges which bound the letters together, rectifies the miſtakes by picking out the faulty or wrong letters with a ſlender ſharp-pointed ſteel-bodkin, and putting others into their places. After this another proof is made, ſent to the author, and corrected as before; and laſtly, there is another proof called a *reviſe*, which is made in order to ſee whether all the miſtakes marked in the laſt proof are corrected.

The preſſman's buſineſs is to work off the forms thus prepared and corrected by the compoſitor; in doing which there are four things required, paper, ink, balls, and a preſs. To prepare the paper for uſe, it is to be firſt wetted by dipping ſeveral ſheets together in water: theſe are afterwards laid in a heap over each other; and to make them take the water equally, they are all preſſed cloſe down with a weight at the top. The ink is made of oil and lamp-black; for the manner of preparing which, ſee *Printing*-Ink. The balls, by which the ink is applied on the forms, are a kind of wooden funnels with handles, the cavities of which are filled with wool or hair, as is alſo a piece of alum leather or pelt nailed over the cavity, and made extremely ſoft by ſoaking in urine and by being well rubbed. One of theſe the preſſman takes in each hand; and applying one of them to the ink-block, daubs and works them together to diſtribute the ink equally; and then blackens the form which is placed on the preſs, by beating with the balls upon the face of the letter.

The *printing-preſs* repreſented in pl. 20. is a very curious though complex machine. The body conſiſts of two ſtrong cheeks, *a a*, placed perpendicularly, and joined together by four croſs-pieces; the cap *b*; the head *c*, which is moveable, being partly ſuſtained by two iron pins or long bolts, that paſs the cap; the till or ſhelf *d d*, by which the ſpindle and its apparatus are kept in their proper poſition; and the winter *e*, which bears the carriage, and ſuſtains the effort of the preſs beneath. The ſpindle *f* is an upright piece of iron pointed with ſteel, having a male ſcrew which goes into the female one in the head about four inches. Through the eye *g* of this ſpindle is faſtened the bar *k*, by which the preſſman makes the impreſſion. The ſpindle paſſes through a hole in the middle of the till; and its point works into a braſs pan or nut, ſupplied with oil, which is fixed to an iron plate let into the top of the platten. The body of the ſpindle is ſuſtained in the centre of an open frame of poliſhed iron, 1, 1, 2, 2, 3, 3, fixed to it in ſuch a manner as, without obſtructing its free play, to keep it in a ſteady direction; and at the ſame time to ſerve for ſuſpending the platten. This frame conſiſts of two parts; the upper called the *garter*, 1, 1; the under, called the *crane*, 2, 2. Theſe are connected together by two ſhort legs or bolts, 3, 3; which being fixed below in the two ends of the crane, paſs upward, through two holes in the till, and are received at top into two eyes at the ends of the garter, where they are ſecured by ſcrews. The carriage *l l* is placed a foot below the platten, having its fore-part ſupported by a prop called the *fore-ſtay*, while the other reſts on the winter. On this carriage, which ſuſtains the plank, are nailed two long iron bars or ribs; and on the plank are nailed ſhort pieces of iron or ſteel called *cramp irons*, equally tempered with the ribs, and which ſlide upon them when the plank is turned in or out. Under the carriage is fixed a long piece of iron called the *ſpit*, with a double wheel in the middle, round which leather-girts are faſtened, nailed to each end of the plank: and to the outſide of the ſpit is fixed a rounce *m*, or handle to turn round the wheel. Upon the plank is a ſquare frame or coffin, in which is incloſed a poliſhed ſtone on which the form *n* is laid; at the end of the coffin are three frames, *viz.* the two tympans and friſket: the tympans *o* are ſquare, and made of three ſlips of very thin wood, and at the top a piece of iron ſtill thinner; that called the *outer tympan* is faſtened with hinges to the coffin: they are both covered with parchment; and between the two are placed blankets, which are neceſſary to take off the impreſſion of the letters upon the paper. The friſket *p* is a ſquare frame of thin iron, faſtened with hinges to the tympan: it is covered with paper cut in the neceſſary places, that the ſheet, which is put between the friſket and the great or outward tympan, may receive the ink, and that nothing may hurt the margins. To regulate the margins, a ſheet of paper is faſtened upon this tympan, which is called the *tympan ſheet*; and on each ſide is fixed an iron point, which makes two holes in the ſheet, which is to be placed on the ſame points when the impreſſion is to be made on the other ſide. In preparing the preſs for working, the parchment which covers the outer tympan is wetted till it is very ſoft, in order to render the impreſſion more equable; the blankets are then put in, and ſecured from ſlipping by the inner tympan: then while one preſsman is beating the letter with the balls *q*, covered with ink taken from the ink-block, the other perſon places a ſheet of white paper on the tympan-ſheet; turns down the friſket upon it, to keep the paper clean and prevent its ſlipping; then bringing the tympans upon the form, and turning the rounce, he brings the form with the ſtone, &c. weighing about 300lbs. weight, under the platten; pulls with the bar, by which means the platten preſſes the blankets and paper cloſe upon the letter, whereby half the form is printed; then eaſing the bar, he draws the form ſtill forward; gives a ſecond pull; and letting go the bar, turns back the form, takes up the tympans and friſket, takes out the printed ſheet, and lays on a freſh one; and this is repeated till he has taken off the impreſſion upon the full number of ſheets the edition is to conſiſt of. One ſide of the ſheet being thus printed, the form for the other is laid upon the preſs, and worked off in the ſame manner.

Chineſe PRINTING, is performed from wooden planks or blocks, cut like thoſe uſed in printing of callico, paper, cards, &c.

Rolling-preſs PRINTING, is employed in taking off prints or impreſſions from copperplates engraven, etched, or ſcraped, as in mezzotintos. See ENGRAVING. This art is ſaid to have been as ancient as the year 1540, and to owe its origin to Finiguerra, a Florentine goldſmith, who pouring ſome melted brimſtone on an engraven plate, found the exact impreſſion of the engraving left in the cold brimſtone, marked with black taken out of the ſtrokes by the liquid ſulphur: upon this he attempted to do the ſame on ſilver plates with wet paper, by rolling it ſmoothly with a roller; and this ſucceeded: but this art was not uſed in England till the reign of king James I. when it was brought from Antwerp by Speed. The form of the rolling preſs, the compoſition of the ink uſed therein, and the manner of applying both in taking off prints, are as follow:

The rolling-preſs AL pl. 20, may be divided into two parts, the body and carriage: the body conſiſts of two wooden cheeks PP, placed perpendicularly on a ſtand or foot LM, which ſuſtains the whole preſs. From the foot likewiſe are four other perpendicular pieces *c, c, c, c*, joined by other croſs or horizontal ones *d, d, d*, which ſerve to ſuſtain a ſmooth even plank or table HIK, about four feet and a half long, two feet and a half broad, and an inch and a half thick. Into the cheeks go two wooden cylinders or rollers, DE, FG, about ſix inches in diameter, borne up at each end by the cheeks, whoſe ends, which are leſſened to about two inches diameter, and called *trunnions*, turn in the cheeks about two pieces of wood in form of half-moons, lined with poliſhed iron to facilitate the motion. Laſtly, to one of the trunnions of the upper roller is faſtened a croſs, conſiſting of two levers AB, or pieces of wood, traverſing each other, the arms of which croſs ſerve inſtead of the bar or handle of the letter-preſs, by turning the upper roller, and when the plank is between the two rollers, giving the ſame motion to the under one, by drawing the plank forward and backward.

The ink uſed for copperplates, is a compoſition made of the ſtones of peaches and apricots, the bones of ſheep and ivory, all well burnt, and called *Frankfort black*, mixed with nut-oil that has been well boiled, and ground together on a marble, after the ſame manner as painters do their colours.

The method of printing from copperplates is as follows: They take a ſmall quantity of this ink on a rubber made of linen-rags, ſtrongly bound about each other, and therewith ſmear the whole face of the plate as it lies on a grate over a charcoal fire. The plate being ſufficiently inked, they firſt wipe it over with a foul rag, then with the palm of their left hand, and then with that of the right; and to dry the hand and forward the wiping, they rub it from time to time in whiting. In wiping the plate perfectly clean, yet without taking the ink out of the engraving, the addreſs of the workman conſiſts. The plate thus prepared, is laid on the plank of the preſs; over the plate is laid the paper, firſt well moiſtened, to receive the impreſſion; and over the paper two or three folds of flannel. Things thus diſpoſed, the arms of the croſs are pulled, and by that means the plate with its furniture paſſed through between the rollers, which pinching very ſtrongly, yet equally, preſſes the moiſtened paper into the ſtrokes of the engraving, whence it licks out the ink.

PRINTS, the impreſſions taken from a copperplate. See the laſt article, and ENGRAVING. From the facility of being multiplied, prints have derived an advantage over paintings by no means inconſiderable. They are found to be more durable; which may, however, in ſome degree be attributed to the different methods in which they are preſerved. Many of the beſt paintings of the early maſters have generally had the misfortune to be either painted on walls, or depoſited in large and unfrequented, and conſequently damp and deſtructive, buildings; whilſt a print, paſſing, at diſtant intervals, from the *porte feuille* of one collector to that of another, is preſerved without any great exertion of its owner: And hence it happens, that whilſt the pictures of Raphael have mouldered from their walls, or deſerted their canvas, the prints of his friend and cotemporary Mark Antonio Raimondi continue in full perfection to this day, and give us a lively idea of the beauties of thoſe paintings, which, without their aſſiſtance, had been loſt to us for ever; or, at leaſt, could have been only known to us, like thoſe of Zeuxis and Apelles, by the deſcriptions which former writers on theſe ſubjects have left us.

Independent of the advantages which prints afford us, when conſidered as accurate repreſentations of paintings, and imitations of ſuperior productions, they are no leſs valuable for their poſitive merit, as immediate repreſentations of nature. For it muſt be recollected, that the art of engraving has not always been confined to the copying other productions, but has frequently itſelf aſpired to originality, and has, in this light, produced more inſtances of its excellence than in the other. Albert Durer, Goltzius, and Rembrandt, amongſt the Dutch and Germans; Parmigiano and Della Bella amongſt the Italians, and Callot amongſt the French, have publiſhed many prints, the ſubjects of which, there is great reaſon to ſuppoſe, were never painted. Theſe prints may therefore be conſidered as original pictures of thoſe maſters, deficient only in thoſe particulars in which a print muſt neceſſarily be inferior to a painting.

The preceding diſtinction may perhaps throw ſome light on the proper method of arranging and claſſing a collection of prints, which has been a matter of no ſmall difficulty. As an art imitating another, the principal ſhould take the lead; and the deſign, compoſition, and drawing, in a print, being previous requiſites to the manner of execution and finiſhing, prints engraved after paintings ſhould be arranged under the name of the painter; and every perſon who looks upon engraving only as auxiliary to painting, will conſequently adopt this mode of arrangement. But when engraving is conſidered as an original art, as imitating nature without the intervention of other methods, then it will certainly be proper to regulate the arrangement according to the names of the engravers.

PRIOR, in general, ſomething before or nearer the beginning than another to which it is compared.

Prior, more particularly denotes the ſuperior of a convent of monks, or the next under the abbot. See Abbot. Priors are either *clauſtral* or *conventual*. *Conventual* are the ſame as abbots. *Clauſtral* prior is he who governs the religious of an abbey or priory *in commendam*, having his juriſdiction wholly from the abbot.

Grand Prior, is the ſuperior of a large abbey, where ſeveral ſuperiors are required.

Prior (Matthew), an eminent Engliſh poet, was born at London in 1664. His father dying while he was very young, an uncle a vintner, having given him ſome education at Weſtminſter ſchool, took him home in order to breed him up to his trade. However, at his leiſure hours he proſecuted his ſtudy of the claſſics, and eſpecially of his favourite Horace. This introduced him to ſome polite company, who frequented his uncle's houſe; among whom the earl of Dorſet took particular notice of him, and procured him to be ſent to St. John's college in Cambridge, where, in 1686, he took the degree of A. B. and afterwards became fellow of that college. Upon the Revolution, Mr. Prior was brought to court by the earl of Dorſet; and in 1690 he was made ſecretary to the earl of Berkeley, plenipotentiary at the Hague; as he was afterward to the ambaſſador and plenipotentiaries at the treaty of Ryſwick in 1697; and the year following to the earl of Portland, ambaſſador to the court of France. He was in 1697 made ſecretary of ſtate for Ireland; and in 1700 was appointed one of the lords commiſſioners of trade and plantations. In 1710, he was ſuppoſed to have had a ſhare in writing *The Examiner*. In 1711, he was made one of the commiſſioners of the cuſtoms; and was ſent miniſter plenipotentiary to France, for the negotiating a peace with that kingdom. Soon after the acceſſion of George I. to the throne in 1714, he preſented a memorial to the court of France, requiring the demoliſhing of the canal and new works at Mardyke. The year following he was recalled; and upon his arrival was taken up by a warrant from the houſe of commons, and ſtrictly examined by a committee of the privy-council. Robert Walpole, Eſq. moved the houſe of commons for an impeachment againſt him; and Mr. Prior was ordered into cloſe cuſtody. In 1717, he was excepted out of the act of grace; however, at the cloſe of that year, he was ſet at liberty. The remainder of his days he ſpent in tranquillity and retirement; and died in 1721. His poems are well known, and juſtly admired. He is ſaid to have written the following epitaph for himſelf:

> "Nobles and heralds, by your leave,
> Here lie the bones of Matthew Prior,
> The ſon of Adam and of Eve:
> Let Bourbon or Naſſau go higher."

Alien Priories, were cells of the religious houſes in England which belonged to foreign monaſteries: for, when manors or tithes were given to foreign convents, the monks, either to increaſe their own rule, or rather to have faithful ſtewards of their revenues, built a ſmall convent here for the reception of ſuch a number as they thought proper, and conſtituted priors over them.—Within theſe cells there was the ſame diſtinction as in thoſe priories which were cells ſubordinate to ſome great abbey; ſome of theſe were conventual, and, having priors of their own chooſing, thereby became entire ſocieties within themſelves, and received the revenues belonging to their ſeveral houſes for their own uſe and benefit, paying only the ancient apport *, acknowledgement, or obvention, at firſt the ſurpluſage, to the foreign houſe; but others depended entirely on the foreign houſes, who appointed and removed their priors at pleaſure. Theſe tranſmitted all their revenues to the foreign head houſes; for which reaſon their eſtates were generally ſeized to carry on the wars between England and France, and reſtored to them again on return of peace. Theſe alien priories were moſt of them founded by ſuch as had foreign abbeys founded by themſelves or by ſome of their family.

The whole number is not exactly aſcertained; the Monaſticon has given a liſt of 100: Weever, p. 338, ſays 110.

Some of theſe cells were made indigenous or denizon, or endenized. The alien priories were firſt ſeized by Edward I. 1285, on the breaking out of the war between France and England; and it appears from a roll, that Edward II. alſo ſeized them, though this is not mentioned by our hiſtorians; and to theſe the act of reſtitution 1 Ed. III. ſeems to refer.

In 1337, Edward III. confiſcated their eſtates, and let out the priories themſelves with all their lands and tenements, at his pleaſure, for 23 years; at the end of which term, peace being concluded between the two nations, he reſtored their eſtates 1361, as appears by his letters patent to that of Montacute, county of Somerſet. printed at large in Rymer, vol. vi. p. 311, and tranſlated in Weever's *Funeral Monuments*, p. 339. At other times he granted their lands, or lay penſions out of them, to divers noblemen. They were alſo ſequeſtered during Richard II.'s reign, and the head monaſteries abroad had the king's licence to ſell their lands to other religious houſes here, or to any particular perſons who wanted to endow others.

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* *Apportus* or *apportagium* (from *portare*), an acknowledgement, oblation, or obvention, to the mother houſe or church. *Du Cange.*

Henry IV. began his reign with ſhowing ſome favour to the alien priories, reſtoring all the conventual ones, only reſerving to himſelf in time of war what they paid in time of peace to the foreign abbeys.

They were all diſſolved by act of parliament 2 Henry V. and all their eſtates veſted in the crown, except ſome lands granted to the college of Fotheringhay. The act of diſſolution is not printed in the ſtatute books, but it is to be found entire in Rymer's *Fœdera*, ix. 283. and in the Parliament Rolls, vol iv. p. 22. In general, theſe lands were appropriated to religious uſes. Henry VI. endowed his foundations at Eton and Cambridge with the lands of the alien priories, in purſuance of his father's deſign to appropriate them all to a noble college at Oxford. Others were granted in fee to the prelates, nobility, or private perſons. Such as remained in the crown were granted by Henry VI. 1440, to archbiſhop Chichley, &c. and they became part of his and the royal foundations. See *Some Account of Alien-Priories*, &c. in two volumes octavo.

PRIORITY, the relation of ſomething conſidered as prior to another.

Priority, in law, denotes an antiquity of tenure, in compariſon of another leſs ancient.

PRISCIANUS, an eminent grammarian born at Cæſarea, taught at Conſtantinople with great reputation about the year 525. Laurentius Valla calls Priſcian, Donatus, and Servius, *triumviri in re grammatica*; and thinks none of the ancients who wrote after them fit to be mentioned with them. He compoſed a work *De arte grammatica*, which was firſt printed by Aldus at Venice in 1476; and another *De naturalibus quæſtionibus*, which he dedicated to Choſroes king of Perſia: beſide which, he tranſlated Dionyſius's deſcription of the world into Latin verſe. A perſon who writes falſe Latin is proverbially ſaid to "break Priſcian's head."

PRISCILLIANISTS, in church-hiſtory, Chriſtian heretics, ſo called from their leader Priſcillian, a Spaniard by birth, and biſhop of Avila. He is ſaid to have practiſed magic, and to have maintained the principal errors of the Manichees; but his peculiar tenet was, That it is lawful to make falſe oaths in order to ſupport one's cauſe and intereſts.

PRISM, an oblong ſolid contained under more than four planes, whoſe baſes are equal, parallel, and alike ſituated. See Optics.

PRISON, a gaol, or place of confinement. Lord Coke obſerves, that a priſon is only a place of ſafe cuſtody, *ſalva cuſtodia*, not a place of puniſhment. If this be ſo, and it cannot be queſtioned, priſons ought not to be, what they are in moſt parts of Europe, loathſome dungeons. Any place where a perſon is confined may be ſaid to be a priſon; and when a proceſs is iſſued againſt one, he muſt, when arreſted thereon, either be committed to priſon, or be bound in a recognizance with ſureties, or elſe give bail, according to the nature of the caſe, to appear at a certain day in court, there to make anſwer to what is alleged againſt him. Where a perſon is taken and ſent to priſon, in a civil caſe, he may be releaſed by the plaintiff in the ſuit; but if it be for felony, he may not regularly be diſcharged, until he is indicted of the fact and acquitted. See Indictment and the next article.

PRISONER, a perſon reſtrained or kept in priſon upon an action civil or criminal, or upon commendment: and one may be a priſoner on matter of record or matter of fact. A priſoner upon matter of record is he who, being preſent in court, is by the court committed to priſon; and the other is one carried to priſon upon an arreſt, whether it be by the ſheriff, conſtable, or other officer.

PRISTIS, the sawfish, is generally conſidered as a ſpecies of the *ſqualus* or *ſhark* genus, comprehending under it ſeveral varieties. Mr. Latham, however, is of opinion that it ought to be conſidered as a diſtinct genus itſelf, and that the characteriſtics of the ſeveral varieties are ſufficient to conſtitute them diſtinct ſpecies. According to him, therefore, the *priſtis* is a genus belonging to the order of *amphibia nantes*; and its characters are as follow: A long plane beak or ſnout, with ſpines growing like teeth out of both edges; four or five *ſpiracula*, or breathing apertures, in the ſides of the neck: the body is oblong and almoſt round, with a rough coriaceous ſkin; the mouth is ſituated in the lower part of the head; and the noſtrils, before the mouth, are half covered with a membranaceous lobe; behind the eyes are two oval holes; the ventral fins approach one another, and in the male are placed about the organs of generation; there are no fins at the anus.

Of this genus our author enumerates five ſpecies. 1. *Priſtis antiquorum*. The head is rather flat at top; the eyes large, with yellow irides; behind each is a hole, which ſome have ſuppoſed may lead to an organ of hearing. The mouth is well furniſhed with teeth, but they are blunt, ſerving rather to bruiſe its prey than to divide it by cutting. Before the mouth are two foramina, ſuppoſed to be the noſtrils. The *roſtrum*, beak, or ſnout, is in general about one-third of the total length of the fiſh, and contains in ſome 18, in others as far as 23 or 24 ſpines on each ſide; theſe are very ſtout, much thicker at the back-part, and channelled, inclining to an edge forwards. The fins are ſeven in number, viz. two dorſal, placed at ſome diſtance from each other; two pectoral, taking riſe juſt behind the breathing-holes, which are five in number; two ventral, ſituated almoſt underneath the firſt dorſal; and laſtly the caudal, occupying the tail both above and beneath, but longeſt on the upper part. The general colour of the body is a dull gray, or browniſh, growing paler as it approaches the belly, where it is nearly white. 2. *Pectinatus*, which, with the former ſpecies, grows to the largeſt ſize of any that have yet come under the inſpection of the naturaliſt, ſome ſpecimens meaſuring 15 feet in length. The pectinatus differs from the priſtis antiquorum, in having the ſnout more narrow in proportion at the baſe, and the whole of it more ſlender in all its parts; whereas the firſt is very broad at the baſe, and tapers conſiderably from thence to the point. The ſpines on each ſide alſo are longer and more ſlender, and vary from 25 to 34 in the different ſpecimens: we have indeed been informed of one which contained no leſs than 36 ſpines on each ſide of the ſnout; but we muſt confeſs that we have never been fortunate enough to have ſeen ſuch a ſpecimen. 3. *Cuſpidatus*, of which our author has ſeen only two ſpecimens, the one about a foot and a half in length, and the other more than two feet and a half. In both of theſe were 28 ſpines on each ſide; but the diſtinguiſhing feature is in the ſpines themſelves, being particularly flat and broad, and ſhaped at the point more like the lancet uſed by ſurgeons in bleeding, than any other figure. We believe that no other author has hitherto taken notice of this ſpecies. 4. *Microdon*, of which the total length is 28 inches, the ſnout occupying 10; from the baſe of this to that of the pectoral fins four inches; between the pectoral and ventral fins ſix. The two dorſal fins occupy nearly the ſame proportions in reſpect to each other; but the hinder one is the ſmalleſt, and all of them are greatly hollowed out at the back-part, much more ſo

PRISTIS.

Fig. 1.

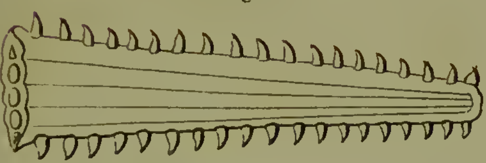


Fig. 2.

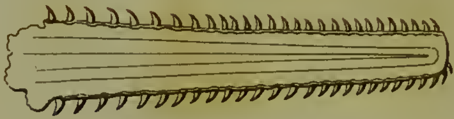


Fig. 4.

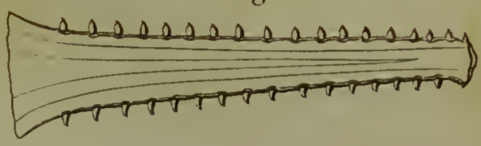
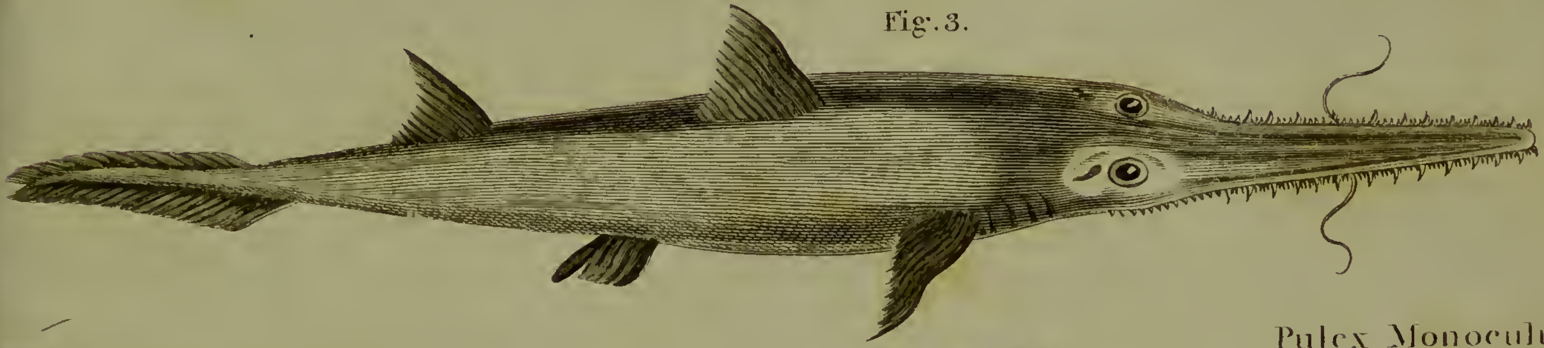
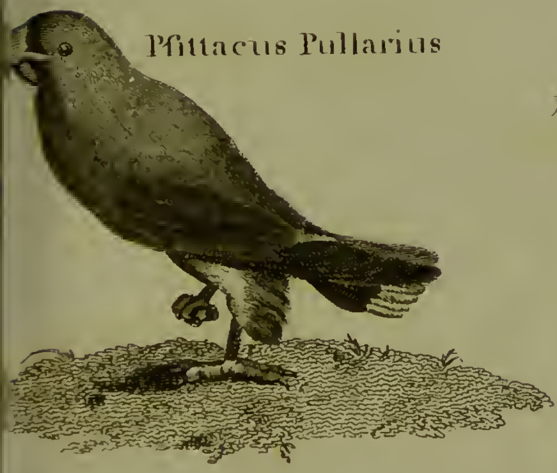


Fig. 3.

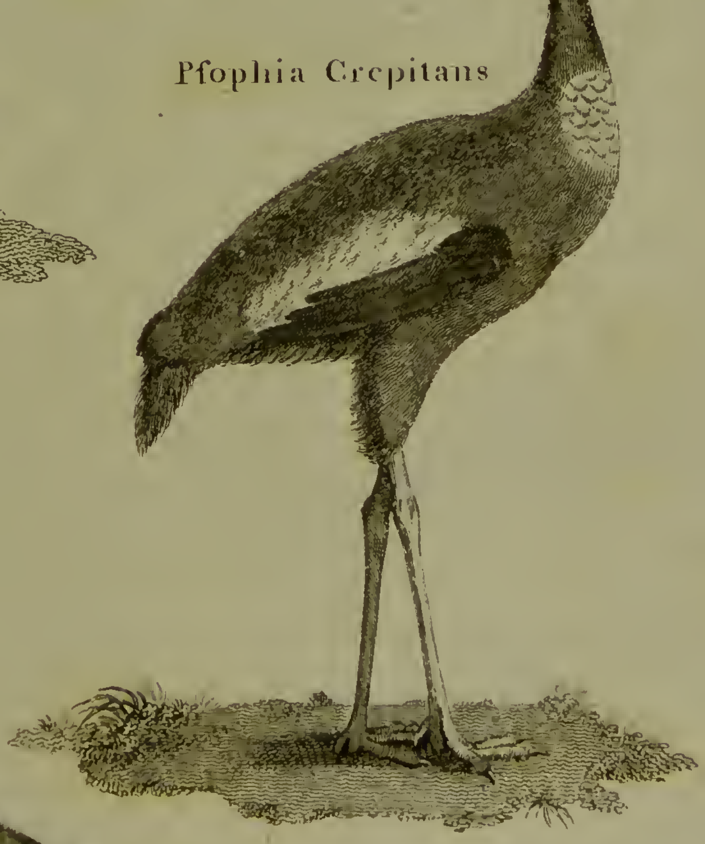


Psittacus Pullarius

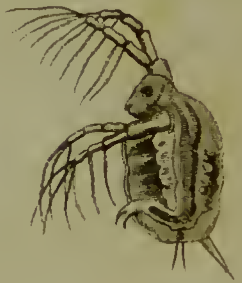


Ptini

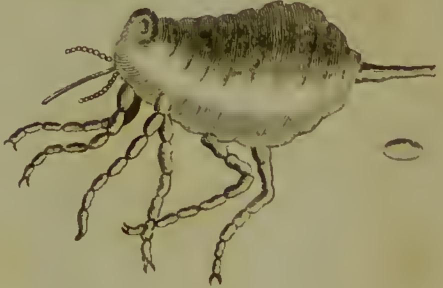
Psophia Crepitans



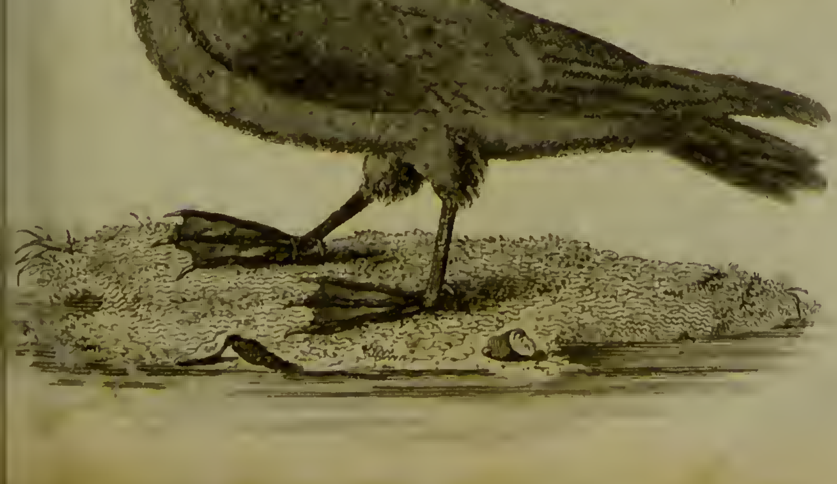
Pulex Monoculus



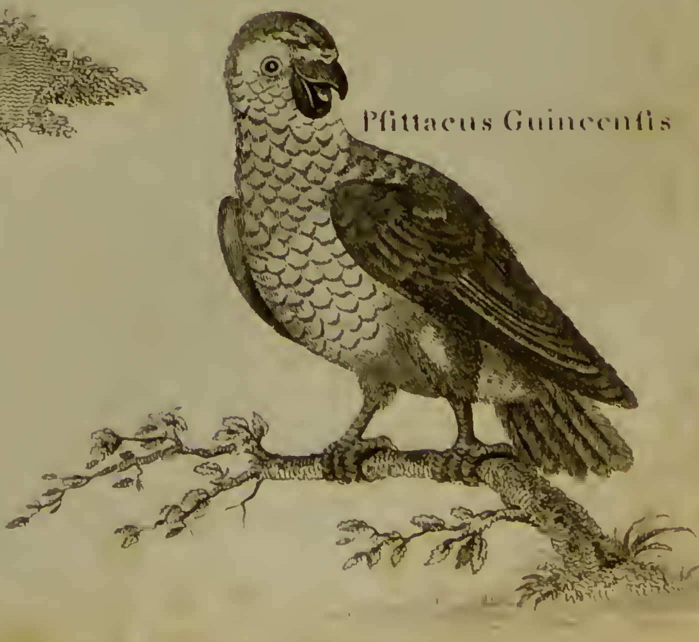
Chego or Pulex Minimus



Procellaria Peteril



Psittacus Guineensis



than in the two firſt ſpecies. The ſnout differs from that of every other, in ſeveral particulars: it is longer in proportion, being more than one-third of the whole fiſh. The ſpines do not ſtand out from the ſides more than a quarter of an inch, and from this circumſtance ſeem far leſs capable of doing injury than any other ſpecies yet known. 5. *Cirratus*, of which, continues our author, we have only met with one ſpecimen, which was brought from Port Jackſon in New Holland. It is a male, and the total length about 40 inches: the ſnout, from the tip of it to the eye, 11: the ſpines widely different from any of the others; they are indeed placed, as uſual, on the edge, but are continued on each ſide even beyond the eyes. The longer ones are ſlender, ſharp, ſomewhat bent, and about 20 in number; and between theſe are others not half the length of the primal ones, between ſome three or four, between others as far as ſix; and in general the middle one of theſe ſmaller ſeries is the longeſt: beſide theſe a ſeries of minute ones may be perceived beneath, at the very edge. In the ſnout likewiſe another ſingularity occurs;—about the middle of it, on each ſide, near the edge, ariſes a flexible, ligamentous cord, about three inches and a half in length, appearing not unlike the beards at the mouth of ſome of the gadus or cod genus, and no doubt as pliant in the recent ſtate. The colour of the fiſh is a pale brown: the breathing apertures four in number: the mouth furniſhed with five rows of minute, but very ſharp teeth. See plate 21. where the ſnout marked fig. 1. is that of the priſtis antiquorum; that marked 2, of pectinatus; and that marked 4, of microdon: the entire fiſh is the cirratus, fig. 3.

PRIVATEERS, are a kind of private men of war, the perſons concerned wherein adminiſter at their own coſts a part of a war, by fitting out theſe ſhips of force, and providing them with all military ſtores; and they have, inſtead of pay, leave to keep what they take from the enemy, allowing the admiral his ſhare, &c.

Privateers may not attempt any thing againſt the laws of nations; as to aſſault an enemy in a port or haven, under the protection of any prince or republic, whether he be friend, ally, or neuter; for the peace of ſuch places muſt be inviolably kept: therefore, by a treaty made by king William and the ſtates of Holland, before a commiſſion ſhall be granted to any privateer, the commander is to give ſecurity, if the ſhip be not above 150 tons, in 1500l. and if the ſhip exceeds that burthen, in 3000l. that they will make ſatisfaction for all damages which they ſhall commit in their courſes at ſea, contrary to the treaties with that ſtate, on pain of forfeiting their commiſſions; and the ſhip is made liable.

Beſides theſe private commiſſions, there are ſpecial commiſſions for privateers, granted to commanders of ſhips, &c, who take pay; who are under a marine diſcipline; and if they do not obey their orders, may be puniſhed with death: and the wars in later ages have given occaſion to princes to iſſue theſe commiſſions, to annoy the enemies in their commerce, and hinder ſuch ſupplies as might ſtrengthen them or lengthen out the war; and likewiſe to prevent the ſeparation of ſhips of greater force from their fleets or ſquadrons.

Ships taken by privateers were to be divided into five parts; four parts whereof to go to the perſons intereſted in the privateer, and the fifth to his majeſty: and as a further encouragement, privateers, &c. deſtroying any French man of war or privateer, ſhall receive, for every piece of ordnance in the ſhip ſo taken, 10l. reward, &c.

By a particular ſtatute lately made, the lord admiral, or commiſſioners of the admiralty, may grant commiſſions to commanders of privateers, for taking ſhips, &c. which being adjudged prize, and the tenth part paid to the admiral, &c. wholly belong to the owners of the privateers and the captors, in proportions agreed on between themſelves.

PRIVATION, in a general ſenſe, denotes the abſence or want of ſomething; in which ſenſe darkneſs is only the privation of light.

PRIVATIVE, in grammar, a particle, which, prefixed to a word, changes it into a contrary ſenſe. Thus, among the Greeks, the α is uſed as a privative; as in α-θεος, *atheiſt*, *acephalus*, &c.—The Latins have their privative *in*; as, *incorrigibilis*, *indeclinabilis*, &c.—The Engliſh, French, &c. on occaſion borrow both the Latin and Greek privatives.

PRIVERNUM, (Livy, Virgil); a town of the Volſci, in Latium, to the eaſt of Setia. *Privernates*, the people. Whoſe ambaſſadors being aſked, What puniſhment they deſerved for their revolt? anſwered, What thoſe deſerve who deem themſelves worthy of liberty. And again, being aſked by the Roman conſul, ſhould the puniſhment be remitted, What peace was to be expected with them? If you grant a good peace, you may hope to have it ſincere and laſting; but if a bad one, you may well expect it of ſhort continuance. At which anſwer, the Romans were ſo far from being diſpleaſed, that by a vote of the people they had the freedom of the city granted them. *Privernas*, *atis*, the epithet. The town is now called *Piperno Vecchio*, ſituated in the Campania of Rome. E. lon. 10. 0. N. lat. 41. 30.

PRIVET, in botany. See LIGUSTRUM.

PRIVILEGE, in law, ſome peculiar benefit granted to certain perſons or places, contrary to the uſual courſe of the law. Privileges are ſaid to be *perſonal* or *real*. 1. *Perſonal* privileges are ſuch as are extended to peers, ambaſſadors, members of parliament, and of the convocation, &c. See LORDS, AMBASSADOR, PARLIAMENT, ARREST, &c. 2. A *real* privilege is that granted to ſome particular place; as the king's palace, the courts at Weſtminſter, the univerſities, &c.

PRIVILEGES *of the Clergy*. See CLERGY.

PRIVY, in law, is a partaker, or perſon having an intereſt, in any action or thing. In this ſenſe they ſay, privies in blood: every heir in tail is privy to recover the land intailed. In old law-books, merchants privy are oppoſed to merchants ſtrangers. Coke mentions four kinds of privies. Privies in blood, as the heir to his father; privies in repreſentation, as executors and adminiſtrators to the deceaſed; privies in eſtate, as he in reverſion, and he in remainder; donor and donee; leſſor and leſſee: laſtly, privy in tenure, as the lord by eſcheat; *i. e.* when land eſcheats to the lord for want of heirs.

PRIVY-*Council*. See COUNCIL. The king's will is the ſole conſtituent of a privy-counſellor; and it alſo regulates their number, which in ancient times was about twelve. Afterwards it increaſed to ſo large a number, that it was found inconvenient for ſecrecy and diſpatch; and therefore Charles II. in 1679, limited it to 30; whereof 15 were principal officers of ſtate, and to be counſellors *ex officio*; and the other 15 were compoſed of 10 lords and five commoners of the king's chooſing. Since that time however the number has been much augmented, and now continues indefinite. At the ſame time, alſo, the ancient office of lord preſident of the council was revived, in the perſon of Anthony, earl of Shafteſbury. Privy-counſellors are made by the king's nomination, without either patent or grant; and, on taking the neceſſary oaths, they become immediately privy-counſellors during the life of the king that chooſes them, but ſubject to removal at his diſcretion.

Any natural born ſubject of England is capable of being a member of the privy-council; taking the proper oaths for ſecurity of the government, and the teſt for ſecurity of the church. By the act of ſettlement, 12 and 13 W. III. cap. 2. it is enacted, that no perſon born out of the dominions of the crown of England, unleſs born of Engliſh parents, even though naturalized by parliament, ſhall be capable of being of the privy-council. The duty of a privy-counſellor appears from the oath of office, which conſiſts of ſeven articles. 1. To adviſe the king according to the beſt of his cunning and diſcretion. 2. To adviſe for the king's honour and good of the public, without partiality, through affection, love, meed, doubt, or dread. 3. To keep the king's counſel ſecret. 4. To avoid corruption. 5. To help and ſtrengthen the execution of what ſhall be there reſolved. 6. To withſtand all perſons who would attempt the contrary. And, laſtly, in general, 7. To obſerve, keep, and do all that a good and true counſellor ought to do to his ſovereign lord.

The privy-council is the *primum mobile* of the ſtate, and that which gives the motion and direction to all the inferior parts. It is likewiſe a court of juſtice of great antiquity; the primitive and ordinary way of government in England being by the king and privy-council. It has been frequently uſed by all our kings for determining controverſies of great importance: the ordinary judges have ſometimes declined giving judgment till they had conſulted the king and privy-council; and the parliament have frequently referred matters of high moment to the ſame, as being by long experience better able to judge of, and, by their ſecrecy and expedition, to tranſact ſome ſtate affairs, than the lords and commons. At preſent, the privy-council takes cognizance of few or no matters except ſuch as cannot well be determined by the known laws and ordinary courts; ſuch as matters of complaint and ſudden emergencies: their conſtant buſineſs being to conſult for the public good in affairs of ſtate. This power of the privy-council is to inquire into all offences againſt the government, and to commit the offenders to ſafe cuſtody, in order to take their trial in ſome of the courts of law. But their juriſdiction herein is only to inquire, and not to puniſh; and the perſons committed by them are entitled to their *babeas corpus* by ſtatute 16. Car. I. cap. 10. as much as if committed by an ordinary juſtice of the peace.

In plantation or admiralty cauſes, which ariſe out of the juriſdiction of this kingdom, and in matters of lunacy and idiocy, the privy-council has cognizance, even in queſtions of extenſive property, being the court of appeal in ſuch cauſes; or, rather, the appeal lies to the king's majeſty himſelf in council. From all the dominions of the crown, excepting Great Britain and Ireland, an appellate juriſdiction (in the laſt reſort) is veſted in this tribunal; which uſually exerciſes its judicial authority in a committee of the whole privy-council, who hear the allegations and proofs, and make their report to his majeſty in council, by whom the judgment is finally given.

Anciently, to ſtrike in the houſe of a privy-counſellor, or elſewhere in his preſence, was grievouſly puniſhed: by 3 Hen. VII. cap. 14. if any of the king's ſervants of his houſehold conſpire or imagine to take away the life of a privy-counſellor, it is felony, though nothing ſhall be done upon it; and by 9 Ann, cap. 16. it is enacted, that any perſons who ſhall unlawfully attempt to kill, or ſhall unlawfully aſſault, and ſtrike, or wound, any privy-counſellor in the execution of his office, ſhall be felons, and ſuffer death as ſuch. With advice of this council, the king iſſues proclamations that bind the ſubject, provided they be not contrary to law. In debates, the loweſt delivers his opinion firſt, the king laſt; and thereby determines the matter. A council is never held without the preſence of a ſecretary of ſtate.

The diſſolution of the privy-council depends upon the king's pleaſure; and he may, whenever he thinks proper, diſcharge any particular member, or the whole of it, and appoint another. By the common law alſo it was diſſolved *ipſo facto* by the king's demiſe, as deriving all its authority from him. But now, to prevent the inconveniencies of having no council in being at the acceſſion of a new prince, it is enacted, by 6 Ann, cap. 7. that the privy-council ſhall continue for ſix months after the demiſe of the crown, unleſs ſooner determined by the ſucceſſor. *Blackſt. Com.* book i. p. 229, &c.

The officers of the privy-council are four clerks of the council in ordinary, three clerks extraordinary, a keeper of the records, and two keepers of the council-chamber. See PRESIDENT.

PRIVY *Seal*, a ſeal which the king uſes previouſly to ſuch grants, &c. as are afterwards to paſs the great ſeal. The privy ſeal is alſo ſometimes uſed in matters of leſs conſequence, which do not require the great ſeal.

Lord PRIVY *Seal.* See KEEPER *of the Privy Seal.*

Clerks of the PRIVY *Seal.* See CLERK.

PRIVY *Chamber.* See CHAMBER.

PRIZE, or PRISE, in maritime affairs, a veſſel taken at ſea from the enemies of a ſtate, or from pirates; and that either by a man of war, a privateer, &c. having a commiſſion for that purpoſe. Veſſels are looked on as prize, if they fight under any other ſtandard than that of the ſtate from which they have their commiſſion; if they have no charter-party, invoice, or bill of lading aboard; if loaded with effects belonging to the king's enemies, or with contraband goods. In ſhips of war, the prizes are to be divided among the officers, ſeamen, &c. as his majeſty ſhall appoint by proclamation; but among privateers, the diviſion is according to the agreement between the owners. By ſtat. 13 Geo. II. c. 4. judges and officers, failing of their duty in reſpect to the condemnation of prizes, forfeit 500l. with full coſts of ſuit; one moiety to the king, and the other to the informer.

PROA, FLYING, in navigation, is a name given to a veſſel uſed in the ſouth ſeas, becauſe with a briſk trade wind it ſails near 20 miles an hour. In the conſtruction of the proa, the head and ſtern are exactly alike, but the ſides are very different; the ſide intended to be always the lee-ſide being flat; and the windward ſide made rounding, in the manner of other veſſels; and to prevent her overſetting, which from her ſmall breadth, and the ſtraight run of her leeward ſide, would, without this precaution, infallibly happen, there is a frame laid out to her from windward, to the end of which is faſtened a log, faſhioned into the ſhape of a ſmall boat and made hollow. The weight of the frame is intended to balance the proa, and the ſmall boat is by its buoyancy (as it is always in the water) to prevent her overſetting to windward; and this frame is uſually called an outrigger. The body of the veſſel is made of two pieces joined endwiſe, and ſewed together with bark, for there is no iron uſed about her; ſhe is about two inches thick at the bottom, which, at the gunwale, is reduced to leſs than one. The ſail is made of matting, and the maſt, yard, boom, and outriggers, are all made of bamboo. See *Anſon's Voyage*, quarto, p. 341.

PROBABILITY is a word of nearly the ſame import with likelihood. It denotes the appearance of truth, or that evidence ariſing from the preponderation of argument which produces opinion. (See OPINION.) Locke claſſes all arguments under the heads of *demonſtrative* and *probable*: Hume with greater accuracy divides them into *demonſtrations*, *proofs*, and *probabilities*. Demonſtration produces *ſcience*; proof, *belief*; and probability, *opinion*.

Hardly any thing is ſuſceptible of ſtrict demonſtration beſides the mathematical ſciences, and a few propoſitions in metaphyſical theology. Phyſics reſt upon principles capable, ſome of them, of complete proof by experience, and others of nothing more than probability by analogical reaſoning. What has *uniformly* happened, we expect with the fulleſt confidence to happen again in ſimilar circumſtances; what has *frequently* happened, we likewiſe expect to happen again; but our expectation is not confident. Uniform experience is proof; frequent experience is probability. The ſtrongeſt man has *always* been able to lift the greateſt weight; and therefore, knowing that one man is ſtronger than another, we expect, with confidence, that the former will lift more than the latter. The beſt diſciplined army has *generally* proved victorious, when all other circumſtances were equal. We therefore expect that an army of veterans will, upon fair ground, defeat an equal number of new levied troops: but as ſudden panics have ſometimes ſeized the oldeſt ſoldiers, this expectation is accompanied with doubt, and the utmoſt that we can ſay of the expected event is, that it is *probable*: whereas in the competition between the two men, we look upon it as *morally certain*. (See Metaphysics.) When two or three perſons of known veracity atteſt the ſame thing as conſiſtent with their knowledge, their teſtimony amounts to *proof*, if not contradicted by the teſtimony of others; if contradicted, it can, at the utmoſt, amount only to probability. In common language we talk of *circumſtantial* proofs, and *preſumptive* proofs; but the expreſſions are improper, for ſuch evidence amounts to nothing more than probability. Of probability there are indeed various degrees from the confines of certainty down to the confines of impoſſibility; and a variety of circumſtances tending to the ſame point, though they amount not to what, in ſtrictneſs of language, ſhould be called *proof*, afford to the mind a very high degree of evidence, upon which, with the addition of one direct teſtimony, the laws of many countries take away the life of a man.

Probability *of an Event*, in the *Doctrine of Chances*, is greater or leſs according to the number of chances by which it may happen or fail. (See Expectation.) The *probability of life* is liable to rules of computation. In the *Encyclopedie Methodique*, we find a table of the probabilities of the duration of life, conſtructed from that which is to be found in the ſeventh volume of the *Supplemens à l'Hiſtoire de M. de Buffon* of which the following is an abridgement.

Of 23,994 children born at the ſame time, there will probably die

$\frac{1}{3}$	In one year - - -	7998
$\frac{2}{3}$	Remaining $\frac{2}{3}$ or 15996	
$\frac{1}{2}$	In eight years - - -	11997
$\frac{1}{2}$	Remaining $\frac{1}{2}$ or 11997	
$\frac{2}{3}$	In thirty-eight years - -	15996
$\frac{1}{3}$	Remaining $\frac{1}{3}$ or 7998	
$\frac{3}{4}$	In fifty years - - -	17994
$\frac{1}{4}$	Remaining $\frac{1}{4}$ or 5998	
$\frac{5}{6}$	In ſixty-one years - -	19995
$\frac{1}{6}$	Remaining $\frac{1}{6}$ or 3999	
$\frac{9}{10}$	In ſeventy years - -	21595
$\frac{1}{10}$	Remaining $\frac{1}{10}$ or 2399	
$\frac{39}{40}$	In eighty years - - -	22395
$\frac{1}{40}$	Remaining $\frac{1}{40}$ or 599	
$\frac{259}{300}$	In ninety years - - -	23914
$\frac{1}{300}$	Remaining $\frac{1}{300}$ or 80	
	In a hundred years - -	23992

Remaining $\frac{1}{10000}$ or 2. See *Bills of* Mortality.

PROBATE of a will or teſtament, in law, is the exhibiting and proving of laſt wills and teſtaments before the eccleſiaſtical judge delegated by the biſhop, who is ordinary of the place where the party died.

PROBATION, in the univerſities, is the examination and trial of a ſtudent who is about to take his degrees.

Probation, in a monaſtic ſenſe, ſignifies the year of a novitiate, which a religious muſt paſs in a convent, to prove his virtue and vocation, and whether he can bear the ſeverities of the rule.

PROBATIONER, in the church of Scotland, a ſtudent in divinity, who bringing a certificate from a profeſſor in an univerſity of his good morals, and his having performed his exerciſes to approbation, is admitted to undergo ſeveral trials; and, upon his acquitting himſelf properly in theſe, receives a licence to preach.

PROBATUM est (*It is proved*), a term formerly ſubjoined to receipts for the cure of diſeaſes.

PROBE, a ſurgeon's inſtrument for examining the circumſtances of wounds, ulcers, and other cavities, ſearching for ſtones in the bladder, &c.

PROBITY means honeſty, ſincerity, or veracity; and conſiſts in the habit of actions uſeful to ſociety, and in the conſtant obſervance of the laws which juſtice and conſcience impoſe on us. The man who obeys all the laws of ſociety with an exact punctuality is not therefore a man of probity; laws can only reſpect the external and definite parts of human conduct, but probity reſpects our more private actions, and ſuch as it is impoſſible in all caſes to define; and it appears to be in morals what charity is in religion. Probity teaches us to perform in ſociety thoſe actions which no external power can oblige us to perform, and is that quality in the human mind from which we claim the performance of the *rights* commonly called *imperfect*. See Moral Philosophy.

PROBLEM, in logic, is a propoſition that neither appears abſolutely true nor falſe; and, conſequently, may be aſſerted either in the affirmative or negative.

Problem, in geometry, is a propoſition, wherein ſome operation or conſtruction is required; as to divide a line or angle, erect or let fall perpendiculars, &c. See Geometry.

PROBOSCIS, in natural hiſtory, is the trunk or ſnout of an elephant, and ſome other animals and inſects. Flies, gnats, &c. are furniſhed with a proboſcis or trunk, by means of which they ſuck the blood of animals, the juice of vegetables, &c. for their food.

PROBUS (Marcus Aurelius), from the ſon of a gardener, became, by his great valour as a ſoldier, and his eminent virtues, emperor of Rome, to which dignity he was raiſed by the army. After having ſubdued the barbarous nations that had made incurſions into different parts of the empire where they committed horrid cruelties, and governed with great wiſdom and clemency, he was maſſacred in the 7th year of his reign, by ſome ſoldiers who were weary of the public works at which he made them labour, in 282.

PROCATARCTIC cause, in medicine, the pre-exiſting, or pre-diſpoſing cauſe or occaſion of a diſeaſe.

PROCELEUSMATICUS, in the ancient poetry, a foot conſiſting of four ſhort ſyllables, or two pyrrhychiuſes; as *hominibus*.

PROCELLARIA, in ornithology; a genus of birds, belonging to the order of anſeres. The beak is ſomewhat compreſſed, and without teeth; the mandibles are equal, the ſuperior one being crooked at the point; the feet are palmated, the hind claw being ſeſſile, without any toe. Mr. Latham (See his *Index Ornithologicus*, p. 820.) enumerates 24 ſpecies, which are principally diſtinguiſhed by their colour. The moſt remarkable are,

1. The *cinerea*, or petrel. The ſize of this bird is rather ſuperior to that of the common gull: the bill very ſtrong, much hooked at the end, and of a yellow colour. The noſtrils are compoſed of two large tubes, lodged in one ſheath: the head, neck, whole under ſide of the body, and tail are white: the back and coverts of the wings aſh-coloured: the quill-feathers duſky: and the legs yellowiſh. In lieu of a back toe, it has only a ſort of ſpur, or ſharp ſtraight nail. Theſe birds feed on the blubber or fat of whales, &c. which being ſoon convertible into oil, ſupplies them conſtantly with means of defence, as well as proviſion for their young, which they caſt up into their mouths. They are likewiſe ſaid to feed on ſorrel, which they uſe to qualify the unctuous diet they live on.

This ſpecies inhabits the iſle of St. Kilda; makes its appearance there in November, and continues the whole year, except September and October; it lays a large, white, and very brittle egg; and the young are hatched the middle of June. No bird is of ſuch uſe to the iſlanders as this: the fulmar ſupplies them with oil for their lamps, down for their beds, a delicacy for their tables, a balm for their wounds, and a medicine for their diſtempers. The fulmar is alſo a certain prognoſticator of the change of the wind: if it come to land, no weſt wind is expected for ſome time; and the contrary when it returns and keeps the ſea. The whole genus of petrels have a peculiar faculty of ſpouting from their bills, to a conſiderable diſtance, a large quantity of pure oil; which they do, by way of defence, into the face of any one that attempts to take them: ſo that they are, for the ſake of this panacæa, ſeized by ſurpriſe; as this oil is ſubſervient to the above-mentioned medical purpoſes. Martin tells us, it has been uſed in London and Edinburgh with ſucceſs in rheumatic caſes. Frederick Martens, who had opportunity of ſeeing vaſt numbers of theſe birds at Spitzbergen, obſerves, that they are very bold, and reſort after the whale fiſhers in great flocks; and that, when a whale is taken, they will, in ſpite of all endeavours, light on it and pick out large lumps of fat, even when the animal is alive: That the whales are often diſcovered at ſea by the multitudes of them flying; and that when one of the former is wounded, prodigious multitudes immediately follow its bloody track. He adds, that it is a moſt gluttonous bird, eating till it is forced to diſgorge itſelf.

2. The *puffinus*, or ſhear-water, is 15 inches in length; the breadth 31; the weight 17 ounces: the bill is an inch and three quarters long; noſtrils tubular, but not very prominent: the head, and whole upper ſide of the body, wings, tail, and thighs, are of a ſooty blackneſs; the under ſide from chin to tail, and inner coverts of the wings, white: the legs weak, and compreſſed ſidewiſe; duſky behind, whitiſh before. Theſe birds are found in the Calf of Man; and, as Mr. Ray ſuppoſes, in the Scilly iſles. They reſort to the former in February; take a ſhort poſſeſſion of the rabbet-burrows, and then diſappear till April. They lay one egg, white and blunt at each end; and the young are fit to be taken the beginning of Auguſt; when great numbers are killed by the perſon who farms the iſle: they are ſalted and barrelled; and when they are boiled, are eaten with potatoes. During the day they keep at ſea, fiſhing; and towards evening return to their young; whom they feed by diſcharging the contents of their ſtomachs into their mouths, which by that time is turned into oil: by reaſon of the backward ſituation of their legs, they ſit quite erect. They quit the iſle the latter end of Auguſt, or beginning of September; and, from accounts lately received from navigators, we have reaſon to imagine that, like the ſtorm-finch, they are diſperſed over the whole Atlantic ocean. This ſpecies inhabits alſo the Orkney iſles, where it makes its neſt in holes on the hearth near the ſhelves of the rocks and headlands: it is called there the *lyre*; and is much valued, both on account of its being a food, and for its feathers. The inhabitants take and ſalt them in Auguſt for winter proviſions, when they boil them with cabbage. They alſo take the old ones in March; but they are then poor, and not ſo well taſted as the young: they appear firſt in thoſe iſlands in February.

3. The *pelagica*, or ſtormy petrel, is about the bulk of the houſe-ſwallow: the length ſix inches; the extent of wings, 13. The whole bird is black, except the coverts of the tail and vent-feathers, which are white: the bill is hooked at the end: the noſtrils tubular: the legs ſlender, and long. It has the ſame faculty of ſpouting oil from its bill as the other ſpecies: and Mr. Brunnich tells us, that the inhabitants of the Ferroe iſles makes this bird ſerve the purpoſes of a candle, by drawing a wick through the mouth and rump, which being lighted, the flame is fed by the fat and oil of the body. Except in breeding-time, it is always at ſea; and is ſeen all over the vaſt Atlantic ocean, at the greateſt diſtance from land; often following the veſſels in great flocks, to pick up any thing that falls from on board: for trial ſake, chopped ſtraw has been flung over, which they would ſtand on with expanded wings; but were never obſerved to ſettle on or ſwim in the water: it preſages bad weather, and cautions the ſeamen of the approach of a tempeſt, by collecting under the ſtern of the ſhips: it braves the utmoſt fury of the ſtorm, ſometimes ſkimming with incredible velocity along the hollows of the waves, ſometimes on the ſummits: Cluſius makes it the Camilla of the ſea.

Vel mare per medium fluctu ſuſpenſa tumenti
Ferret iter, celeres nec tingeret æquore plantas. VIRG.

She ſwept the ſeas; and, as ſhe ſkimm'd along,
Her flying feet unbath'd on billows hung. DRYDEN.

Theſe birds are the *cypſelli* of Pliny, which he places among the *apodes* of Ariſtotle; not becauſe they wanted feet, but were Κακοποδα, or had bad or uſeleſs ones; an attribute he gives to theſe ſpecies, on a ſuppoſition that they were almoſt always on the wing. In Auguſt 1772, Mr. Pennant found them on the rocks called *Macdonald's Table*, off the north end of the iſle of Skie; ſo conjectures they breed there. They lurked under the looſe ſtones, but betrayed themſelves by their twittering noiſe.

In Mr. White's *Journal of a Voyage to New South Wales* we have a figure of the fuliginous petrel, with a whitiſh beak; which he takes to be a variety of the *Procellaria Æquinoctialis* of Linnæus. It is nearly of the ſize of a raven; its colour is a deep ſooty brown or blackiſh; on the chin there is a ſmall patch of white running down a little on each ſide from the lower mandible; the beak is of yellowiſh white. See plate 21. Captain Bligh, in his *Voyage to the South Seas*, in S. lat. 60. 1. and W. long. 71. 45. ſaw both petrels and pintadas; ſome whom he took with baited hooks.

PROCESS, in law denotes the proceedings in any cauſe, real or perſonal, civil or criminal, from the original writ to the end thereof. In a more limited ſenſe, proceſs denotes that by which a man is called firſt into any temporal court. It is the next ſtep for carrying on the ſuit, after ſuing out the original writ. See SUIT and WRIT. It is the method taken by the law to compel a compliance with the original writ, of which the primary ſtep is by giving the party notice to obey it. This notice is given upon all real *præcipes*; and alſo upon all perſonal writs for injuries not againſt the peace, by *ſummons*; which is a warning to appear in court at the return of the original writ, given to the defendant by two of the ſheriff's meſſengers called *ſummoners*, either in perſon, or left at his houſe or land: in like manner as in the civil law the firſt proceſs is by perſonal citation, *in jus vocando*. This warning on the land is given, in real actions, by erecting a white ſtick or wand on the defendant's grounds (which ſtick or wand among the northern nations is called the *baculus nunciatorius*), and by ſtatute 31 Eliz. c. 3. the notice muſt alſo be proclaimed on ſome Sunday before the door of the pariſh-church.

If the defendant diſobeys this verbal monition, the next proceſs is by writ of *attachment*, or *pone*; ſo called from the words of the writ, *pone per vadium et ſalvos plegios*, "put by gage and ſafe pledges A. B. the defendant," &c. This is a writ not iſſuing out of chancery, but out of the court of common pleas, being grounded on the non-appearance of the defendant at the return of the original writ; and thereby the ſheriff is commanded to attach him, by taking *gage*, that is, certain of his goods, which he ſhall forfeit if he doth not appear; or by making him find *ſafe pledges* or ſureties, which ſhall be amerced in caſe of his non-appearance. This is alſo the firſt and immediate proceſs without any previous ſummons, upon actions of treſpaſs *vi et armis*, or for other injuries, which, though not forcible, are yet treſpaſſes againſt the peace, as *deceit* and *conſpiracy*: where the violence of the wrong requires a more ſpeedy remedy, and therefore the original writ commands the defendant to be at once attached, without any precedent warning.

If, after attachment, the defendant neglects to appear, he not only forfeits this ſecurity, but is moreover to be further compelled by writ of *diſtringas*, or diſtreſs infinite; which is a ſubſequent proceſs iſſuing from the court of common pleas, commanding the ſheriff to diſtrain the defendant from time to time, and continually afterwards, by taking his goods and the profits of his lands, which are called *iſſues*, and which he forfeits to the king if he doth not appear. But the iſſues may be ſold, if the court ſhall ſo direct, in order to defray the reaſonable coſts of the plaintiff. In like manner, by the civil law, if the defendant abſconds, ſo that the citation is of no effect, *mittitur adverſarius in poſſeſſionem bonorum ejus*.

And here, by the common as well as the civil law, the proceſs ended in caſe of injuries without force: the defendant if he had any ſubſtance, being gradually ſtripped of it all by repeated diſtreſſes, till he rendered obedience to the king's writ: and, if he had no ſubſtance, the law held him incapable of making ſatisfaction, and therefore looked upon all further proceſs as nugatory. And beſides, upon feodal principles, the perſon of a feudatory was not liable to be attached for injuries merely civil, leſt thereby his lord ſhould be deprived of his perſonal ſervices. But in caſes of injury accompanied with force, the law, to puniſh the breach of the peace and prevent its diſturbance for the future, provided alſo a proceſs againſt the defendant's perſon, in caſe he neglected to appear upon the former proceſs of attachment, or had no ſubſtance whereby to be attached; ſubjecting his body to impriſonment by the writ of *capias ad reſpondendum*. But this immunity of the defendant's perſon, in caſe of peaceable though fraudulent injuries, producing great contempt of the law in indigent wrong-doers, a *capias* was alſo allowed, to arreſt the perſon in actions of account, though no breach of the peace be ſuggeſted, by the ſtatutes of Marlbridge, 52 Hen. III. c. 23. and Weſtm. 2. 13 Edw. I. c. 11. in actions of debt and detinue, by ſtatute 25 Edw. III. c. 17, and in all actions on the caſe by ſtatute 19 Hen. VII. c. 9. Before which laſt ſtatute a practice had been introduced of commencing the ſuit by bringing an original writ of treſpaſs *quare clauſum fregit*, by breaking the plaintiff's cloſe, *vi et armis*; which by the old common law ſubjected the defendant's perſon to be arreſted by writ of *capias*: and then afterwards, by connivance of the court, the plaintiff might proceed to proſecute for any other leſs forcible injury. This practice (through cuſtom rather than neceſſity, and for ſaving ſome trouble and expenſe, in ſuing out a ſpecial original adapted to the particular injury) ſtill continues in almoſt all caſes, except in actions of debt; though now, by virtue of the ſtatutes above cited and others, a *capias* might be had upon almoſt every ſpecies of complaint.

If, therefore, the defendant, being ſummoned or attached, makes default, and neglects to appear; or if the ſheriff returns a *nihil*, or that the defendant hath nothing whereby he may be ſummoned, attached, or diſtrained, the *capias* now uſually iſſues: being a writ commanding the ſheriff to take the body of the defendant, if he may be found in his bailiwick or county, and him ſafely to keep, ſo that he may have him in court on the day of the return, to anſwer to the plaintiff of a plea of debt, or treſpaſs, &c. as the caſe may be. This writ, and all others ſubſequent to the original writ, not iſſuing out of chancery, but from the court into which the original was returnable, and being grounded on what has paſſed in that court in conſequence of the ſheriff's return, are called *judicial*, not *original* writs; they iſſue under the private ſeal of that court, and not under the great ſeal of England; and are *teſted*, not in the king's name, but in that of the chief juſtice only. And theſe ſeveral writs being grounded on the ſheriff's return, muſt reſpectively bear date the ſame day on which the writ immediately preceding was returnable.

This is the regular and orderly method of proceſs. But it is now uſual in practiſe to ſue out the *capias* in the firſt inſtance, upon a ſuppoſed return of the ſheriff; eſpecially if it be ſuſpected that the defendant, upon notice of the action, will abſcond; and afterwards a fictitious original is drawn up, with a proper return thereupon, in order to give the proceedings a colour of regularity. When this *capias* is delivered to the ſheriff, he by his under-ſheriff grants a warrant to his inferior officers or bailiffs to execute it on the defendant. And, if the ſheriff of Oxfordſhire (in which county the injury is ſuppoſed to be committed and the action is laid) cannot find the defendant in his juriſdiction, he returns that he is not found, *non eſt inventus*, in his bailiwick: whereupon another writ iſſues called a *teſtatum capias*, directed to the ſheriff of the county where the defendant is ſuppoſed to reſide, as of Berkſhire, reciting the former writ, and that it is teſtified, *teſtatum eſt*, that the defendant lurks or wanders in his bailiwick, where he is commanded to take him, as in the former *capias*. But here alſo, when the action is brought in one county and the defendant lives in another, it is uſual, for ſaving trouble, time, and expenſe, to make out a *teſtatum capias* at the firſt; ſuppoſing not only an original, but alſo a former *capias*, to have been granted; which in fact never was. And this fiction, being beneficial to all parties, is readily acquieſced in, and is now become the ſettled practice; being one among many inſtances to illuſtrate that maxim of law, that *in fictione juris conſiſtit equitas*.

But where a defendant abſconds, and the plaintiff would proceed to an outlawry againſt him, an original writ muſt then be ſued out regularly, and after that a *capias*. And if the ſheriff cannot find the defendant upon the firſt writ of *capias*, and returns a *non eſt inventus*, there iſſues out an *alias* writ, and after that a *pluries*, to the ſame effect as the former: only after theſe words "we command you," this clauſe is inſerted, "as we have formerly," or, "as we have often commanded you;"—"*ſicut* alias," or, "*ſicut* pluries, *præcepimus*." And if a *non eſt inventus* is returned upon all of them, then a writ of *exigent* or *exigi facias* may be ſued out, which requires the ſheriff to cauſe the defendant to be proclaimed, required, or exacted, in five county-courts ſucceſſively, to render himſelf; and if he does, then to take him, as in a *capias*: but if he does not appear, and is returned *quinto exactus*, he ſhall then be outlawed by the coroners of the county. Alſo by ſtatute 6 Hen. VIII. c. 4. and 31 Eliz. c. 3. whether the defendant dwells within the ſame or another county than that wherein the *exigent* is ſued out, a *writ of proclamation* ſhall iſſue out at the ſame time with the *exigent*, commanding the ſheriff of the county wherein the defendant dwells, to make three proclamations thereof in places the moſt notorious, and moſt likely to come to his knowledge, a month before the outlawry ſhall take place. Such outlawry is putting a man out of the protection of the law, ſo that he is incapable to bring an action for redreſs of injuries; and it is alſo attended with a forfeiture of all one's goods and chattels to the king. And therefore, till ſome time after the conqueſt, no man could be outlawed but for felony: but in Bracton's time, and ſomewhat earlier, proceſs of outlawry was ordained to lie in all actions for treſpaſſes *vi et armis*. And ſince, by a variety of ſtatutes (the ſame which allow the writ of *capias* before-mentioned), proceſs of outlawry doth lie in divers actions that are merely civil; providing they be commenced by original and not by bill. If after outlawry the defendant appears publicly, he may be arreſted by a writ of *capias utlagatum*, and committed till the outlawry be reverſed. Which reverſal may be had by the defendant's appearing perſonally in court (and in the king's bench without any perſonal appearance. ſo that he appears by attorney, according to ſtat. 4 and 5 W. & M. c. 18); and any plauſible cauſe, however ſlight, will in general be ſufficient to reverſe it, it being conſidered only as a proceſs to compel an appearance. But then the defendant muſt pay full coſts, and put the plaintiff in the ſame condition as if he had appeared before the writ of *exigi facias* was awarded.

Such is the firſt proceſs in the court of common pleas. In the king's bench they may alſo (and frequently do) proceed in certain cauſes, particularly in actions of ejectment and treſpaſs, by *original* writ, with *attachment* and *capias* thereon; returnable, not at Weſtminſter, where the common pleas are now fixed in conſequence of *magna charta*, but *ubicunque fuerimus in Anglia*, whereſoever the king ſhall then be in England; the king's bench being removable into any part of England, at the pleaſure and diſcretion of the crown. But the more uſual method of proceeding therein is without any original, but by a peculiar ſpecies of proceſs intitled a *bill of Middleſex*; and therefore ſo intitled, becauſe the court now ſits in that county; for if it ſat in Kent, it would then be a bill of Kent. For though, as the juſtices of this court have, by its fundamental conſtitution, power to determine all offences and treſpaſſes, by the common law and cuſtom of the realm, it needed no original writ from the crown to give it cognizance of any miſdemeanor in the county wherein it reſides; yet as, by this court's coming into any county, it immediately ſuperſeded the ordinary adminiſtration of juſtice by the general commiſſions of *eyre* and of *oyer and terminer*, a proceſs of its own became neceſſary, within the county where it ſat, to bring in ſuch perſons as were accuſed of committing any forcible injury. The bill of Middleſex (which was formerly always founded on a plaint of treſpaſs *quare clauſum fregit*, entered on the records of the court) is a kind of *capias*, directed to the ſheriff of that county, and commanding him to take the defendant, and have him before our lord the king at Weſtminſter on a day prefixed, to anſwer to the plaintiff of a plea of treſpaſs. For this accuſation of treſpaſs it is that gives the court of king's bench juriſdiction in other civil cauſes, ſince, when once the defendant is taken into cuſtody of the marſhal, or priſon-keeper of his court, for the ſuppoſed treſpaſs, he, being then a priſoner of this court, may here be proſecuted for any other ſpecies of injury. Yet, in order to found this juriſdiction, it is not neceſſary that the defendant be actually the marſhal's priſoner; for, as ſoon as he appears, or puts in bail, to the proceſs, he is deemed by ſo doing to be in ſuch cuſtody of the marſhal as will give the court a juriſdiction to proceed. And, upon theſe accounts, in the bill or proceſs, a complaint of treſpaſs is always ſuggeſted, whatever elſe may be the real cauſe of action. This bill of Middleſex muſt be ſerved on the defendant by the ſheriff, if he finds him in that county: but if he returns, *non eſt inventus*, then there iſſues out a writ of *latitat*, to the ſheriff of another county, as Berks; which is ſimilar to the *teſtatum capias* in the common pleas, and recites the bill of Middleſex and the proceedings thereon, and that it is teſtified that the defendant *latitat et diſcurrit*, lurks and wanders about in Berks; and therefore commands the ſheriff to take him, and have his body in court on the day of the return. But as in the common-pleas the *teſtatum capias* may be ſued out upon only a ſuppoſed, and not an actual preceding, *capias*; ſo in the king's bench a *latitat* is uſually ſued out upon only a ſuppoſed, and not an actual bill of Middleſex. So that, in fact, a *latitat* may be called the firſt proceſs in the court of king's bench, as the *teſtatum capias* is in the common pleas. Yet, as in the common pleas, if the defendant lives in the county wherein the action is laid, a common *capias* ſuffices; ſo in the king's bench likewiſe, if he lives in Middleſex, the proceſs muſt ſtill be by bill of Middleſex only.

In the exchequer the firſt proceſs is by writ of *quo minus*, in order to give the court a juriſdiction over pleas between party and party. In which writ the plaintiff is alleged to be the king's farmer or debtor, and that the defendant hath done him the injury complained of, *quo minus ſufficiens exiſtit*, by which he is the leſs able to pay the king his rent or debt. And upon this the defendant may be arreſted as upon a *capias* from the common pleas.

Thus differently do the three courts ſet out at firſt, in the commencement of a ſuit, in order to entitle the two courts of king's bench and exchequer to hold plea in ſubjects' cauſes, which by the original conſtitution of Weſtminſter-hall they were not empowered to do. Afterwards, when the cauſe is once drawn into the reſpective courts, the method of purſuing it is pretty much the ſame in all of them.

If the ſheriff had found the defendant upon any of the former writs, the *capias latitat*, &c. he was anciently obliged to take him into cuſtody, in order to produce him in court upon the return, however ſmall and minute the cauſe of action might be. For, not having obeyed the original ſummons, he had ſhown a contempt of the court, and was no longer to be truſted at large. But when the ſummons fell into diſuſe, and the *capias* became in fact the firſt proceſs, it was thought hard to impriſon a man for a contempt which was only ſuppoſed: and therefore, in common caſes, by the gradual indulgence of the courts (at length authoriſed by ſtatute 12 Geo. I. c. 29. which was amended by ſtatute 5 Geo. II. c. 27. and made perpetual by ſtatute 21 Geo. II. c. 3.) the ſheriff or his officer can now only perſonally ſerve the defendant with the copy of the writ or proceſs, and with notice in writing to appear by his attorney in court to defend this action; which in effect reduces it to a mere ſummons. And if the defendant thinks proper to appear upon this notice, his appearance is recorded, and he puts in ſureties for his future attendance and obedience; which ſureties are called *common bail*, being the ſame two imaginary perſons that were pledges for the plaintiff's proſecution, John Doe and Richard Roe. Or, if the defendant does not appear upon the return of the writ, or within four (or in ſome caſes eight) days after, the plaintiff may enter an appearance for him, as if he had really appeared; and may file common bail in the defendant's name, and proceed thereupon as if the defendant had done it himſelf.

But if the plaintiff will make affidavit, or aſſert upon oath, that the cauſe of action amounts to ten pounds or upwards, then in order to arreſt the defendant, and make him put in ſubſtantial ſureties for his appearance, called *ſpecial bail*, it is required by ſtatute 13 Car. II. ſtat. 2. c. 2. that the true cauſe of action ſhould be expreſſed in the body of the writ or proceſs: elſe no ſecurity can be taken in a greater ſum than L. 40. This ſtatute (without any ſuch intention in the makers) had like to have ouſted the king's bench of all its juriſdiction over civil injuries without force: for, as the bill of Middleſex was framed only for actions of treſpaſs, a defendant could not be arreſted and held to bail thereupon for breaches of civil contracts. But to remedy this inconvenience, the officers of the king's bench deviſed a method of adding what is called a clauſe of *ac etiam* to the uſual complaint of treſpaſs; the bill of Middleſex commanding the defendant to be brought in to anſwer the plaintiff of a plea of treſpaſs, *and alſo* to a bill of debt: the complaint of treſpaſs giving cognizance to the court, and that of debt authorizing the arreſt. In imitation of which, lord chief juſtice North, a few years afterwards, in order to ſave the ſuitors of his court the trouble and expenſe of ſuing out ſpecial originals, directed, that in the common pleas, beſides the uſual complaint of breaking the plaintiff's cloſe, a clauſe of *ac etiam* might be alſo added to the writ of *capias*, containing the true cauſe of action; as, "that the ſaid Charles the defendant may anſwer to the plaintiff of a plea of treſpaſs in breaking his cloſe: and alſo, *ac etiam* may anſwer him, according to the cuſtom of the court, in a certain plea of treſpaſs upon the caſe, upon promiſes, to the value of 20l. &c." The ſum ſworn to by the plaintiff is marked upon the back of the writ; and the ſheriff, or his officer the bailiff, is then obliged actually to arreſt or take into cuſtody the body of the defendant, and, having ſo done, to return the writ with a *cepi corpus* indorſed thereon. See ARREST.

When the defendant is regularly arreſted, he muſt either go to priſon, for ſafe cuſtody; or put in *ſpecial bail* to the ſheriff. For, the intent of the arreſt being only to compel an appearance in court at the return of the writ, that purpoſe is equally anſwered, whether the ſheriff detains his perſon, or takes ſufficient ſecurity for his appearance, called *bail* (from the French word *bailler*, "to deliver,") becauſe the defendant is bailed, or delivered, to his ſureties, upon their giving ſecurity for his appearance; and is ſuppoſed to continue in their friendly cuſtody inſtead of going to gaol. See BAIL. The method of putting in bail to the ſheriff is by entering into a bond or obligation, with one or more ſureties, (not fictitious perſons, as in the former caſe of common bail, but real, ſubſtantial, reſponſible bondſmen), to inſure the defendant's appearance at the return of the writ; which obligation is called the *bail-bond*. The ſheriff, if he pleaſes, *may* let the defendant go without any ſureties; but that is at his own peril: for, after once taking him, the ſheriff is bound to keep him ſafely, ſo as to be forthcoming in court; otherwiſe an action lies againſt him for an eſcape. But, on the other hand, he is obliged, by ſtatute 23 Hen. VI. c. 10. to take (if it be tendered) a ſufficient bail-bond; and, by ſtatute 12 Geo. I. c. 29. the ſheriff ſhall take bail for no other ſum than ſuch as is ſworn to by the plaintiff, and indorſed on the back of the writ.

Upon the return of the writ, or within four days after, the defendant muſt *appear* according to the exigency of the writ. This *appearance* is effected by putting in and juſtifying bail *to the action*; which is commonly called *putting in bail above*. If this be not done, and the bail that were taken by the ſheriff *below* are reſponſible perſons, the plaintiff may take an aſſignment from the ſheriff of the bail-bond (under the ſtatute 4 & 5 Ann. c. 16.) and bring an action thereupon againſt the ſheriff's bail. But if the bail ſo accepted by the ſheriff be inſolvent perſons, the plaintiff may proceed againſt the ſheriff himſelf, by calling upon him, firſt to return the writ (if not already done), and afterwards to bring in the body of the defendant. And if the ſheriff does not then cauſe ſufficient bail to be put in *above*, he will himſelf be reſponſible to the plaintiff.

The bail *above*, or bail *to the action*, muſt be put in either in open court, or before one of the judges thereof; or elſe, in the country, before a commiſſioner appointed for that purpoſe by virtue of the ſtatute 4 W. & M. c. 4. which muſt be tranſmitted to the court. Theſe bail, who muſt at leaſt be two in number, muſt enter into a recognizance in court, or before the judge or commiſſioner, whereby they do jointly and ſeverally undertake, that if the defendant be condemned in the action, he ſhall pay the coſts and condemnation, or render himſelf a priſoner, or that they will pay it for him: which recognizance is tranſmitted to the court in a ſlip of parchment, intitled a *bail-piece*. And, if required, the bail muſt *juſtify* themſelves in court, or before the commiſſioner in the country, by ſwearing themſelves houſekeepers, and each of them to be worth double the ſum for which they are bail, after payment of all their debts. This anſwers in ſome meaſure to the *ſtipulatio* or *ſatiſdatio* of the Roman laws, which is mutually given by each litigant party to the other: by the plaintiff that he will proſecute his ſuit, and pay the coſts if he loſes his cauſe; in like manner as our law ſtill requires nominal pledges of proſecution from the plaintiff: by the defendant, that he ſhall continue in court, and abide the ſentence of the judge, much like our ſpecial bail; but with this difference, that the *fide-juſſores* were there abſolutely bound *judicatum ſolvere*, to ſee the coſts and condemnation paid at all events: whereas our ſpecial bail may be diſcharged, by ſurrendering the defendant into cuſtody within the time allowed by law; for which purpoſe they are at all times intitled to a warrant to apprehend him.

Special bail is required (as of courſe) only upon actions of debt, or actions on the caſe in trover, or for money due, where the plaintiff can ſwear that the cauſe of action amounts to ten pounds: but in actions where the damages are precarious, being to be aſſeſſed *ad libitum* by a jury, as in actions for words, ejectment or treſpaſs, it is very ſeldom poſſible for a plaintiff to ſwear to the amount of his cauſe of action; and therefore no ſpecial bail is taken thereon, unleſs by a judge's order, or the particular directions of the court, in ſome peculiar ſpecies of injuries, as in caſes of mayhem or atrocious battery; or upon ſuch ſpecial circumſtances as make it abſolutely neceſſary that the defendant ſhould be kept within the reach of juſtice. Alſo in actions againſt heirs, executors, and adminiſtrators, for debts of the deceaſed, ſpecial bail is not demandable; for the action is not ſo properly againſt them in perſon, as againſt the effects of the deceaſed in their poſſeſſion. But ſpecial bail is required even of them, in actions for a *devaſtavit*, or waſting the goods of the deceaſed; that wrong being of their own committing.

Thus much for *proceſs*; which is only meant to bring the defendant into court, in order to conteſt the ſuit, and abide the determination of the law. When he appears either in perſon as a priſoner, or out upon bail, then follow the *pleadings* between the parties. See PLEADINGS.

PROCESS *upon an Indictment*. See PROSECUTION. The proper proceſs on an indictment for any petty miſdemeſnor, or on a penal ſtatute, is a writ of *venire facias*, which is in the nature of a ſummons to cauſe the party to appear. And if by the return to ſuch *venire* it appears that the party hath lands in the county whereby he may be diſtrained, then a *diſtreſs infinite* ſhall be iſſued from time to time till he appears. But if the ſheriff returns, that he hath no lands in his bailiwick, then (upon his non-appearance) a writ of *capias* ſhall iſſue, which commands the ſheriff to take his body, and have him at the next aſſiſes; and if he cannot be taken upon the firſt *capias*, a ſecond and a third ſhall iſſue, called an *alias*, and a *pluries capias*. But, on indictments for treaſon or felony, a *capias* is the firſt proceſs: and, for treaſon or homicide, only one ſhall be allowed to iſſue, or two in the caſe of other felonies, by ſtatute 25 Edw. III. c. 14. though the uſage is to iſſue only one in any felony; the proviſions of this ſtatute being in moſt caſes found impracticable. And ſo, in the caſe of miſdemeſnors, it is now the uſual practice for any judge of the court of king's bench, upon certificate of an indictment found, to award a writ of *capias* immediately, in order to bring in the defendant. But if he abſconds, and it is thought proper to purſue him to an outlawry, then a greater exactneſs is neceſſary. For, in ſuch caſe, after the ſeveral writs have iſſued in a regular number, according to the nature of the reſpective crimes, without any effect, the offender ſhall be put in the *exigent* in order to his outlawry: that is, he ſhall be exacted, proclaimed, or required, to ſurrender, at five county-courts; and if he be returned *quinto exactus*, and does not appear at the fifth exaction or requiſition, then he is adjudged to be *outlawed*, or put out of the protection of the law; ſo that he is incapable of taking the benefit of it in any reſpect, either by bringing actions or otherwiſe.

The puniſhment for outlawries upon indictments for miſdemeſnors is the ſame as for outlawries upon civil actions; viz. forfeiture of goods and chattels. But an outlawry in treaſon or felony amounts to a conviction and attainder of the offence charged in the indictment, as much as if the offender had been found guilty by his country. His life is, however, ſtill under the protection of the law, as hath elſewhere been obſerved; (ſee HOMICIDE): that though anciently an outlawed felon was ſaid to have *caput lupinum*, and might be knocked on the head like a wolf, by any one that ſhould meet him; becauſe, having renounced all law, he was to be dealt with as in a ſtate of nature, when every one that ſhould find him might ſlay him: yet now, to avoid ſuch inhumanity, it is holden that no man is entitled to kill him wantonly or wilfully; but in ſo doing is guilty of murder, unleſs it happens in the endeavour to apprehend him. For any perſon may arreſt an outlaw on a criminal proſecution, either of his own head, or by writ or warrant of *capias utlagatum*, in order to bring him to execution. But ſuch outlawry may be frequently reverſed by writ of error, the proceedings therein being (as it is fit they ſhould be) exceedingly nice and circumſtantial; and if any ſingle minute point be omitted or miſconducted, the whole outlawry is illegal, and may be reverſed: upon which reverſal the party accuſed is admitted to plead to, and defend himſelf againſt the indictment.

Thus much for proceſs to bring in the offender after indictment found; during which ſtage of the proſecution it is that writs of *certiorari facias* are uſually had, though they may be had at any time before trial, to certify and remove the indictment, with all the proceedings thereon, from any inferior court of criminal juriſdiction into the court of king's bench; which is the ſovereign ordinary court of juſtice in cauſes criminal. And this is frequently done for one of theſe four purpoſes; either, 1. To conſider and determine the validity of appeals or indictments and the proceedings thereon; and to quaſh or confirm them as there is cauſe; or, 2. Where it is ſurmiſed that a partial or inſufficient trial will probably be had in the court below, the indictment is removed, in order to have the priſoner or defendant tried at the bar of the court of king's bench, or before the juſtices of *niſi prius*: or, 3. It is ſo removed, in order to plead the king's pardon there: or, 4. To iſſue proceſs of outlawry againſt the offender, in thoſe counties or places where the proceſs of the inferior judges will not reach him. Such writ of *certiorari*, when iſſued or delivered to the inferior court for removing any record or other proceeding, as well upon indictment as otherwiſe, ſuperſedes the juriſdiction of ſuch inferior court, and makes all ſubſequent proceedings therein entirely erroneous and illegal; unleſs the court of king's bench remands the record to the court below, to be there tried and determined. A *certiorari* may be granted at the inſtance of either the proſecutor or the defendant: the former as a matter of right, the latter as a matter of diſcretion; and therefore it is ſeldom granted to remove indictments from the juſtices of gaol-delivery, or after iſſue joined, or confeſſion of the fact in any of the courts below.

At this ſtage of proſecution alſo it is, that indictments found by the grand jury againſt a peer, muſt, in conſequence of a writ of *certiorari*, be certified and tranſmitted into the court of parliament, or into that of the lord high ſteward of Great Britain; and that, in places of excluſive juriſdiction, as the two univerſities, indictments muſt be delivered (upon challenge and claim of cognizance) to the courts therein eſtabliſhed by charter, and confirmed by act of parliament, to be there reſpectively tried and determined. See PLEA.

PROCESS, in chemiſtry, the whole courſe of an experiment or ſeries of operations, tending to produce ſomething new.

PROCESS, in anatomy, denotes any protuberance or eminence in a bone.

PROCESSION, a ceremony in the Romiſh church, conſiſting of a formal march of the clergy and people, putting up prayers, &c. And in this manner viſiting ſome church, &c. They have alſo proceſſions of the hoſt or ſacrament, &c. See HOST.

PROCHEIN AMY, in law, the perſon next a-kin to a child in non-age, and who, in that reſpect, is allowed to act for him, and be his guardian, &c. if he hold land in ſoccage. To ſue, an infant is not allowed to make an attorney; but the court will admit his next friend as plaintiff, or his guardian as defendant.

PROCKIA, in botany: A genus of the monogynia order, belonging to the polyandria claſs of plants; and in the natural method ranking with thoſe of which the order is doubtful. The calyx is triphyllous, beſides two leaflets at the baſe. There is no corolla; the berry is quinquangular, and polyſpermous.

PROCLAMATION, a public notice given of any thing of which the king thinks proper to advertiſe his ſubjects.

Proclamations are a branch of the king's prerogative (ſee PREROGATIVE); and have then a binding force, when (as Sir Edward Coke obſerves) they are grounded upon and enforce the laws of the realm. For, though the making of laws is entirely the work of a diſtinct part, the legiſlative branch of the ſovereign power, yet the manner, time, and circumſtances of putting thoſe laws in execution, muſt frequently be left to the diſcretion of the executive magiſtrate. And therefore his conſtitutions or edicts, concerning thoſe points which we call *proclamations*, are binding upon the ſubject, where they do not either contradict the old laws, or tend to eſtabliſh new ones; but only enforce the execution of ſuch laws as are already in being, in ſuch manner as the king ſhall judge neceſſary. Thus the eſtabliſhed law is, that the king may prohibit any of his ſubjects from leaving the realm: a proclamation therefore forbidding this in general for three weeks, by laying an embargo upon all ſhipping in time of war, will be equally binding as an act of parliament, becauſe founded upon a prior law. But a proclamation to lay an embargo in time of peace upon all veſſels laden with wheat, (though in the time of a public ſcarcity), being contrary to law, and particularly to ſtatute 22 Car. II. c. 13. the adviſers of ſuch a proclamation, and all perſons acting under it, found it neceſſary to be indemnified by a ſpecial act of parliament, 7 Geo. III. c. 7. A proclamation for diſarming Papiſts is alſo binding, being only in execution of what the legiſlature has firſt ordained: but a proclamation for allowing arms to papiſts, or for diſarming any proteſtant ſubjects will not bind; becauſe the firſt would be to aſſume a diſpenſing power, the latter a legiſlative one; to the veſting of either of which in any ſingle perſon the laws of England are abſolutely ſtrangers. Indeed, by the ſtatute 31 Hen. VIII. c. 8. it was enacted, that the king's proclamations ſhould have the force of acts of parliament: a ſtatute which was calculated to introduce the moſt deſpotic tyranny; and which muſt have proved fatal to the liberties of this kingdom had it not been luckily repealed in the minority of his ſucceſſor, about five years after. By a late act of parliament the king is empowered to raiſe regiments of Roman Catholics, to ſerve in the preſent war.

PROCLUS, ſurnamed DIADOCUS, a Greek philoſopher and mathematician, was born in Lycia, and lived about the year 500. He was the diſciple of Syrianus, and had a great ſhare in the friendſhip of the emperor Anaſtaſius. It is ſaid, that when Vitalian laid ſiege to Conſtantinople, Proclus burnt his ſhips with large brazen ſpeculums. This philoſopher was a pagan, and wrote againſt the Chriſtian religion. There are ſtill extant his Commentaries on ſome of Plato's books, and other of his works written in Greek.

PROCONSUL, a Roman magiſtrate, ſent to govern a province with conſular authority. The proconſuls were appointed out of the body of the ſenate; and uſually as the year of any one's conſulate expired, he was ſent proconſul into ſome province. The proconſuls decided caſes of equity and juſtice, either privately in their pretorium or palace, where they received petitions, heard complaints, granted writs under their ſeal, and the like; or elſe publicly, in the common hall, with the uſual formalities obſerved in the court of judicature at Rome. They had beſides, by virtue of their edicts, the power of ordering all things relating to the tribunes, taxes, contributions, and proviſions of corn and money, &c. Their office laſted only a year. See CONSUL.

PROCOPIUS, a famous Greek hiſtorian, born in Cæſarea, acquired great reputation by his works in the reign of Juſtinian, and was ſecretary to Beliſarius during all the wars carried on by that general in Perſia, Africa, and Italy. He at length became ſenator, obtained the title of *illuſtrious*, and was made pretor of Conſtantinople.

PROCREATION, the begetting and bringing forth young. See GENERATION and SEMEN.

PROCTOR, a perſon commiſſioned to manage another perſon's cauſe in any court of the civil or eccleſiaſtical law.

PROCTOR, in the Engliſh univerſities. See UNIVERSITY.

PROCURATION, an act or inſtrument by which a perſon is empowered to treat, tranſact, receive, &c. in another perſon's name.

PROCURATOR. See PROCTOR.

PRODIGALITY, means extravagance, profuſion, waſte, or exceſſive liberality, and is the oppoſite extreme to the vice of parſimony. By the Roman law, if a man by notorious prodigality was in danger of loſing his eſtate, he was looked upon as *non compos*, and committed to the care of curators, or tutors, by the prætor. And by the laws of Solon, ſuch prodigals were branded with perpetual infamy.

PRODUCT, in arithmetic and geometry, the factum of two or more numbers, or lines, &c. into one another: thus $5 \times 4 = 20$ the product required.

PROEDRI, among the Athenians, were magiſtrates, who had the firſt ſeats at the public aſſemblies, and whoſe office it was to propoſe at each aſſembly the things to be deliberated upon and determined. Their office always ended with the meeting. Their number was nine ſo long as the tribes were ten in number.

PROFANATION, the acting diſreſpectfully to ſacred things.

PROFANE, a term uſed in oppoſition to *holy*; and in general is applied to all perſons who have not the ſacred character, and to things which do not belong to the ſervice of religion.

PROFESSION means a calling, vocation, or known employment. In Knox's *Eſſays*, vol. 1ſt, page 234, we find an excellent paper on the choice of a profeſſion, which that elegant writer concludes thus: "All the occupations of life (ſays he) are found to have their advantages and diſadvantages admirably adapted to preſerve the juſt equilibrium of happineſs. This we may confidently aſſert, that, whatever are the inconveniences of any of them, they are all preferable to a life of inaction; to that wretched liſtleſsneſs, which is conſtrained to purſue pleaſure as a buſineſs, and by rendering it the object of ſevere and unvaried attention, deſtroys its very eſſence." Among the Romaniſts profeſſion denotes the entering into a religious order, whereby a perſon offers himſelf to God by a vow of inviolably obſerving obedience, chaſtity, and poverty.

PROFESSOR, in the univerſities, a perſon who teaches or reads public lectures in ſome art or ſcience from a chair for the purpoſe.

PROFILE, in architecture, the draught of a building, fortification, &c. wherein are expreſſed the ſeveral heights, widths, and thickneſſes, ſuch as they would appear were the building cut down perpendicularly from the roof to the foundation. Whence the profile is alſo called the *ſection*, ſometimes *orthographical ſection*, and by Vitruvius alſo *ſciagraphy*.

Profile, in this ſenſe, amounts to the ſame with *elevation*; and ſtands oppoſed to a *plan* or *ichnography*.

PROFILE is alſo uſed for the contour or out-line of a figure, building, member of architecture, or the like; as a baſe, a cornice, &c. Hence *profiling* is ſometimes uſed for deſigning, or deſcribing the member with rule, compaſs, &c.

PROFILE, in ſculpture and painting.—A head, a portrait, &c. are ſaid to be in *profile*, when they are repreſented ſidewiſe, or in a ſide-view; as, when in a portrait there is but one ſide of the face, one eye, one cheek, &c. ſhown, and nothing of the other.—On almoſt all medals, the faces are repreſented in *profile*.

PROFLUVIUM, in medicine denotes a flux or liquid evacuation of any thing.

PROGNOSTIC, among phyſicians, ſignifies a judgment concerning the event of a diſeaſe, as whether it ſhall end in life or death, be ſhort or long, mild or malignant, &c.

PROGRAMMA, anciently ſignified a letter ſealed with the king's ſeal. *Programma* is alſo an univerſity term for a billet or advertiſement, poſted up or given into the hand, by way of invitation to an oration, &c. containing the argument, or ſo much as is neceſſary for underſtanding thereof.

PROGRESSION, in general, denotes a regular advancing, or going forward, in the ſame courſe and manner.

PROGRESSION, in mathematics, is either arithmetical or geometrical. Continued arithmetic proportion is, where the terms do increaſe and decreaſe by equal differences, and is called *arithmetic progreſſion*.

$$\text{Thus}\left\{\begin{array}{l} a,\ a+d,\ a+2d,\ a+3d,\ \text{\&c. increaſing} \\ a,\ a-d,\ a-2d,\ a-3d,\ \text{\&c. decreaſing}\end{array}\right\}\text{by the difference } d,$$

$$\text{In numbers}\left\{\begin{array}{rrrrrl} 2, & 4, & 6, & 8, & 10, & \text{\&c. increaſing} \\ 10, & 8, & 6, & 4, & 2, & \text{\&c. decreaſing}\end{array}\right\}\text{by the difference } 2.$$

Geometric Progreſſion, or *Continued Geometric Proportion*, is when the terms do increaſe or decreaſe by equal ratios: thus,

$$\left.\begin{array}{l} a,\ ar,\ arr,\ arrr,\ \text{\&c. increaſing} \\ a,\ \dfrac{a}{r},\ \dfrac{a}{rr},\ \dfrac{a}{rrr},\ \text{\&c. decreaſing}\end{array}\right\}\text{from a continual}\left\{\begin{array}{l}\text{multiplication} \\ \text{diviſion}\end{array}\right\}\text{by } r.$$

$$\left.\begin{array}{rrrrrrl} 2, & 4, & 8, & 16, & 32, & 64, & \text{increaſing} \\ 64, & 32, & 16, & 8, & 4, & 2, & \text{decreaſing}\end{array}\right\}\text{from a continual}\left\{\begin{array}{l}\text{multiplication} \\ \text{diviſion}\end{array}\right\}\text{by } 2.$$

See the articles FLUXIONS, GEOMETRY, and SERIES.

PROJECTILES.

THIS is the name for that part of mechanical philoſophy which treats of the motion of bodies any how projected from the ſurface of this earth, and influenced by the action of terreſtrial gravity.

It is demonſtrated in the phyſical part of aſtronomy that a body ſo projected muſt deſcribe a conic ſection, having the centre of the earth in one focus; and that it will deſcribe round that focus areas proportional to the times. And it follows from the principles of that ſcience, that if the velocity of projection exceeds 36700 feet in a ſecond, the body (if not reſiſted by the air) would deſcribe a hyperbola; if it be juſt 36700, it would deſcribe a parobola; and if it be leſs than this, it would deſcribe an ellipſis. If projected directly upwards, in the firſt caſe, it would never return, but proceed for ever; its velocity continually diminiſhing, but never becoming leſs than an aſſignable portion of the exceſs of the initial velocity above 36700 feet in a ſecond; in the ſecond caſe, it would never return, its velocity would diminiſh without end, but never be extinguiſhed. In the third caſe, it would proceed till its velocity was reduced to an aſſignable portion of the difference between 36700 and its initial velocity; and would then return, regaining its velocity by the ſame degrees, and in the ſame places, as it loſt it. Theſe are neceſſary conſequences of a gravity directed to the centre of the earth, and inverſely proportional to the ſquare of the diſtance. But in the greateſt projections that we are able to make, the gravitations are ſo nearly equal, and in directions ſo nearly parallel, that it would be ridiculous affectation to pay any regard to the deviations from equality and paralleliſm. A bullet riſing a mile above the ſurface of the earth, loſes only one two-thouſandth of its weight, and a horizontal range of four miles makes only 4′ of deviation from paralleliſm.

Let us therefore aſſume gravitation as equal and parallel. The errors ariſing from this aſſumption are quite inſenſible in all the uſes which can be made of this theory.

The theory itſelf will ever be regarded with ſome veneration and affection by the learned. It was the firſt fruits of mathematical philoſophy. Galileo was the firſt who applied mathematical knowledge to the motions of free bodies, and this was the ſubject on which he exerciſed his fine genius.

Gravity muſt be conſidered by us as a conſtant or uniform accelerating or retarding force, according as it produces the deſcent, or retards the aſcent, of a body. A conſtant or invariable accelerating force is one which produces an uniform acceleration; that is, which in equal times produces equal increments of velocity, and therefore produces increments of velocity proportional to the times in which they are produced. Forces are of themſelves imperceptible, and are ſeen only in their effects; and they have no meaſure but the effect, or what *meaſures* the effect; and every thing which we can diſcover with regard to thoſe meaſures, we muſt affirm with regard to the things of which we aſſume them as the meaſures. Therefore,

The motion of a falling body, or of a body projected directly downwards, is uniformly accelerated; and that of a body projected directly upwards is uniformly retarded: that is, the acquired velocities are as the times in which they are acquired by falling, and the extinguiſhed velocities are as the times in which they are extinguiſhed.

Cor. 1. If bodies ſimply fall, not being projected downwards by any external force, the times of the falls are proportional to the final velocities; and the times of aſcents, which terminate by the action of gravity alone, are proportional to the initial velocities.

2. The ſpaces deſcribed by a heavy body falling from reſt are as the ſquares of the acquired velocities; and the differences of theſe ſpaces are as the differences of the ſquares of the acquired velocities: and, on the other hand, the heights to which bodies projected upwards will riſe, before their motions be extinguiſhed, are as the ſquares of the initial velocities.

3. The ſpaces deſcribed by falling bodies are proportional to the ſquares of the times from the beginning of the fall; and the ſpaces deſcribed by bodies projected directly upwards are as the ſquares of the times of the aſcents.

4. The ſpace deſcribed by a body falling from reſt is one half of the ſpace which the body would have uniformly deſcribed in the ſame time, with the velocity acquired by the fall.—And the height to which a body will riſe, in oppoſition to the action of gravity, is one half of the ſpace which it would uniformly deſcribe in the ſame time with the initial velocity.

In like manner the difference of the ſpaces which a falling or riſing body deſcribes in any equal ſucceſſive parts of its fall or riſe, is one half of the ſpace which it would uniformly deſcribe in the ſame time with the difference of the initial and final velocities.

This propoſition will be more conveniently expreſſed for our purpoſe thus:

A body moving uniformly during the time of any fall with the velocity acquired thereby, will in that time deſcribe a ſpace double of that fall; and a body projected directly upwards will riſe to a height which is one half of the ſpace which it would, uniformly continued, deſcribe in the time of its aſcent with the initial velocity of projection.

Theſe theorems have been already demonſtrated in a popular way, in the articles MECHANICS, GUNNERY, &c. But we would recommend to our readers the 39th prop. of the firſt book of Newton's *Principia*, as giving the moſt general inveſtigation of this ſubject; equally eaſy with theſe more looſe methods of demonſtration, and infinitely ſuperior to them, by being equally applicable to every variation of the accelerating force. See an excellent application of this propoſition by Mr. Robins, for defining the motion of a ball diſcharged from a cannon, in the article GUNNERY. See another in OPTICS, for defining the motion of light in refraction, &c.

5. It is a matter of obſervation and experience, that a heavy body falls 16 feet and an inch Engliſh meaſure in a ſecond of time; and therefore acquires the velocity of 32 feet 2 inches *per* ſecond. This cannot be aſcertained directly with the preciſion that is neceſſary. A ſecond is too ſmall a portion of time to be exactly meaſured and compared with the ſpace deſcribed; but it is done with the greateſt accuracy by comparing the motion of a falling body with that of a pendulum. The time of a vibration is to the time of falling through half the length of the pendulum, as the circumference of a circle is to its diameter. The length of a pendulum can be aſcertained with great preciſion; and it can be lengthened or ſhortened till it makes juſt 86,400 vibrations in a day: and this is the way in which the ſpace fallen through in a ſecond has been accurately aſcertained.

As all other forces are aſcertained by the accelerations which they produce, they are conveniently meaſured by comparing their accelerations with the acceleration of gravity. This, therefore, has been aſſumed by all the later and beſt writers on mechanical philoſophy, as the unit by which every other force is meaſured. It gives us a perfectly diſtinct notion of the force which retains the moon in its orbit, when we ſay it is the 3600th part of the weight of the moon at the ſurface of the earth. We mean by this, that if a bullet were here weighed by a ſpring ſteelyard, and pulled it out to the mark 3600; if it were then taken to the diſtance of the moon, it would pull it out only to the mark 1. And we make this aſſertion on the authority of our having obſerved that a body at the diſtance of the moon falls from that diſtance $\frac{1}{3600}$ part of 16 feet in a ſecond. We do not, therefore, compare the *forces*, which are imperceptible things; we compare the accelerations, which are their indications, effects, and meaſures.

This has made philoſophers ſo anxious to determine with preciſion the fall of heavy bodies, in order to have an exact value of the accelerating power of terreſtrial gravity. Now we muſt here obſerve, that this meaſure may be taken in two ways: we may take the ſpace through which the heavy body falls in a ſecond; or we may take the velocity it acquires in conſequence of gravity having acted on it during a ſecond. The laſt is the proper meaſure; for the laſt is the immediate effect on the body. The action of gravity has changed the ſtate of the body—in what way? by giving it a determination to motion downward; this both points out the kind and the degree or intenſity of the force of gravity. The ſpace deſcribed in a ſecond by falling, is not an invariable meaſure; for, in the ſucceſſive ſeconds, the body falls through 16, 48, 80, 112, &c. feet, but the changes of the bodies' ſtate in each ſecond is the ſame. At the beginning it had no determination to move with any appreciable velocity; at the end of the firſt ſecond it had a determination by which it would have gone on for ever (had no ſubſequent force acted on it) at the rate of 32 feet *per* ſecond. At the end of the ſecond ſecond, it had a determination by which it would have moved for ever, at the rate of 64 feet *per* ſecond. At the end of the third ſecond, it had a determination by which it would have moved for ever, at the rate of 96 feet *per* ſecond, &c. &c. The difference of theſe determinations is a determination to the rate of 32 feet *per* ſecond. This is therefore conſtant, and the indication and proper meaſure of the conſtant or invariable force of gravity. The ſpace fallen through in the firſt ſecond is of uſe only as it is one half of the meaſure of this determination; and as halves have the proportion of their wholes, different accelerating forces may be ſafely affirmed to be in the proportion of the ſpaces through which they uniformly impel bodies in the ſame time. But we ſhould always recollect that this is but one half of the true meaſure of the accelerating force. Mathematicians of the firſt rank have committed great miſtakes by not attending to this; and it is neceſſary to notice it juſt now, becauſe caſes will occur in the proſecution of this ſubject, where we ſhall be very apt to confound our reaſonings by a confuſion in the uſe of thoſe meaſures. Thoſe mathematicians who are accuſtomed to the geometrical conſideration of curvilineal motions, are generally diſpoſed to take the *actual deflection* from the tangent as the meaſure of the deflecting force; while thoſe who treat the ſame ſubject algebraically, by the aſſiſtance of fluxions, take *the change of velocity*, which is meaſured by *twice* the deflection. The reaſon is this: when a body paſſes through the point B of a curve ABC, (pl. 22. fig. 1.) if the deflecting force were to ceaſe at that inſtant, the body would deſcribe the tangent BD in the ſame time in which it deſcribes the arch BC of the curve, and DC is the deflection, and is therefore taken for the meaſure of the deflecting force. But the algebraiſt is accuſtomed to conſider the curve by means of an equation between the abſciſſæ H *a*, H *b*, H *c*, and their reſpective ordinates A*a*, B*b*, C*c*, and he meaſures the deflections by the changes made on the increments of the ordinates. Thus the increment of the ordinate A*a*, while the body deſcribes the arch AB of the curve, is BG. If the deflecting force were to ceaſe when the body is at B, the next increment would have been equal to BG, that is, it would have been EF; but in conſequence of the deflection, it is only CF: therefore he takes EC for the meaſure of the deflection, and of the deflecting force. Now EC is ultimately twice DC; and thus the meaſure of the algebraiſt (derived ſolely from the nature of the differential method, and without any regard to phyſical conſiderations) happens to coincide with the true phyſical meaſure. There is therefore great danger of mixing theſe meaſures. Of this we cannot give a more remarkable inſtance than Leibnitz's attempt to demonſtrate the elliptical motion of the planets in the Leipſic Acts, 1689. He firſt conſiders the ſubject mechanically, and takes the deflection or DC for the meaſure of the deflecting force. He then introduces his differential calculus, where he takes the difference of the increments for the meaſure; and thus brings himſelf into a confuſion, which luckily compenſates for the falſe reaſoning in the preceding part of his paper, and gives his reſult the appearance of a demonſtration of Newton's great diſcovery, while, in fact, it is a confuſed jumble of aſſumptions, ſelf-contradictory, and inconſiſtent with the very laws of mechanics which are uſed by him in the inveſtigation. Seventeen years after this, in 1706, having been criticiſed for his bad reaſoning, or rather accuſed of an envious and unſucceſsful attempt to appropriate Newton's inventions to himſelf, he gives a correction of his paralogiſm, which he calls a correction of language. But he either had not obſerved where the paralogiſm lay, or would not let himſelf down by acknowledging a miſtake in what he wiſhed the world to think his own calculus (fluxions); he applied the correction where no fault had been committed for he had meaſured both the centrifugal force and the ſolicitation of gravity in the ſame way, but had applied the fluxionary expreſſion to the laſt and not to the firſt, and by ſo doing, he completely deſtroyed all coincidence between his reſult and the planetary motions. We mention this inſtance, not only as a caution to our mathematical readers, but alſo as a very curious literary anecdote. This diſſertation of Leibnitz is one of the moſt obſcure of his obſcure writings, but deſerves the attention of an intelligent and curious reader, and cannot fail of making an indelible impreſſion on his mind, with relation to the modeſty, candour, and probity of the author. It is preceded by a diſſertation on the ſubject which we are now entering upon, the motion of projectiles in a reſiſting medium. Newton's *Principia* had been publiſhed a few years before, and had been reviewed, in a manner ſhamefully ſlight, in the Leipſic Acts. Both theſe ſubjects make the capital articles of that immortal work. Mr. Leibnitz publiſhed theſe diſſertations without (ſays he) having ſeen Newton's book, in order to ſhow the world that he had, ſome years before, diſcovered the ſame theorems. Mr. Nicholas Fatio carried a copy of the *Principia* from the author to Hanover in 1686, where he expected to find Mr. Leibnitz; he was then abſent, but Fatio ſaw him often before his return to France in 1687, and does not ſay that the book was not given him. Read along with theſe diſſertations Dr. Keill's letter to John Bernoulli and others, publiſhed in the *Journal Literaire de la Haye* 1714, and to John Bernoulli in 1719.

Newton has been accuſed of a ſimilar overſight by John Bernoulli, (who indeed calls it a miſtake in principle) in his Propoſition X. Book 2. on the very ſubject we are now conſidering. But Dr. Keill has ſhown it to be only an overſight, in drawing the tangent on the wrong ſide of the ordinate. For in this very propoſition Newton exhibits, in the ſtricteſt and moſt beautiful manner, the difference between the geometrical and algebraical manner of conſidering the ſubject; and expreſsly warns the reader, that *his* algebraical ſymbol expreſſes the deflection only, and not the variation of the increment of the ordinate. It is therefore in the laſt degree improbable that he would make this miſtake. He moſt expreſsly does not; and as to the real miſtake, which he corrected in the ſecond edition, the writer of this article has in his poſſeſſion a manuſcript copy of notes and illuſtrations on the whole Principia, written in 1693 by Dr. David Gregory, Savilian profeſſor of aſtronomy at Oxford, at the deſire of Mr. Newton, as preparatory for a new edition, where he has rectified this and ſeveral other miſtakes in that work, and ſays that Mr. Newton had ſeen and approved of the amendments. We mention theſe particulars, becauſe Mr. Bernoulli publiſhed an elegant diſſertation on this ſubject in the Leipſic Acts in 1713; in which he charges Newton (though with many proteſtations of admiration and reſpect) with this miſtake in principle; and ſays that he communicated his correction to Mr. Newton by his nephew Nicholas Bernoulli, that it might be corrected in the new edition, which he heard was in the preſs. And he afterwards adds, that it appears by ſome ſheets being cancelled, and new ones ſubſtituted in this part of the work, that the miſtake would have continued, had he not corrected it. We would deſire our readers to conſult this diſſertation, which is extremely elegant, and will be of ſervice to us in this article; and let them compare the civil things which are here ſaid of the *vir incomparabilis*, the *omni laude major*, the *ſummus Newtonus*, with what the ſame author, in the ſame year, in the Leipſic Acts, but under a borrowed name, ſays of him. Our readers will have no heſitation in aſcribing this letter to this author. For after praiſing John Bernoulli as *ſummus geometra, natus ad ſummorum geometrarum paralogiſmos corrigendos. ſummi candoris ut et modeſtiæ*, he betrays himſelf by an unguarded warmth, when defending J. B.'s demonſtration of the inverſe problem of centripetal forces, by calling it MEAM *demonſtrationem*.

Let our readers now conſider the ſcope and intention of this diſſertation on projectiles, and judge whether the author's aim was to inſtruct the world, or to acquire fame, by correcting Newton. The diſſertation does not contain one theorem, one corollary, nor one ſtep of argument, which is not to be found in Newton's firſt edition; nor has he gone further than Newton's ſingle propoſition the Xth. To us it appears an exact companion to his propoſition on centripetal forces, which he boaſts of having firſt demonſtrated, although it is in every ſtep a tranſcript of the 42d of the 1ſt Book of Newton's Principia, the geometrical language of Newton being changed into algebraic, as he has in the preſent caſe changed Newton's algebraic analyſis into a very elegant geometrical one.

We hope to be forgiven for this long digreſſion. It is a very curious piece of literary hiſtory, and ſhows the combination which envy and want of honourable principle had formed againſt the reputation of our illuſtrious countryman; and we think it our duty to embrace any opportunity of doing it juſtice.—To return to our ſubject:

The accurate meaſure of the accelerative power of gravity, is the *fall* $16\frac{1}{12}$ feet, if we meaſure it by the ſpace, or the *velocity* of $32\frac{1}{6}$ feet per ſecond, if we take the velocity. It will greatly facilitate calculation, and will be ſufficiently exact for all our purpoſes, if we take 16 and 32, ſuppoſing that a body falls 16 feet in a ſecond, and acquires the velocity of 32 feet per ſecond. Then, becauſe the heights are as the ſquares of the times, and as the ſquares of the acquired velocities a body will fall one foot in one fourth of a ſecond, and will acquire the velocity of eight feet per ſecond. Now let h expreſs the height in feet, and call it the PRODUCING HEIGHT; v the velocity in feet per ſecond, and call it the PRODUCED VELOCITY, the velocity DUE; and t the time in ſeconds.—We ſhall have the following formulæ, of eaſy recollection, and which will ſerve, without tables, to anſwer all queſtions relative to projectiles.

$$\text{I. } v = 8\sqrt{h}, = 8 \times 4t, = 32t$$

$$\text{II. } t = \frac{\sqrt{h}}{4}, = \frac{v}{32}$$

$$\text{III. } \sqrt{h} = \frac{v}{8}, = 4t$$

$$\text{IV. } h = \frac{v^2}{64}, = 16t^2$$

To give ſome examples of their uſe, let it be required,

1. To find the time of falling through 256 feet. Here $h = 256$, $\sqrt{256} = 16$, and $\frac{16}{4} = 4$. Anſwer 4″.

2. To find the velocity acquired by falling four ſeconds. $t = 4 \cdot 32 \times 4 = 128$ feet per ſecond.

3. To find the velocity acquired by falling 625 feet. $h = 625$, $\sqrt{h} = 25$. $8\sqrt{h} = 200$ feet per ſecond.

4. To find the height to which a body will riſe when projected with the velocity of 56 feet per ſecond, or the height through which a body muſt fall to acquire this velocity.

$$v = 56 \cdot \frac{56}{8} = 7, = \sqrt{h} \cdot 7^2 = h, = 49 \text{ feet.}$$

$$\text{or } 56^2 = 3136 \cdot \frac{3136}{64} = 49 \text{ feet.}$$

5. Suppoſe a body projected directly downwards with the velocity of 10 feet per ſecond; what will be its velocity after four ſeconds? In four ſeconds it will have acquired, by the action of gravity, the velocity of 4 × 32, or 128 feet, and therefore its whole velocity will be 138 feet per ſecond.

6. To find how far it will have moved, compound its motion of projection, which will be 40 feet in four ſeconds, with the motion which gravity alone would have given it in that time, which is 256 feet; and the whole motion will be 296 feet.

7. Suppoſe the body projected as already mentioned, and that it is required to determine the time it will take to go 296 feet downwards, and the velocity it will have acquired.

Find the height x, through which it muſt fall to acquire the velocity of projection, 10 feet, and the time y of falling from this height. Then find the time z of falling through the height $296 + x$, and the velocity v acquired by this fall. The time of deſcribing the 296 feet will be $z - y$, and v is the velocity required.

From ſuch examples, it is eaſy to ſee the way of anſwering every queſtion of the kind.

Writers on the higher parts of mechanics always compute the actions of other accelerating and retarding forces by comparing them with the acceleration of gravity, and in order to render their expreſſions more general, uſe a ſymbol, ſuch as g for gravity, leaving the reader to convert it into numbers. Agreeably to this view, the general formulæ will ſtand thus:

$$\text{I. } v = \sqrt{2gh}, \text{ i. e. } \sqrt{2}\sqrt{g}\sqrt{h}, = gt,$$

$$\text{II. } t = \frac{v}{g}, = \frac{\sqrt{4h}}{\sqrt{2g}}, = \sqrt{\frac{4h}{2g}}, = \sqrt{\frac{2h}{g}}$$

$$\text{IIII. } h = \frac{v^2}{2g}, = \frac{gt^2}{2}.$$

In all theſe equations, gravity, or its accelerating power, is eſtimated, as it ought to be, by the change of velocity which it generates in a particle of matter in an unit of time. But many mathematicians, in their inveſtigations of curvilineal and other varied motions, meaſure it by the deflection which it produces in this time from the tangent of the curve, or by the increment by which the ſpace deſcribed in an unit of time exceeds the ſpace deſcribed in the preceding unit. This is but one half of the increment which gravity would have produced, had the body moved through the whole moment with the acquired addition of velocity. In this ſenſe of the ſymbol g, the equations ſtand thus:

$$\text{I.}\quad v = 2\sqrt{gh}, = 2gt$$

$$\text{II.}\quad t = \sqrt{\frac{h}{g}}, = \frac{v}{2g}$$

$$\text{IV.}\quad h = \frac{v^2}{4g}, = g t^2, \text{ and } \sqrt{h} = \frac{v}{2\sqrt{g}}$$

It is alſo very uſual to conſider the accelerating force of gravity as the unit of compariſon. This renders the expreſſions much more ſimple. In this way, v expreſſes not the velocity, but the height neceſſary for acquiring it, and the velocity itſelf is expreſſed by $\sqrt{v}$. To reduce ſuch an expreſſion of a velocity to numbers, we muſt multiply it by $\sqrt{2g}$, or by $2\sqrt{g}$, according as we make g to be the generated velocity, or the ſpace fallen through in the unit of time.

This will ſuffice for the perpendicular aſcents or deſcents of heavy bodies, and we proceed to conſider their motions when projected obliquely. The circumſtance which renders this an intereſting ſubject is, that the flight of cannon ſhot and ſhells are inſtances of ſuch motion, and the art of gunnery muſt in a great meaſure depend on this doctrine.

Let a body B (fig. 2), be projected in any direction BC, not perpendicular to the horizon, and with any velocity. Let AB be the height producing this velocity; that is, let the velocity be that which a heavy body would acquire by falling freely through AB. It is required to determine the path of the body, and all the circumſtances of its motion in this path.

1. It is evident, that by the continual action of gravity, the body will be continually deflected from the line BC, and will deſcribe a curve line BVG concave towards the earth.

2. This curve line is a parabola, of which the vertical line ABE is a diameter, B the vertex of this diameter, and BC a tangent in B.

Through any two points V, G of the curve draw VC, GH parallel to AB, meeting BC in C and H, and draw VE, GK parallel to BC, meeting AB in E, K. It follows, from the compoſition of motions, that the body would arrive at the points V G of the curve in the ſame time that it would have uniformly deſcribed BC, BH with the velocity of projection; or that it would have fallen through BE, BK, with a motion uniformly accelerated by gravity; therefore the times of deſcribing BC, BH, uniformly, are the ſame with the times of falling through BE, BK. But, becauſe the motion along BH is uniform, BC is to BH as the time of deſcribing BC to the time of deſcribing BH, which we may expreſs thus, BC : BH = T, BC : T, BH, = T, BE . T, BK. But, becauſe the motion along BK is uniformly accelerated, we have BE : BK = T², BE : T² BK, = BC² : BH² = EV² : KG; therefore the curve BVG is ſuch, that the abſciſſæ BE, BK are as the ſquares of the correſponding ordinates EV, KG; that is, the curve BVG is a parabola, and BC, parallel to the ordinates, is a tangent in the point B.

3. If through the point A there be drawn the horizontal line AD *d*, it is the directrix of the parabola.

Let BE be taken equal to AB. The time of falling through BE is equal to the time of falling through AB; but EC is deſcribed with the velocity acquired by falling through AB: and therefore (by the rule of perpendicular deſcents), BC is double of AB, and EV is double of BE; therefore EV² = 4 BE², = 4 BE × AB, = BE × 4 AB, and 4 AB is the parameter or *latus rectum* of the parabola BVG, and AB being one-fourth of the parameter, AD is the directrix.

4. The times of deſcribing the different arches BV, VG of the parabola are as the portions BC, BH of the tangent, or as the portions AD, A *d* of the directrix, intercepted by the ſame vertical lines AB CV, HG; for the times of deſcribing BV, BVG are the ſame with thoſe of deſcribing the correſponding parts BC, BH of the tangent, and are proportional to theſe parts, becauſe the motion along BH is uniform; and BC, BH are proportional to AD, A *d*.

Therefore the motion eſtimated horizontally is uniform.

5. The velocity in any point G of the curve is the ſame with that which a heavy body would acquire by falling from the directrix along *d* G. Draw the tangent GT, cutting the vertical AB in T; take the points *a*, *f*, equidiſtant from A and *d*, and extremely near them, and draw the verticals *a b*, *f g*; let the points *a*, *f*, continually approach A and *d*, and ultimately coincide with them. It is evident that B *b* will ultimately be to *g* G, in the ratio of the velocity at B to the velocity at G; for the portions of the tangent ultimately coincide with the portions of the curve, and are deſcribed in equal times; but B *b* is to *g* G as BH to TG: therefore the velocity at B is to that at G as BH to TG. But, by the properties of the parabola, BH² is to TG², as AB to *d* G; and AB is to *d* G as the ſquare of the velocity acquired by falling through AB to the ſquare of the velocity acquired by falling through *d* G; and the velocity in BH, or in the point B of the parabola, is the velocity acquired by falling along AB; therefore the velocity in TG or in the point G of the parabola, is the velocity acquired by falling along *d* G.

Theſe few ſimple propoſitions contain all the theory of the motion of projectiles in vacuo, or independent on the reſiſtance of the air; and being a very eaſy and neat piece of mathematical philoſophy, and connected with very intereſting practice, and a very reſpectable profeſſion, they have been much commented on, and have furniſhed matter for many ſplendid volumes. But the air's reſiſtance occaſions ſuch a prodigious diminution of motion in the great velocities of military projectiles, that this parabolic theory, as it is called, is hardly of any uſe. A muſket-ball, diſcharged with the ordinary allotment of powder, iſſues from the piece, with the velocity of 1670 feet per ſecond: this velocity would be acquired by falling from the height of eight miles. If the piece be elevated to an angle of 45°, the parabola ſhould be of ſuch extent that it would reach 16 miles on the horizontal plain; whereas it does not reach much above half a mile. Similar deficiencies are obſerved in the ranges of cannon ſhot.

We do not propoſe, therefore, to dwell much on this theory, and ſhall only give ſuch a ſynoptical view of it as ſhall make our readers underſtand the more general circumſtances of the theory, and be maſters of the language of the art.

Let OB (plate 22. fig. 3.) be a vertical line. About the centres A and B, with the diſtance AB, deſcribe the ſemicircles ODB, AHK and with the axis AB, and ſemiaxis GE, equal to AB, deſcribe the ſemiellipſe AEB: with the focus B, vertex A, diameter AB, and tangent AD, parallel to the horizon, deſcribe the parabola APS.

Let a body be projected from B, in any direction BC, with the velocity acquired by falling through AB. By what has already been demonſtrated, it will deſcribe a parabola BVPM. Then,

1. ADL parallel to the horizon is the directrix of every parabola which can be deſcribed by a body projected from B with this velocity. This is evident.

2. The ſemicircle AHK is the locus of all the foci of theſe parabolas: for the diſtance BH of a point B of any parabola from the directrix AD is equal to its diſtance BF from the focus F of that parabola; therefore the foci of all the parabolas which paſs through B, and have AD for their directrix, muſt be in the circumference of the circle which has AB for its radius, and B for its centre.

3. If the line of direction BC cut the upper ſemicircle in C, and the vertical line CF be drawn, cutting the lower ſemicircle

F is the focus of the parabola BVPM, deſcribed by the body which is projected in the direction BC, with the velocity acquired by falling through BA: for drawing AC, BF, it is evident that ACFB is a rhombus, and that the angle ABF is biſected by BC, and therefore the focus lies in the line BF; but it alſo lies in the circumference AFK, and therefore in F.

If C be in the upper quadrant of ODB, F is in the upper quadrant of AFK; and if C be in the lower quadrant of ODB (as when BC is the line of direction) then the focus of the correſponding parabola BvM is in the lower quadrant of AHK, as at f.

4. The ellipſis AEB is the locus of the vertex of all the parabolas, and the vertex V of any one of them BVPM is in the interſection of this ellipſis with the vertical CF: for let this vertical cut the horizontal lines AD, GE, BN, in θ, λ, N. Then it is plain that Nλ is half of Nθ, and λV is half of Cθ; therefore NV is half of NC, and V is the vertex of the axis.

If the focus be in the upper or lower quadrant of the circle AHK, the vertex is in the upper or the lower quadrant of the ellipſe AEG.

5. If BFP be drawn through the focus of any one of the parabolas, ſuch as BVM, cutting the parabola APS in P, the parabola BVM touches the parabola APS in P: for drawing P$\delta\varkappa$ parallel to AB, cutting the directrix O$\varkappa$ of the parabola APS in $\varkappa$, and the directrix AL of the parabola BVM in δ, then $PB = P\varkappa$; but $BF = BA, = AO, = \varkappa\delta$: therefore $P\delta = PF$, and the point P is in the parabola BVM. Alſo the tangents to both parabolas in P coincide, for they biſect the angle $\varkappa$PB; therefore the two parabolas having a common tangent, touch each other in P.

Cor. All the parabolas which can be deſcribed by a body projected from B, with the velocity acquired by falling through AB, will touch the concavity of the parabola APS, and lie wholly within it.

6. P is the moſt diſtant point of the line BP which can be hit by a body projected from B with the velocity acquired by falling through AB. For if the direction be more elevated than BC, the focus of the parabola deſcribed by the body will lie between F and A, and the parabola will touch APS in ſome point between P and A; and being wholly within the parabola APS, it muſt cut the line BP in ſome point within P. The ſame thing may be ſhown when the direction is leſs elevated than BC.

7. The parabola APS is the locus of the greateſt ranges on any planes BP, BS, &c. and no point lying without this parabola can be ſtruck.

8. The greateſt range on any plane BP is produced when the line of direction BC biſects the angle OBP formed by that plane with the vertical: for the parabola deſcribed by the body in this caſe touches APS in P, and its focus is in the line BP, and therefore the tangent BC biſects the angle OBP.

Cor. The greateſt range on a horizontal plane is made with an elevation of 45°.

9. A point M in any plane BS, lying between B and S, may be ſtruck with two directions, BC and Bc; and theſe directions are equidiſtant from the direction Bt, which gives the greateſt range on that plane: for if about the centre M, with the diſtance ML from the directrix AL, we deſcribe a circle LFf, it will cut the circle AHK in two points F and f, which are evidently the foci of two parabolas BVM, BvM, having the directrix AL and diameter ABK. The interſection of the circle ODB, with the verticals FC, fc, determine the directions BC, Bc of the tangents. Draw At parallel to BS, and and join tB, Cc, Ff; then $OBt = \frac{1}{2} OBS$, and Bt is the direction which gives the greateſt range on the plane BS: but becauſe Ff is a chord of the circles deſcribed round the centres B and M, Ff is perpendicular to BM, and Cc to At, and the arches Ct, ct are equal; and therefore the angles CBt, cBt are equal.

Thus we have given a general view of the ſubject, which ſhows the connection and dependence of every circumſtance which can influence the reſult; for it is evident that to every velocity of projection there belongs a ſet of parabolas, with their directions and ranges; and every change of velocity has a line AB correſponding to it, to which all the others are proportional. As the height neceſſary for acquiring any velocity increaſes or diminiſhes in the duplicate proportion of that velocity, it is evident that all the ranges with given elevations will vary in the ſame proportion, a double velocity giving a quadruple range, a triple velocity giving a noncuple range, &c. And, on the other hand, when the ranges are determined beforehand (which is the uſual caſe), the velocities are in the ſubduplicate proportion of the ranges. A quadruple range will require a double velocity, &c.

On the principles now eſtabliſhed is founded the ordinary theory of gunnery, furniſhing rules which are to direct the art of throwing ſhot and ſhells, ſo as to hit the mark with a determined velocity.

But we muſt obſerve, that this theory is of little ſervice for directing us in the practice of cannonading. Here it is neceſſary to come as near as we can to the object aimed at, and the hurry of ſervice allows no time for geometrical methods of pointing the piece after each diſcharge. The gunner either points the cannon directly to the object, when within 200 or 300 yards of it, in which caſe he is ſaid to ſhoot point blank (*pointer au blanc*, i. e. at the white mark in the middle of the gunner's target); or, if at a greater diſtance, he eſtimates to the beſt of his judgment the deflection correſponding to his diſtance, and points the cannon accordingly. In this he is aided by the greater thickneſs at the breech of a piece of ordnance. Or, laſtly, when the intention is not to batter, but to rake along a line occupied by the enemy, the cannon is elevated at a conſiderable angle, and the ſhot diſcharged with a ſmall force, ſo that it drops into the enemy's poſt, and bounds along the line. In all theſe ſervices the gunner is directed entirely by trial, and we cannot ſay that this parabolic theory can do him any ſervice.

The principal uſe of it is to direct the bombardier in throwing ſhells. With theſe it is propoſed to break down or ſet fire to buildings, to break through the vaulted roofs of magazines, or to intimidate and kill troops by burſting among them. Theſe objects are always under cover of the enemy's works, and cannot be touched by a direct ſhot. The bombs and carcaſſes are therefore thrown upwards, ſo as to get over the defences and produce their effect.

Theſe ſhells are of very great weight, frequently exceeding 200 lbs. The mortars from which they are diſcharged muſt therefore be very ſtrong, that they may reſiſt the exploſion of gunpowder which is neceſſary for throwing ſuch a maſs of matter to a diſtance; they are conſequently unwieldy, and it is found moſt convenient to make them almoſt a ſolid and immoveable lump. Very little change can be made in their elevation, and therefore their ranges are regulated by the velocities given to the ſhell. Theſe again are produced by the quantities of powder in the charge; and experience (confirming the beſt theoretical notions that we can form of the ſubject) has taught us, that the ranges are nearly proportional to the quantities of powder employed, only not increaſing quite ſo faſt. This method is much eaſier than by differences of elevation; for we can ſelect the elevation which gives the greateſt range on the given plane, and then we are certain that we are employing the ſmalleſt quantity of powder with which the ſervice can be performed: and we have another advantage, that the deviations which unavoidable cauſes produce in the real directions of the bomb will then produce the ſmalleſt poſſible deviation from the intended range. This is the caſe in moſt mathematical maxima.

In military projectiles the velocity is produced by the exploſion of a quantity of gunpowder; but in our theory it is conceived as produced by a fall from a certain height, by the proportions of which we can accurately determine its quantity. Thus a velocity of 1600 feet per ſecond is produced by a fall from the height of 40,000 feet or 1333 yards.

The height CA (fig. 4.) for producing the velocity of projection is called, in the language of gunnery, the IMPETUS. We ſhall expreſs it by the ſymbol *b*.

The diſtance AB to which the ſhell goes on any plane AB is called the AMPLITUDE of the RANGE *r*.

The angle DBA, made by the vertical line and the plane AB, may be called the angle of POSITION of that plane, *p*.

The angle DAB, made by the axis or direction of the piece, and the direction of the object, may be called the angle of ELEVATION of the piece above the plane AB, *e*.

The angle ZAD, made by the vertical line, and the direction of the piece, may be called the ZENITH diſtance, *z*.

The relations between all the circumſtances of velocity, diſtance, poſition, elevation, and time, may be included in the following propoſitions.

I. Let a ſhell be projected from A, with the velocity acquired by falling through CA, with the intention of hitting the mark B ſituated in the given line AB.

Make ZA = 4AC, and draw BD perpendicular to the horizon. Deſcribe on ZA an arch of a circle ZDA containing an angle equal to DBA, and draw AD to the interſection of this circle with DB; then will a body projected from A, in the direction AD, with the velocity acquired by falling through CA, hit the mark B.

For, produce CA downwards, and draw BF parallel to AD, and draw ZD. It is evident from the conſtruction that AB touches the circle in B, and that the angles ADZ, DBA, are equal, as alſo the angles AZD, DAB; therefore the triangles ZAD, ADB are ſimilar.

$$\begin{aligned}&\text{Therefore } \mathrm{BD} : \mathrm{DA} = \mathrm{DA} : \mathrm{AZ},\\ &\text{And } \mathrm{DA}^2 = \mathrm{BD} \times \mathrm{AZ};\\ &\text{Therefore } \mathrm{BF}^2 = \mathrm{AF} \times \mathrm{AZ}, = \mathrm{AF} \times 4\mathrm{AC}.\end{aligned}$$

Therefore a parabola, of which AF is a diameter, and AZ its parameter, will paſs through B, and this parabola will be the path of the ſhell projected as already mentioned.

Remark. When BD cuts this circle, it cuts it in two points D, *d*; and there are two directions which will ſolve the problem. If B′D′ only touches the circle in D′, there is but one direction, and AB′ is the greateſt poſſible range with this velocity. If the vertical line through B does not meet the circle, the problem is impoſſible, the velocity being too ſmall. When B′D′ touches the circle, the two directions AD′ and A*d*′ coaleſce into one direction, producing the greateſt range, and biſecting the angle ZAB; and the other two directions AD, A*d*, producing the ſame range AB, are equi-diſtant from AD′, agreeably to the general propoſition.

$$\begin{aligned}&\text{It is evident that } \mathrm{AZ} : \mathrm{AD} = \mathrm{S,ADZ} : \mathrm{S,AZD}, = \mathrm{S,DBA} : \mathrm{S,DAB}, = \mathrm{S},p : \mathrm{S},e\\ &\text{And } \mathrm{AD} : \mathrm{DB} = \mathrm{S,DBA} : \mathrm{S,DAB}, = \mathrm{S},p : \mathrm{S},e\\ &\text{And } \mathrm{DB} : \mathrm{AB} = \mathrm{S,DAB} : \mathrm{S,ADB}, = \mathrm{S},e : \mathrm{S},z\\ &\text{Therefore } \mathrm{AZ} : \mathrm{AB} = \mathrm{S}^2,p \times \mathrm{S},e : \mathrm{S}^2,e \times \mathrm{S},z; = \mathrm{S}^2,p : \mathrm{S},e \times \mathrm{S},z\\ &\text{Or } 4b : r = \mathrm{S}^2,p : \mathrm{S},e \times \mathrm{S},z, \text{ and } 4b \times \mathrm{S},e \times \mathrm{S},z = r \times \mathrm{S}^2,p\end{aligned}$$

Hence we obtain the relations wanted.

$$\text{Thus } b = \frac{r \times \mathrm{S}^2,p}{4\mathrm{S},e \times \mathrm{S},z}, \text{ and } r = \frac{4b \times \mathrm{S}.e \times \mathrm{S},z}{\mathrm{S}^2,p}$$

$$\text{And } \mathrm{S},z = \frac{r \times \mathrm{S}^2 p}{4b \times \mathrm{S},e}, \text{ and } \mathrm{S},e = \frac{r \times \mathrm{S}^2,p,}{4b \times \mathrm{S},z}.$$

The only other circumſtance in which we are intereſted is the time of the flight. A knowledge of this is neceſſary for the bombardier, that he may cut the fuzes of his ſhells to ſuch lengths as that they may burſt at the very inſtant of their hitting the mark.

Now AB : DB = Sin, ADB : Sin, DAB, = S, *z* : S, *e*, and $\mathrm{DB} = \frac{r \times \mathrm{S},e}{\mathrm{S},z}$. But the time of the flight is the ſame with the time of falling through DB, and 16 feet : DB = $1'' : t''^2$. Hence $t''^2 = \frac{r \times \mathrm{S},e}{16\,\mathrm{S},z}$, and we have the following eaſy rule.

From the ſum of the logarithms of the range, and of the ſine of elevation, ſubtract the ſum of the logarithms of 16, and of the ſine of the zenith diſtance, half the remainder is the logarithm of the time in ſeconds.

This becomes ſtill eaſier in practice; for the mortar ſhould be ſo elevated that the range is a maximum: in which caſe AB = DB, and then half the difference of the logarithms of AB and of 16 is the logarithm of the time in ſeconds.

Such are the deductions from the general propoſitions which conſtitute the ordinary theory of gunnery. It remains to compare them with experiment.

In ſuch experiments as can be performed with great accuracy in a chamber, the coincidence is as great as can be wiſhed. A jet of water, or mercury, gives us the fineſt example, becauſe we have the whole parabola exhibited to us in the ſimultaneous places of the ſucceeding particles. Yet even in theſe experiments a deviation can be obſerved. When the jet is made on a horizontal plane, and the curve carefully traced on a perpendicular plane held cloſe by it, it is found that the diſtance between the higheſt point of the curve and the mark is leſs than the diſtance between it and the ſpout, and that the deſcending branch of the curve is more perpendicular than the aſcending branch. And this difference is more remarkable as the jet is made with greater velocity, and reaches to a greater diſtance. This is evidently produced by the reſiſtance of the air, which diminiſhes the velocity, without affecting the gravity of the projectile. It is ſtill more ſenſible in the motion of bombs. Theſe can be traced through the air by the light of their fuzes; and we ſee that their higheſt point is always much nearer to the mark than to the mortar on a horizontal plane.

The greateſt horizontal range on this plane ſhould be when the elevation is 45°. It is always found to be much lower.

The ranges on this plane ſhould be as the ſines of twice the elevation.

A ball diſcharged at the elev.	19°. 5′ ranged	448 yards
at	9. 45	330
It ſhould have ranged by theory		241

The range at an elevation of 45° ſhould be twice the impetus. Mr. Robins found that a muſket-ball, diſcharged with the uſual allotment of powder, had the velocity of 1700 feet in a ſecond. This requires a fall of 45156 feet, and the range ſhould be 90312, or $17\frac{1}{8}$ miles; whereas it does not much exceed half a mile. A 24-pound ball diſcharged with 16 pounds of powder ſhould range about 16 miles; whereas it is generally ſhort of three miles.

Such facts ſhow incontrovertibly how deficient the parabolic theory is, and how unfit for directing the practice of the artilleriſt. A very ſimple conſideration is ſufficient for rendering this obvious to the moſt uninſtructed. The reſiſtance of the air to a very light body may greatly exceed its weight. Any one will feel this in trying to move a fan very rapidly through the air; therefore this reſiſtance would occaſion a greater deviation from uniform motion than gravity would *in that body*. Its path, therefore, through the air may differ more from a parabola than the parabola itſelf deviates from the ſtraight line.

It is for ſuch cogent reaſons that we preſume to ſay, that the voluminous treatiſes which have been publiſhed on this ſubject are nothing but ingenious amuſements for young mathematicians. Few perſons who have been much engaged in the ſtudy of mechanical philoſophy have miſſed this opportunity in the beginning of their ſtudies. The ſubject is eaſy. Some property of the parabola occurs, by which they can give a neat and ſyſtematic ſolution of all the queſtions; and at this time of ſtudy it ſeems a conſiderable eſſay of ſkill. They are tempted to write a book on the ſubject; and it finds readers among other young mechanicians, and employs all the mathematical knowledge that moſt of the young gentlemen of the military profeſſion are poſſeſſed of. But theſe performances deſerve little attention from the practical artilleriſt. All that ſeems poſſible to do for his education is, to multiply judicious experiments on real pieces of ordnance, with the charges that are uſed in actual ſervice, and to furniſh him with tables calculated from ſuch experiments.

Theſe obſervations will ſerve to juſtify us for having given ſo conciſe an account of this doctrine of the parabolic flight of bodies.

But it is the buſineſs of a philoſopher to enquire into the cauſes of ſuch a prodigious deviation from a well-founded theory, and having diſcovered them, to aſcertain preciſely the deviations they occaſion. Thus we ſhall obtain another theory, either in the form of the parabolic theory corrected, or as a ſubject of independent diſcuſſion. This we ſhall now attempt.

The motion of projectiles is performed in the atmoſphere. The air is diſplaced, or put in motion. Whatever motion it acquires muſt be taken from the bullet. The motion communicated to the air muſt be in the proportion of the quantity of air put in motion, and of the velocity communicated to it. If, therefore the diſplaced air be always *ſimilarly diſplaced*, whatever be the velocity of the bullet, the motion communicated to it, and loſt by the bullet, muſt be proportional to the ſquare of the velocity of the bullet and to the denſity of the air jointly. Therefore the diminution of its motion muſt be greater when the motion itſelf is greater, and in the very great velocity of ſhot and ſhells it muſt be prodigious. It appears from Mr. Robins's experiments that a globe of $4\frac{1}{2}$ inches in diameter, moving with the velocity of 25 feet in a ſecond, ſuſtained a reſiſtance of 315 grains, nearly $\frac{3}{4}$ of an ounce. Suppoſe this ball to move 800 feet in a ſecond, that is 32 times faſter, its reſiſtance would be 32×32 times $\frac{3}{4}$ of an ounce, or 768 ounces or 48 pounds. This is four times the weight of a ball of caſt iron of this diameter; and if the initial velocity had been 1600 feet per ſecond, the reſiſtance would be at leaſt 16 times the weight of the ball. It is indeed much greater than this.

This reſiſtance, operating conſtantly and uniformly on the ball muſt take away four times as much from its velocity as its gravity would do in the ſame time. We know that, in one ſecond, gravity would reduce the velocity 800 to 768 if the ball were projected ſtraight upwards. This reſiſtance of the air would therefore reduce it in one ſecond to 672, if it operated uniformly; but as the velocity diminiſhes continually by the reſiſtance, and the reſiſtance diminiſhes along with the velocity, the real diminution will be ſomewhat leſs than 128 feet. We ſhall, however, ſee afterwards that in one ſecond its velocity will be reduced from 800 to 687. From this ſimple inſtance we ſee that the reſiſtance of the air muſt occaſion great deviation from parabolic motion.

In order to judge accurately of its effect, we muſt conſider it as a retarding force, in the ſame way as we conſider gravity. The weight W of a body is the aggregate of the action of the force of gravity g on each particle of the body. Suppoſe the number of equal particles, or the quantity of matter, of a body to be M, then W is equivalent to gM. In like manner, the reſiſtance R, which we obſerve in any experiment, is the aggregate of the action of a retarding force R' on each particle, and is equivalent to $R'M$: and as g is equal to $\frac{W}{M}$, ſo R' is equal to $\frac{R}{M}$. We ſhall keep this diſtinction in view, by adding the differential mark ′ to the letter R or r, which expreſſes the aggregate reſiſtance.

If we, in this manner, conſider reſiſtance as a retarding force, we can compare it with any other ſuch force by means of the retardation which it produces in ſimilar circumſtances. We would compare it with gravity by comparing the diminution of velocity which its uniform action produces in a given time with the diminution produced in the ſame time by gravity. But we have no opportunity of doing this directly; for when the reſiſtance of the air diminiſhes the velocity of a body, it diminiſhes it gradually, which occaſions a gradual diminution of its own intenſity. This is not the caſe with gravity, which has the ſame action on a body in motion or at reſt. We cannot, therefore, obſerve the uniform action of the air's reſiſtance as a retarding force. We muſt fall on ſome other way of making the compariſon. We can ſtate them both as dead preſſures. A ball may be fitted to the rod of a ſpring ſteelyard, and expoſed to the impulſe of the wind. This will compreſs the ſteelyard to the mark 3, for inſtance. Perhaps the weight of the ball will compreſs it to the mark 6. We know that half this weight would compreſs it to 3. We account this equal to the preſſure of the air, becauſe they balance the ſame elaſticity of the ſpring. And in this way we can eſtimate the reſiſtance by weights, whoſe preſſures are equal to its preſſure, and we can thus compare it with other reſiſtances, weights, or any other preſſures. In fact, we are meaſuring them all by the elaſticity of the ſpring. This elaſticity in its different poſitions is ſuppoſed to have the proportions of the weights which keep it in theſe poſitions. Thus we reaſon from the nature of gravity, no longer conſidered as a dead preſſure, but as a retarding force; and we apply our concluſions to reſiſtances which exhibit the ſame preſſures, but which we cannot make to act uniformly. This ſenſe of the words muſt be carefully remembered whenever we ſpeak of reſiſtances in pounds and ounces.

The moſt direct and convenient way of ſtating the compariſon between the reſiſtance of the air and the accelerating force of gravity, is to take a caſe in which we know that they are equal. Since the reſiſtance is here aſſumed as proportional to the ſquare of the velocity, it is evident that the velocity may be ſo increaſed that the reſiſtance ſhall equal or exceed the weight of the body. If a body be already moving downwards with this velocity, it cannot accelerate; becauſe the accelerating force of gravity is balanced by an equal retarding force of reſiſtance. It follows from this remark, that this velocity is the greateſt that a body can acquire by the force of gravity only. Nay, we ſhall afterwards ſee that it never can completely attain it; becauſe as it approaches to this velocity, the remaining accelerating force decreaſes faſter than the velocity increaſes. It may therefore be called the limiting or TERMINAL velocity by gravity.

Let a be the height through which a heavy body muſt fall, in vacuo, to acquire its terminal velocity in air. If projected directly upwards with this velocity, it will riſe again to this height, and the height is half the ſpace which it would deſcribe uniformly, with this velocity in the time of its aſcent. Therefore the reſiſtance to this velocity being equal to the weight of the body, it would extinguiſh this velocity, by its *uniform* action, in the ſame time, and after the ſame diſtance that gravity would.

Now let g be the velocity which gravity generates or extinguiſhes during an unit of time, and let u be the terminal velocity of any particular body. The theorems for perpendicular aſcents give us $g = \frac{u^2}{2a}$, u and a being both numbers repreſenting units of ſpace; therefore, in the preſent caſe, we have $r' = \frac{u^2}{2a}$. For the whole reſiſtance r, or r'M, is ſuppoſed equal to the weight, or to gM; and therefore r' is equal to g, $= \frac{u^2}{2a}$ and $2a = \frac{u^2}{g}$. There is a conſideration which ought to have place here. A body deſcends in air, not by the whole of its weight, but by the exceſs of its weight above that of the air which it diſplaces. It deſcends by its *ſpecific* gravity only as a ſtone does in water. Suppoſe a body 32 times heavier than air, it will be buoyed up by a force equal to $\frac{1}{32}$ of its weight; and inſtead of acquiring the velocity of 32 feet in a ſecond, it will only acquire a velocity of 31, even though it ſuſtained no reſiſtance from the *inertia* of the air. Let p be the weight of the body and π that of an equal bulk of air: the accelerative force of relative gravity on each particle will be $g \times 1 - \frac{\pi}{p}$; and this relative accelerating force might be diſtinguiſhed by another ſymbol γ. But in all caſes in which we have any intereſt, and particularly in military projectiles, $\frac{\pi}{p}$ is ſo ſmall a quantity that it would be pedantic affectation to attend to it. It is much more than compenſated when we make $g = 32$ feet inſtead of $32\frac{1}{12}$ which it ſhould be.

Let e be the time of this aſcent in oppoſition to gravity. The ſame theorems give us $eu = 2a$; and ſince the reſiſtance competent to this terminal velocity is equal to gravity, e will alſo be the time in which it would be extinguiſhed by the uniform action of the reſiſtance; for which reaſon we may call it the extinguiſhing time for this velocity. Let R and E mark the reſiſtance and extinguiſhing time for the ſame body moving with the velocity 1.

Since the reſiſtances are as the ſquares of the velocities, and the reſiſtance to the velocity u is $\frac{u^2}{2a}$, R will be $= \frac{1}{2a}$. Moreover, the times in which the ſame velocity will be extinguiſhed by different forces, acting uniformly, are inverſely as the forces, and gravity would extinguiſh the velocity 1 in the time $\frac{1}{g}$, $=$ (in theſe meaſures) to $\frac{1}{\frac{u^2}{2a}}$, $= \frac{2a}{u^2}$. Therefore we have the following proportion $\frac{1}{2a}$ $(= \text{R}) : \frac{u^2}{2a}$ $(= g) = \frac{2a}{u^2} : 2a$, and $2a$ is equal to E, the time in which the velocity 1 will be extinguiſhed by the uniform action of the reſiſtance competent to this velocity.

The velocity 1 would in this caſe be extinguiſhed after a motion uniformly retarded, in which the ſpace deſcribed is one-half of what would be uniformly deſcribed during the ſame time with the conſtant velocity 1. Therefore the ſpace thus deſcribed, by a motion which begins with the velocity 1 and is uniformly retarded by the reſiſtance competent to this velocity, is equal to the height through which *this* body muſt fall *in vacuo* in order to acquire *its* terminal velocity in air.

All theſe circumſtances may be conceived in a manner which, to ſome readers, will be more familiar and palpable. The terminal velocity is that where the reſiſtance of the air balances and is equal to the weight of the body. The reſiſtance of the air to any particular body is as the ſquare of the velocity; therefore let R be the whole reſiſtance to the body moving with the velocity 1, and r the reſiſtance to its motion with the terminal velocity u; we muſt have $r = \text{R} \times u^2$, and this muſt be $=$W the weight. Therefore, to obtain the terminal velocity, divide the weight by the reſiſtance to the velocity 1, and the quotient is the ſquare of the terminal velocity, or $\frac{\text{W}}{\text{R}} = u^2$: And this is a very expeditious method of determining it, if R be previouſly known.

Then the common theorems give a, the fall neceſſary for producing this velocity *in vacuo* $= \frac{u^2}{2g}$, and the time of the fall $= \frac{u}{g} = e$, and $eu = 2a$, $=$ the ſpace uniformly deſcribed with the velocity u during the time of the fall, or its equal, the time of the extinction by the uniform action of the reſiſtance r; and, ſince r extinguiſhes it in the time e, R, which is u^2 times ſmaller, will extinguiſh it in the time u^2e, and R will extinguiſh the velocity 1, which is u times leſs than u, in the time ue, that is, in the time $2a$; and the body, moving uniformly during the time $2a$, $=$ E, with the velocity 1, will deſcribe the ſpace $2a$; and, if the body begin to move with the velocity 1, and be uniformly oppoſed by the reſiſtance R, it will be brought to reſt when it has deſcribed the ſpace a; and the ſpace in which the reſiſtance to the velocity 1 will extinguiſh that velocity by its uniform action, is equal to the height through which that body muſt fall *in vacuo* in order to acquire its terminal velocity in air. And thus every thing is regulated by the time E in which the velocity 1 is extinguiſhed by the uniform action of the correſponding reſiſtance, or by $2a$, which is the ſpace uniformly deſcribed during this time, with the velocity 1. And E and $2a$ muſt be expreſſed by the ſame number. It is a number of units, of time, or of length.

Having aſcertained theſe leading circumſtances for an unit of velocity, weight, and bulk, we proceed to deduce the ſimilar circumſtances for any other magnitude; and, to avoid unneceſſary complications, we ſhall always ſuppoſe the bodies to be ſpheres, differing only in diameter and denſity.

Firſt, then, let the velocity be increaſed in the ratio of 1 to v, The reſiſtance will now be $\frac{v^2}{2a}$, $= r$.

The extinguiſhing time will be $\frac{\text{E}}{v}$, $= e$, $= \frac{2a}{v}$, and $ev = 2a$; ſo that the rule is general, that the ſpace along which *any* velocity will be extinguiſhed by the uniform action of the correſponding reſiſtance, is equal to the height neceſſary for communicating the terminal velocity to *that* body by gravity. For ev is twice the ſpace through which the body moves while the velocity v is extinguiſhed by the uniform reſiſtance.

In the 2d place, let the diameter increaſe in the proportion of 1 to d. The aggregate of the reſiſtance changes in the proportion of the ſurface ſimilarly reſiſted, that is, in the proportion of 1 to d^2. But the quantity of matter, or number of particles among which this reſiſtance is to be diſtributed, changes in the proportion of 1 to d^3. Therefore the retarding power of the reſiſtance changes in the proportion of 1 to $\frac{1}{d}$.

When the diameter was 1, the reſiſtance to a velocity 1 was $\frac{1}{2a}$. It muſt now be $\frac{1}{2ad}$. The time in which this diminiſhed reſiſtance will extinguiſh the velocity 1 muſt increaſe in the proportion of the diminution of force, and muſt now be Ed, or $2ad$, and the ſpace uniformly deſcribed during this time with the initial velocity 1 muſt be $2ad$; and this muſt ſtill be twice the height neceſſary for communicating the terminal velocity w to *this* body. We muſt ſtill have $g = \frac{w^2}{2ad}$; and therefore $w^2 = 2gad$, and $w = \sqrt{2gad}, = \sqrt{2ga}\sqrt{d}$. But $u = \sqrt{2ga}$. Therefore the terminal velocity w for this body is $= u\sqrt{d}$; and the height neceſſary for communicating it is ad. Therefore the terminal velocity varies in the ſubduplicate ratio of the diameter of the ball, and the fall neceſſary for producing it varies in the ſimple ratio of the diameter. The extinguiſhing time for the velocity v muſt now be $\frac{\mathrm{E}d}{v}$.

If, in the 3d place, the denſity of the ball be increaſed in the proportion of 1 to m, the number of particles among which the reſiſtance is to be diſtributed is increaſed in the ſame proportion, and therefore the retarding force of the reſiſtance is equally diminiſhed; and if the denſity of the air be increaſed in the proportion of 1 to n, the retarding force of the reſiſtance increaſes in the ſame proportion: hence we eaſily deduce theſe *general* expreſſions.

The terminal velocity $= u\sqrt{d\frac{m}{n}}, = \sqrt{2gad\frac{m}{n}}$.

The producing fall *in vacuo* $= ad\frac{m}{n}$.

The retarding power of reſiſtance to any velocity $= r, = \frac{v^2}{2ad\frac{m}{n}}$.

The extinguiſhing time for any velocity $v = \frac{\mathrm{E}dm}{vn}$.

And thus we ſee that the chief circumſtances are regulated by the terminal velocity, or are conveniently referred to it.

To render the deductions from theſe premiſes perſpicuous, and for communicating diſtinct notions or ideas, it will be proper to aſſume ſome convenient units, by which all theſe quantities may be meaſured; and, as this ſubject is chiefly intereſting in the caſe of military projectiles, we ſhall adapt our units to this purpoſe. Therefore, let a ſecond be the unit of time, a foot the unit of ſpace and velocity, an inch the unit of diameter of a ball or ſhell, and a pound avoirdupoiſe the unit of preſſure, whether of weight or of reſiſtance; therefore g is 32 feet.

The great difficulty is to procure an abſolute meaſure of r, or u, or a; any one of theſe will determine the others.

Sir Iſaac Newton has attempted to determine r by theory, and employs a great part of the ſecond book of the *Principia* in demonſtrating that the reſiſtance to a ſphere moving with any velocity is to the force which would generate or deſtroy its whole motion in the time that it would uniformly move over $\frac{8}{3}$ of its diameter with this velocity as the denſity of the air is to the denſity of the ſphere. This is equivalent to demonſtrating that the reſiſtance of the air to a ſphere moving through it with any velocity, is equal to half the weight of a column of air having a great circle of the ſphere for its baſe, and for its altitude the height from which a body muſt fall *in vacuo* to acquire this velocity. This appears from Newton's demonſtration; for, let the ſpecific gravity of the air be to that of the ball as 1 to m; then, becauſe the times in which the ſame velocity will be extinguiſhed by the uniform action of different forces are inverſely as the forces, the reſiſtance to this velocity would extinguiſh it in the time of deſcribing $\frac{8}{3}\,md$, d being the diameter of the ball. Now 1 is to m as the weight of the diſplaced air to the weight of the ball, or as $\frac{2}{3}$ of the diameter of the ball to the length of a column of air of equal weight. Call this length a; a is therefore equal to $\frac{2}{3}\,md$. Suppoſe the ball to fall from the height a in the time t, and acquire the velocity u. If it moved uniformly with this velocity during this time, it would deſcribe a ſpace $= 2a$, or $\frac{4}{3}\,md$. Now its weight would extinguiſh this velocity, or deſtroy this motion, in the ſame time, that is, in the time of deſcribing $\frac{4}{3}\,md$; but the reſiſtance of the air would do this in the time of deſcribing $\frac{8}{3}\,md$; that is, in twice the time. The reſiſtance therefore is equal to half the weight of the ball, or to half the weight of the column of air whoſe height is the height producing the velocity. But the reſiſtances to different velocities are as the ſquares of the velocities; and therefore, as their producing heights, and, in general, the reſiſtance of the air to a ſphere moving with any velocity, is equal to the half weight of a column of air of equal ſection, and whoſe altitude is the height producing the velocity. The reſult of this inveſtigation has been acquieſced in by all ſir Iſaac Newton's commentators. Many faults have indeed been found with his reaſoning, and even with his principles; and it muſt be acknowledged that although this inveſtigation is by far the moſt ingenious of any in the *Principia*, and ſets his acuteneſs and addreſs in the moſt conſpicuous light, his reaſoning is liable to ſerious objections, which his moſt ingenious commentators have not completely removed. However, the concluſion has been acquieſced in, as we have already ſtated, but as if derived from other principles, or by more logical reaſoning. We cannot, however, ſay that the reaſonings or aſſumptions of theſe mathematicians are much better than Newton's: and we muſt add, that all the cauſes of deviation from the duplicate ratio of the velocities, and the cauſes of increaſed reſiſtance, which the later authors have valued themſelves for diſcovering and introducing into their inveſtigations, were pointed out by ſir Iſaac Newton, but purpoſely omitted by him, in order to facilitate the diſcuſſion *in re difficillima*. (See *Schol.* prop. 37. b. ii.)

It is known that the weight of a cubic foot of water is $62\frac{1}{2}$ pounds, and that the medium denſity of the air is $\frac{1}{840}$ of water; therefore let a be the height producing the velocity (in feet), and d the diameter of the ball (in inches), and π the periphery of a circle whoſe diameter is 1; the reſiſtance of the air will be $= \frac{62\frac{1}{2}}{840} \times \frac{\pi}{4} \times \frac{1}{144} \times \frac{a}{2} \times d^2 = \frac{ad^2}{4928\frac{1}{2}}$ pounds, very nearly, $= \frac{v^2}{4928\frac{1}{2} \times 64}d^2, = \frac{v^2d^2}{315417}$ pounds.

We may take an example. A ball of caſt iron weighing 12 pounds, is $4\frac{1}{2}$ inches in diameter. Suppoſe this ball to move at the rate of $25\frac{1}{10}$ feet in a ſecond (the reaſon of this choice will appear afterwards). The height which will produce this velocity in a falling body is $9\frac{7}{8}$ feet. The area of its great circle is 0,11044 feet, or $\frac{11044}{100000}$ of one foot. Suppoſe water to be 840 times heavier than air, the weight of the air incumbent on this great circle, and $9\frac{7}{8}$ feet high, is 0,081151 pounds: half of this is 0,0405755 or $\frac{405755}{10000000}$, or nearly $\frac{1}{25}$ of a pound. This ſhould be the reſiſtance of the air to this motion of the ball.

In all matters of phyſical diſcuſſion, it is prudent to confront every theoretical concluſion with experiment. This is particularly neceſſary in the preſent inſtance, becauſe the theory on which this propoſition is founded is extremely uncertain. Newton ſpeaks of it with the moſt cautious diffidence, and ſecures the juſtneſs of the concluſions by the conditions which he aſſumes in his inveſtigation. He deſcribes with the greateſt preciſion the ſtate of the fluid in which the body muſt move, ſo as that the demonſtrations may be ſtrict, and leaves it to others to pronounce whether this is the real conſtitution of our atmoſphere. It muſt be granted that it is not; and that many other ſuppoſitions have been introduced by his commentators and followers, in order to ſuit his inveſtigation (for we muſt aſſert that little or nothing has been added to it) to the circumſtances of the caſe.

Newton himſelf, therefore, attempted to compare his propoſitions with experiment. Some were made by dropping balls from the dome of St. Paul's cathedral; and all theſe ſhowed as great a coincidence with his theory as they did with each other: but the irregularities were too great to allow him to ſay with preciſion what was the reſiſtance. It appeared to follow the proportion of the ſquares of the velocities with ſufficient exactneſs; and though he could not ſay that the reſiſtance was equal to the weight of the column of air having the height neceſſary for communicating the velocity, it was always equal to a determinate part of it; and might be ſtated $= n\,a$, n being a number to be fixed by numerous experiments.

One great ſource of uncertainty in his experiments ſeems to have eſcaped his obſervation: the air in that dome is almoſt always in a ſtate of motion. In the ſummer ſeaſon there is a very ſenſible current of air downwards, and frequently in winter it is upwards: and this current bears a very great proportion to the velocity of the deſcents. Sir Iſaac takes no notice of this.

He made another ſet of experiments with pendulums; and has pointed out ſome very curious and unexpected circumſtances of their motions in a reſiſting medium. There is hardly any part of his noble work in which his addreſs, his patience, and his aſtoniſhing penetration, appear in greater luſtre. It requires the utmoſt intenſeneſs of thought to follow him in theſe diſquiſitions; and we cannot enter on the ſubject at preſent: ſome notice will be taken of theſe experiments in the article Resistance *of Fluids*. Their reſults were much more uniform, and confirmed his general theory; and, as we have ſaid above, it has been acquieſced in by the firſt mathematicians of Europe.

But the deductions from this theory were ſo inconſiſtent with the obſerved motions of military projectiles, when the velocities are prodigious, that no application could be made which could be of any ſervice for determining the path and motion of cannon ſhot and bombs; and although Mr. John Bernoulli gave in 1718 a moſt elegant determination of the trajectory and motion of a body projected in a fluid which reſiſts in the duplicate ratio of the velocities (a problem which even Newton did not attempt), it has remained a dead letter. Mr. Benjamin Robins, equally eminent for phyſical ſcience and mathematical genius, was the firſt who ſuſpected the true cauſe of the imperfection of the uſually received theories; and in 1737 he publiſhed a ſmall tract, in which he ſhowed clearly, that even the Newtonian theory of reſiſtance muſt cauſe a cannon ball, diſcharged with a full allotment of powder, to deviate further from the parabola, in which it would move *in vacuo*, than the parabola deviates from a ſtraight line. But he further aſſerted, on the authority of good reaſoning, that in ſuch great velocities the reſiſtance muſt be much greater than this theory aſſigns; becauſe, beſides the reſiſtance ariſing from the *inertia* of the air which is put in motion by the ball, there muſt be a reſiſtance ariſing from a condenſation of the air on the anterior ſurface of the ball, and a rarefaction behind it: and there muſt be a third reſiſtance, ariſing from the ſtatical preſſure of the air on its anterior part, when the motion is ſo ſwift that there is a vacuum behind. Even theſe cauſes of diſageeement with the theory had been foreſeen and mentioned by Newton (ſee the Scholium to prop. 37, Book II. *Princip.*); but the ſubject ſeems to have been little attended to. The eminent mathematicians had few opportunities of making experiments; and the profeſſional men, who were in the ſervice of princes, and had their countenance and aid in this matter, were generally too deficient in mathematical knowledge to make a proper uſe of their opportunities. The numerous and ſplendid volumes which theſe gentlemen have been enabled to publiſh by the patronage of ſovereigns are little more than prolix extenſions of the ſimple theory of Galileo. Some of them, however, ſuch as St. Remy, Antonini, and Le Blond, have given moſt valuable collections of experiments, ready for the uſe of the profound mathematician.

Two or three years after this firſt publication, Mr. Robins hit upon that ingenious method of meaſuring the great velocities of military projectiles, which has handed down his name to poſterity with great honour. And having aſcertained theſe velocities, he diſcovered the prodigious reſiſtance of the air, by obſerving the diminution of velocity which it occaſioned. This made him anxious to examine what was the real reſiſtance to any velocity whatever, in order to aſcertain what was the law of its variation; and he was equally fortunate in this attempt.

It appears (Robins's *Math. Works*, vol. i. page 205.) that a ſphere of $4\frac{1}{2}$ inches in diameter, moving at the rate of $25\frac{1}{5}$ feet in a ſecond, ſuſtained a reſiſtance of 0,04914 pounds, or $\frac{4914}{100000}$ of a pound. This is a greater reſiſtance than that of the Newtonian theory, which gave $\frac{405755}{10000000}$ in the proportion of 1000 to 1211, or very nearly in the proportion of five to 6 in ſmall numbers. And we may adopt as a rule in all moderate velocities, that the reſiſtance to a ſphere is equal to $\frac{61}{100}$ of the weight of a column of air having the great circle of the ſphere for its baſe, and for its altitude the height through which a heavy body muſt fall *in vacuo* to acquire the velocity of projection.

This experiment is peculiarly valuable, becauſe the ball is preciſely the ſize of a 12-pound ſhot of caſt iron; and its accuracy may be depended on. There is but one ſource of error. The whirling motion muſt have occaſioned ſome whirl in the air, which would continue till the ball again paſſed through the ſame point of its revolution. The reſiſtance obſerved is therefore probably ſomewhat leſs than the true reſiſtance to the velocity of $25\frac{1}{5}$ feet, becauſe it was exerted in a relative velocity which was leſs than this, and is, in fact, the reſiſtance competent to this relative and ſmaller velocity.—Accordingly, Mr. Smeaton, a moſt ſagacious naturaliſt, places great confidence in the obſervations of a Mr. Rouſe of Leiceſterſhire, who meaſured the reſiſtance by the effect of the wind on a plane properly expoſed to it. He does not tell us in what way the velocity of the wind was aſcertained; but our deference for his great penetration and experience diſpoſes us to believe that this point was well determined. The reſiſtance obſerved by Mr. Rouſe exceeds that reſulting from Mr. Robins's experiments nearly in the proportion of 7 to 10. Chevalier de Borda made experiments ſimilar to thoſe of Mr. Robins, and his reſults exceed thoſe of Robins in the proportion of 5 to 6. Theſe differences are ſo conſiderable, that we are at a loſs what meaſure to abide by. It is much to be regretted, that in a ſubject ſo intereſting both to the philoſopher and the man of the world, experiments have not been multiplied. Nothing would tend ſo much to perfect the ſcience of gunnery; and indeed till this be done, all the labours of mathematicians are of no avail. Their inveſtigations muſt remain an unintelligible cipher, till this key be ſupplied. It is to be hoped that Dr. Charles Hutton of Woolwich, who has ſo ably extended Mr. Robin's Examination of the Initial Velocities of Military Projectiles, will be encouraged to proceed to this part of the ſubject. We ſhould wiſh to ſee, in the firſt place, a numerous ſet of experiments for aſcertaining the reſiſtances in moderate velocities; and, in order to avoid all poſſible error from the reſiſtance and inertia of the machine, which is neceſſarily blended with the reſiſtance of the ball, in Mr. Robins's form of the experiment, and is ſeparated with great uncertainty and riſk of error, we would recommend a form of experiment ſomewhat different.

Let the axis and arm which carries the ball be connected with wheelwork, by which it can be put in motion, and gradually accelerated. Let the ball be ſo connected with a bent ſpring, that this ſhall gradually compreſs it as the reſiſtance increaſes, and leave a mark of the degree of compreſſion; and let all this part of the apparatus be ſcreened from the air except the ball. The velocity will be determined preciſely by the revolutions of the arm, and the reſiſtance by the compreſſion of the ſpring. The beſt method would be to let this part of the apparatus be made to ſlide along the revolving arm, ſo that the ball can be made to deſcribe larger and larger circles. An intelligent mechanician will eaſily contrive an apparatus of this kind, held at any diſtance from the axis by a cord, which paſſes over a pulley in the axis itſelf, and is then brought along a perforation in the axis, and comes out at its extremity, where it is fitted with a ſwivel, to prevent it from ſnapping by being twiſted. Now let the machine be put in motion. The centrifugal force of the ball and apparatus will cauſe it to fly out as far as it is allowed by the cord; and if the whole be put in motion by connecting it with ſome mill, the velocity may be moſt accurately aſcertained. It may alſo be fitted with a bell and hammer like Graveſande's machine for meaſuring centrifugal forces. Now by gradually veering off more cord, the diſtance from the centre, and conſequently the velocity and reſiſtance increaſe, till the hammer is diſengaged and ſtrikes the bell.

Another great advantage of this form of the experiment is, that the reſiſtance to very great velocities may be thus examined, which was impoſſible in Mr. Robins's way. This is the great deſideratum, that we may learn in what proportion of the velocities the reſiſtances increaſe.

In the ſame manner an apparatus, conſiſting of Dr. Lynd's ANEMOMETER, deſcribed in the article PNEUMATICS, might be whirled round with prodigious rapidity, and the fluid on it might be made clammy, which would leave a mark at its greateſt elevation, and thus diſcover the reſiſtance of the air to rapid motions.

Nay, we are of opinion that the reſiſtance to very rapid motions may be meaſured directly in the conduit-pipe of ſome of the great cylinder bellows employed in blaſt furnaces: the velocity of the air in this pipe is aſcertained by the capacity of the cylinder and the ſtrokes of the piſton. We think it our duty to point out to ſuch as have the opportunities of trying them, methods which promiſe accurate reſults for aſcertaining this moſt deſirable point.

We are the more puzzled what meaſure to abide by, becauſe Mr. Robins himſelf, in his Practical Propoſitions, does not make uſe of the reſult of his own experiments, but takes a much lower meaſure. We muſt content ourſelves, however, with this experimental meaſure, becauſe it is as yet the only one of which any account can be given, or well-founded opinion formed.

Therefore, in order to apply our formulæ, we muſt reduce this experiment, which was made on a ball of 4½ inches diameter, moving with the velocity of 25⅕ feet per ſecond, to what would be the reſiſtance to a ball of one inch, having the velocity 1 foot. This will evidently give us $R = \frac{0,04914}{4,5^2 \times 25.2^2}$, being diminiſhed in the duplicate ratio of the diameter and velocity. This gives us R = 0,00000381973 pounds, or $\frac{3.81973}{1000000}$ of a pound. The logarithm is $\bar{4}$,58204. The reſiſtance here determined is the ſame whatever ſubſtance the ball be of; but the retardation occaſioned by it will depend on the proportion of the reſiſtance to the *vis inſita* of the ball; that is, to its quantity of motion. This in ſimilar velocities and diameters is as the denſity of the ball. The balls uſed in military ſervice are of caſt iron or of lead, whoſe ſpecific gravities are 7,207 and 11,37 nearly, water being 1. There is conſiderable variety in caſt iron, and this denſity is about the medium. Theſe data will give us

	For Iron.	For Lead.
W, or weight of a ball 1 inch in diameter - - -	lb. 0,13648	0,21533
Log. of W - - -	9.13509	9.33310
E″ - - - -	1116″,6	1761″,6
Log. of E - - -	3.04790	3.24591
u, or terminal velocity - -	189,03	237,43
Log. u - - -	2.27653	2.37553
a, or producing height - -	558,3	880,8

Theſe numbers are of frequent uſe in all queſtions on this ſubject.

Mr. Robins gives an expeditious rule for readily finding a, which he calls F (ſee the article GUNNERY), by which it is made 900 feet for a caſt iron ball of an inch diameter. But no theory of reſiſtance which he profeſſes to uſe will make this height neceſſary for producing the terminal velocity. His F therefore is an *empirical* quantity, analogous indeed to the producing height, but accommodated to his theory of the trajectory of cannon-ſhot, which he promiſed to publiſh, but did not live to execute. We need not be very anxious about this; for all our quantities change in the ſame proportion with R, and need only a correction by a multiplier or diviſor, when R ſhall be accurately eſtabliſhed.

We may illuſtrate the uſe of theſe formulæ by examples.

1. Then, to find the reſiſtance to a 24-pound ball moving with the velocity of 1670 feet in a ſecond, which is nearly the velocity communicated by 16 lb. of powder. The diameter is 5,603 inches.

Log. R - - - -	+$\bar{4}$.58204
Log. d^2 - - - -	+1.49674
Log. 1670^2 - - -	+6.44548
Log. 334,4 lb. = r - -	2.52426

But it is found, by unequivocal experiments on the retardation of ſuch a motion, that it is 504 lb. This is owing to the cauſes often mentioned, the additional reſiſtance to great velocities, ariſing from the condenſation of the air, and from its preſſure into the vacuum left by the ball.

2. Required the terminal velocity of this ball?

Log. R - - -	+ 4.58204
Log. d^2 - - - -	+ 1.49674
Log. reſiſt. to veloc. 1 - -	6.07878 = a
Log. W - - -	1.38021 = b
Diff. of a and b, = log. u^2 - -	5.30143
Log. 447.4 = u -	2.65071

As the terminal velocity u, and its producing height a, enter into all computations of military projectiles, we have inſerted the following Table for the uſual ſizes of cannon-ſhot, computed both by the Newtonian theory of reſiſtance, and by the reſiſtances obſerved in Robins's experiments.

Lb. Ball	Newton.		Robins.		Diam. Inch.
	u. Term. Vel.	2 a	Term Vel.	2 a	
1	289,9	2626,4	263,4	2168,6	1,94
2	324,9	3298,5	295,2	2723,5	2,45
3	348,2	3788,2	316,4	3127,9	2,80
4	365,3	4170,3	331,9	3442,6	3,08
6	390,8	4472,7	355,1	3940,7	3,52
9	418,1	5463,5	379,9	4511,2	4,04
12	438,6	6010,6	398,5	4962,9	4,45
18	469,3	6883,3	426,5	5683,5	5,09
24	492,4	7576,3	447,4	6255,7	5,61
32	512,6	8024,8	465,8	6780,4	6,21
	540,5	91299	491,5	7538,3	6,75

Mr. Muller, in his writings on this ſubject, gives a much ſmaller meaſure of reſiſtance, and conſequently much greater terminal velocity: but his theory is a miſtake from beginning to end (See his *Supplement* to his *Treatiſe of Artillery*, art. 150, &c.) In art. 148. he aſſumes an algebraic expreſſion for a principle of mechanical argument; and from its conſequence draws erroneous concluſions. He makes the reſiſtance of a cylinder one-third leſs than Newton *ſuppoſes* it; and his reaſon is falſe. Newton's meaſure is demonſtrated by his commentators Le Seur and Jaquier to be even a little too ſmall, upon his own principles, (Not. 277. Prop. 36. B. II.) Mr. Muller then, without any ſeeming reaſon, introduces a new principle, which he makes the chief ſupport of his theory, in oppoſition to the theories of other mathematicians. The principle is falſe, and even abſurd, as we ſhall have occaſion to ſhow by and by. In conſequence, however, of this principle, he is enabled to compare the reſults with many experiments, and the agreement is very flattering. But we ſhall ſoon ſee that little dependence can be had on ſuch compariſons. We notice theſe things here, becauſe Mr. Muller being head of the artillery-ſchool in Britain, his publications have become a ſort of text-books. We are miſerably deficient in works on this ſubject, and muſt have recourſe to the foreign writers.

We now proceed to conſider theſe motions through their whole courſe: and we ſhall firſt conſider them as affected by the reſiſtance only; then we ſhall conſider the perpendicular aſcents and deſcents of heavy bodies through the air; and, laſtly, their motion in a curvilineal trajectory, when projected obliquely. This muſt be done by the help of the abſtruſer parts of fluxionary mathematics. To make it more perſpicuous, we ſhall, by way of introduction, conſider the ſimply reſiſted rectilineal motions geometrically, in the manner of Sir Iſaac Newton. As we advance, we ſhall quit this track, and proſecute it algebraically, having by this time acquired diſtinct ideas of the algebraic quantities.

We muſt keep in mind the fundamental theorems of varied motions.

1. The momentary variation of the velocity is proportional to the force and the moment of time jointly, and may therefore be repreſented by $\pm \dot{v} = f \dot{t}$, where $\dot{v}$ is the momentary increment or decrement of the velocity v, f the accelerating or retarding force, and $\dot{t}$ the moment or increment of the time t.

2. The momentary variation of the ſquare of the velocity is as the force, and as the increment or decrement of the ſpace jointly; and may be repreſented by $\pm v \dot{v} = f \dot{s}$. The firſt propoſition is familiarly known. The ſecond is the 39th of Newton's *Principia*, B. I. It is demonſtrated in the article Optics, and is the moſt extenſively uſeful propoſition in mechanics.

Theſe things being premiſed, let the ſtraight line AC (pl. 22. fig. 5.) repreſent the initial velocity V, and let CO, perpendicular to AC, be the time in which this velocity would be extinguiſhed by the uniform action of the reſiſtance. Draw through the point A an equilateral hyperbola A e B, having OF, OCD for its aſymptotes; then let the time of the reſiſted motion be repreſented by the line CB, C being the firſt inſtant of the motion. If there be drawn perpendicular ordinates $\varkappa$ e, g f, DB, &c. to the hyperbola, they will be proportional to the velocities of the body at the inſtants $\varkappa$, g, D, &c. and the hyperbolic areas AC $\varkappa$ e, AC g f, ACDB, &c. will be proportional to the ſpaces deſcribed during the times C $\varkappa$, C g, CB, &c.

For, ſuppoſe the time divided into an indefinite number of ſmall and equal moments, C c, D d, &c. draw the ordinates ac, $b\,d$, and the perpendiculars b β, a α. Then, by the nature of the hyperbola, AC : $a\,c$ = O c : OC; and AC—$a\,c$: $a\,c$ = O c—OC : OC, that is, A α : $a\,c$ = C c : OC, and A α : C c = $a\,c$: OC, = AC· $a\,c$: AC·OC; in like manner, B β : D d = BD· b D : BD· OD. Now D d = C c, becauſe the moments of time were taken equal, and the rectangles AC·CO, BD·DO, are equal, by the nature of the hyperbola; therefore A α : B β = AC· $a\,c$: BD· $b\,d$: but as the points c, d continually approach, and ultimately coincide with C, D, the ultimate ratio of AC· $a\,c$ to BD· $b\,d$ is that of AC^2 to BD^2; therefore the momentary decrements of AC and BD are as AC^2 and BD^2. Now, becauſe the reſiſtance is meaſured by the momentary diminution of velocity, theſe diminutions are as the ſquares of the velocities; therefore the ordinates of the hyperbola and the velocities diminiſh by the ſame law; and the initial velocity was repreſented by AC: therefore the velocities at all the other inſtants $\varkappa$, g, D, are properly repreſented by the correſponding ordinates. Hence,

1. Since the abſciſſæ of the hyperbola are as the times, and the ordinates are as the velocities, the areas will be as the ſpaces deſcribed, and AC $\varkappa$ e is to A $c\,g\,f$ as the ſpace deſcribed in the time C $\varkappa$ to the ſpace deſcribed in the time C g (1ſt Theorem on varied motions).

2. The rectangle ACOF is to the area ACDB as the ſpace formerly expreſſed by 2 a, or E to the ſpace deſcribed in the reſiſting medium during the time CD: for AC being the velocity V, and OC the extinguiſhing time e, this rectangle is = e V, or E, or 2 a, of our former diſquiſitions; and becauſe all the rectangles, ſuch as ACOF, BDOG, &c. are equal, this correſponds with our former obſervation, that the ſpace uniformly deſcribed with any velocity during the time in which it would be uniformly extinguiſhed by the correſponding reſiſtance is a conſtant quantity, viz. that in which we always had $e\,v$ = E, or 2 a.

3. Draw the tangent A $\varkappa$; then, by the hyperbola, C $\varkappa$ = CO: now C $\varkappa$ is the time in which the reſiſtance to the velocity AC would extinguiſh it; for the tangent coinciding with the elemental arc A a of the curve, the firſt impulſe of the uniform action of the reſiſtance is the ſame with the firſt impulſe of its varied action. By this the velocity AC is reduced to $a\,c$. If this operated uniformly like gravity, the velocities would diminiſh uniformly, and the ſpace deſcribed would be repreſented by the triangle AC $\varkappa$.

This triangle, therefore, repreſents the height through which a heavy body muſt fall in vacuo, in order to acquire the terminal velocity.

4. The motion of a body reſiſted in the duplicate ratio of the velocity will continue without end, and a ſpace will be deſcribed which is greater than any aſſignable ſpace, and the velocity will grow leſs than any that can be aſſigned; for the hyperbola approaches continually to the aſymptote, but never coincides with it. There is no velocity BD ſo ſmall, but a ſmaller ZP will be found beyond it; and the hyperbolic ſpace may be continued till it exceeds any ſurface that can be aſſigned.

5. The initial velocity AC is to the final velocity BD as the ſum of the extinguiſhing time and the time of the retarded motion, is to the extinguiſhing time alone: for AC : BD = OD (or OC + CD) : OC; or V : v = e : e + t.

6. The extinguiſhing time is to the time of the retarded motion as the final velocity is to the velocity loſt during the retarded motion: for the rectangles AFOC, BDOG are equal; and therefore AVGF and BVCD are equal and VC : VA = VG : VB; therefore $t = e\,\frac{V-v}{v}$, and $e = t\,\frac{v}{V-v}$.

7. Any velocity is reduced in the proportion of m to n in the time $e\,\frac{m-n}{n}$. For, let AC : BD = m : n; then DO : CO = m : n, and DC : CO = m — n : n, and DC = $\frac{m-n}{n}$ CO, or

$t = c\,\frac{m-n}{n}$. Therefore any velocity is reduced to one-half in the time in which the initial reſiſtance would have extinguiſhed it by its uniform action.

Thus may the chief circumſtances of this motion be determined by means of the hyperbola, the ordinates and abſciſſæ exhibiting the relations of the times and velocities, and the areas exhibiting the relations of both to the ſpaces deſcribed. But we may render the conception of theſe circumſtances infinitely more eaſy and ſimple, by expreſſing them all by lines, inſtead of this combination of lines and ſurfaces. We ſhall accompliſh this purpoſe by conſtructing another curve LKP, having the line ML δ, parallel to OD for its abſciſſa, and of ſuch a nature, that if the ordinates to the hyperbola AC, $c\,\varkappa$, fg, BD, &c. be produced till they cut this curve in L, p, n, K, &c, and the abſciſſa in L, ε, b, δ, &c. the ordinates $\varepsilon\,p$, $b\,n$, δ K, &c. may be proportional to the hyperbolic areas c A $c\,\varkappa$, f A $c\,g$, δ A c K. Let us examine what kind of curve this will be.

Make OC : O $\varkappa$ = O $\varkappa$: O g; then (Hamilton's *Conics*, IV. 14. Cor.), the areas AC $\varkappa\,c$, $e\,\varkappa\,g\,f$ are equal: therefore drawing $p\,s$, $n\,t$ perpendicular to OM, we ſhall have (by the aſſumed nature of the curve L p K), M s = $s\,t$; and if the abſciſſa OD be divided into any number of ſmall parts in geometrical progreſſion (reckoning the commencement of them all from O), the axis V i of this curve will be divided by its ordinates into the ſame number of equal parts; and this curve will have its ordinates LM, $p\,s$, $n\,t$, &c. in geometrical progreſſion, and its abſciſſæ in arithmetical progreſſion.

Alſo, let KN, MV touch the curve in K and L, and let OC be ſuppoſed to be to O c, as OD to O d, and therefore C c to D d as OC to OD; and let theſe lines C c, D d be indefinitely ſmall; then (by the nature of the curve) L o is equal to K r: for the areas a AC c, b BD d are in this caſe equal. Alſo $l\,o$ is to $k\,r$, as LM to KI, becauſe c C : d D = CO : DO:

$$\begin{aligned} \text{Therefore IN} : \text{IK} &= r\,\text{K} : r\,k \\ \text{IK} : \text{ML} &= r\,k : o\,l \\ \text{ML} : \text{MV} &= o\,l : o\,\text{L} \\ \text{and IN} : \text{MN} &= r\,\text{K} : o\,\text{L}. \end{aligned}$$

That is, the ſubtangent IN, or MV, is of the ſame magnitude, or is a conſtant quantity in every part of the curve.

Laſtly, the ſubtangent IN, correſponding to the point K of the curve, is to the ordinate K δ as the rectangle BDOG or ACOF to the parabolic area BDCA.

For let $f\,g\;b\,n$ be an ordinate very near to BD δ K; and let $b\,n$ cut the curve in n, and the ordinate KI in q; then we have

$$\begin{aligned} \text{K}\,q : q\,n &= \text{KI} : \text{IN, or} \\ \text{D}\,g : q\,n &= \text{DO} : \text{IN}; \\ \text{but BD} : \text{AC} &= \text{CO} : \text{DO}; \\ \text{therefore BD} \,.\, \text{D}\,g : \text{AC} \,.\, q\,n &= \text{CO} : \text{IN}: \end{aligned}$$

Therefore the ſum of all the rectangles BD. D g is to the ſum of all the rectangles AC. $q\,n$, as CO to IN; but the ſum of the rectangles BD. D g is the ſpace ACDB; and, becauſe AC is given, the ſum of the rectangles AC. $q\,n$ is the rectangle of AC and the ſum of all the lines $q\,n$; that is, the rectangle of AC and RL: therefore the ſpace ACDB : AC. RL = CO : IN and ACDB × IN = AC. CO. RL; and therefore IN : RL = AC. CO : ACDB.

Hence it follows that QT expreſſes the area BVA, and, in general, that the part of the line parallel to OM, which lies between the tangent KN and the curve L p K, expreſſes the correſponding area of the hyperbola which lies without the rectangle FCOG.

Now, by the help of this curve, we have an eaſy way [illegible] and computing the motion of a body through the air. For the ſubtangent of our curve now repreſents twice the height through which the ball muſt fall in vacuo, in order to acquire the terminal velocity; and therefore ſerves for a ſcale on which to meaſure all the other repreſentatives of the motion.

But it remains to make another obſervation on the curve L p K, which will ſave us all the trouble of graphical operations, and reduce the whole to a very ſimple arithmetical computation. It is of ſuch a nature, that when MI is conſidered as the abſciſſa, and is divided into a number of equal parts, and ordinates are drawn from the points of diviſion, the ordinates are a ſeries of lines in geometrical progreſſion, or are continual proportionals. Whatever is the ratio between the firſt and ſecond ordinate, there is the ſame between the ſecond and third, between the third and fourth, and ſo on; therefore the number of parts into which the abſciſſa is divided is the number of theſe equal ratios which is contained in the ratio of the firſt ordinate to the laſt: for this reaſon, this curve has got the name of the *logiſtic* or *logarithmic* curve; and it is of immenſe uſe in the modern mathematics, giving us the ſolution of many problems in the moſt ſimple and expeditious manner, on which the genius of the ancient mathematicians had been exerciſed in vain. Few of our readers are ignorant, that the numbers called *logarithms* are of equal utility in arithmetical operations, enabling us not only to ſolve common arithmetical problems with aſtoniſhing diſpatch, but alſo to ſolve others which are quite inacceſſible in any other way. Logarithms are nothing more than the numerical meaſures of the abſciſſa of this curve, correſponding to ordinates, which are meaſured on the ſame or any other ſcale by the natural numbers; that is, if ML δ be divided into equal parts, and from the points of diviſion lines be drawn parallel to MI, cutting the curve L p K, and from the points of interſection ordinates be drawn to MI, theſe will divide MI into portions, which are in the ſame proportion to the ordinates, that the logarithms bear to their natural numbers.

In conſtructing this curve we were limited to no particular length of the line LR, which repreſented the ſpace ACDB; and all that we had to take care of was, that when OC, O $\varkappa$, O g were taken in geometrical progreſſion, M s M t ſhould be in arithmetical progreſſion. The abſciſſæ having ordinates equal to $p\,s$, $n\,t$, &c. might have been twice as long, as is ſhown in the dotted curve which is drawn through L. All the lines which ſerve to meaſure the hyperbolic ſpaces would then have been doubled. But NI would alſo have been doubled, and our proportions would have ſtill held good; becauſe this ſubtangent is the ſcale of meaſurement of our figure, as E or 2 a is the ſcale of meaſurement for the motions.

Since then we have tables of logarithms calculated for every number, we may make uſe of them inſtead of this geometrical figure, which ſtill requires conſiderable trouble to ſuit it to every caſe. There are two ſets of logarithmic tables in common uſe. One is called a table of hyperbolic or natural logarithms. It is ſuited to ſuch a curve as is drawn in the figure, where the ſubtangent is equal to that ordinate $\tau\,\upsilon$ which correſponds to the ſide π O of the ſquare $\pi\,\theta\,\lambda$ O inſerted between the hyperbola and its aſymptotes. This ſquare is the unit of ſurface, by which the hyperbolic areas are expreſſed; its ſide is the unit of length, by which the lines belonging to the hyperbola are expreſſed; $\tau\,\upsilon$ is = 1, or the unit of numbers to which the logarithms are ſuited, and then IN is alſo 1. Now the ſquare $\theta\,\pi$ O λ being unity, the area BACD will be ſome number; π O being alſo unity, OD is ſome number: Call it x. Then, by the nature of the hyperbola, OB : O π = $\pi\,\theta$: DB: That is, $x : 1 = 1 : \frac{1}{x}$, ſo that DB is $\frac{1}{x}$. Now calling D d $\dot{x}$, the area BD $d\,b$, which is the fluxion (ultimately) of the hyperbolic area, is $\frac{\dot{x}}{x}$. Now in the curve LpK, MI has the ſame ratio to NI that BACD has to $\vartheta\,\lambda\,O\,\pi$: Therefore, if there be a ſcale of which NI is the unit, the number on this ſcale correſponding to MI has the ſame ratio to 1 which the number meaſuring BACD has to 1 ; and I *i*, which correſponds to BD *db* is the fluxion (ultimately) of MI: Therefore if MI be called the logarithm of x, $\frac{\dot{x}}{x}$ is properly repreſented by the fluxion of MI. In ſhort, the line MI is divided preciſely as the line of numbers on a Gunter's ſcale, which is therefore a line of logarithms; and the numbers called logarithms are juſt the lengths of the different parts of this line meaſured on a ſcale of equal parts. Therefore when we meet with ſuch an expreſſion as $\frac{\dot{x}}{x}$ viz. the fluxion of a quantity divided by the quantity itſelf, we conſider it as the fluxion of the logarithm of that quantity, becauſe it is really ſo when the quantity is a number; and it is therefore ſtrictly true that the fluent of $\frac{\dot{x}}{x}$ is the hyperbolic logarithm of x.

Certain reaſons of convenience have given riſe to another ſet of logarithms; theſe are ſuited to a logiſtic curve whoſe ſubtangent is only $\frac{43429}{100000}$ of the ordinate $\tau\, v$, which is equal to the ſide of the hyperbolic ſquare, and which is aſſumed for the unit of number. We ſhall ſuit our applications of the preceeding inveſtigation to both theſe, and ſhall firſt uſe the common logarithms whoſe ſubtangent is 0,43429.

The whole ſubject will be beſt illuſtrated by taking an example of the different queſtions which may be propoſed.

Recollect that the rectangle ACOF is $= 2\,a$, or $\frac{u^2}{g}$, or E, for a ball of caſt-iron one inch diameter, and if it has the diameter d, it is $\frac{u^2 d}{g}$, or $2\,a\,d$, or E d.

I. It may be required to determine what will be the ſpace deſcribed in a given time t by a ball ſetting out with a given velocity V, and what will be its velocity v at the end of that time.

Here we have NI : MI = ACOF : BDCA; now NI is the ſubtangent of the logiſtic curve; MI is the difference between the logarithms of OD and OC; that is, the difference between the logarithms of $e + t$ and e; ACOF is $2\,ad$ or $\frac{u^2 d}{g}$, or Ed.

Therefore by common logarithms 0,43429 : log. $\overline{e+t}$ — log. $e = 2\,a\,d$: S, = ſpace deſcribed,

or 0,43429 : log. $\frac{e+t}{e} = 2\,a\,d$: S,

and S. $= \frac{2\,a\,d}{0{,}43429} \times$ log. $\frac{e+t}{e}$,

by hyperbolic logarithms S $= 2\,a\,d \times$ log. $\frac{e+t}{e}$.

Let the ball be a twelve pounder, and the initial velocity be 1600 feet, and the time 20 ſeconds. We muſt firſt find e, which is $\frac{2\,a\,d}{\text{V}}$.

Therefore, log. $2\,a$ - - - + 3.03236
log. d (4, 5) - + 0.65321
log. V. (1600) - — 3.20412

Log. of 3″,03, e , - 0.48145
And $e + t$ is 23″,03, of which the log is - 1.36229
from which take the log. of e - - 0.48145

remains the log. of $\frac{e+t}{e}$ - - 0.88084

This muſt be conſidered as a common number by which we are to multiply $\frac{2\,a\,d}{0{,}43429}$.

Therefore add the logarithms of $2\,a\,d$ + 3.68557.
log. $\frac{e+t}{e}$ - - + 9.94490
log. 0,43429 - — 9.63778

Log. S. 9833 feet - - 3.99269

For the final velocity,

OD : OC = AC : BD, or $e+t : e = \text{V} : v$.

23″,03 : 3″,03 = 1600 : 210½, = v.

The ball has therefore gone 3278 yards, and its velocity is reduced from 1600 to 210.

It may be agreeable to the reader to ſee the gradual progreſs of the ball during ſome ſeconds of its motion.

T.	*S.*	*Diff.*	*V.*	*Diff.*
1″	1383		1203	397
2″	2456	1073	964	239
3″	3336	880	804	160
4″	4080	744	690	114
5″	4725	645	604	86
6″	5294	569	537	67

The firſt column is the time of the motion, the ſecond is the ſpace deſcribed, the third is the differences of the ſpaces, ſhowing the motion during each ſucceſſive ſecond; the fourth column is the velocity at the end of the time t; and the laſt column is the differences of velocity, ſhowing its diminution in each ſucceſſive ſecond. We ſee that at the diſtance of 1000 yards the velocity is reduced to one half, and at the diſtance of leſs than a mile it is reduced to one third.

II. It may be required to determine the diſtance at which the initial velocity V is reduced to any other quantity v. This queſtion is ſolved in the very ſame manner, by ſubſtituting the logarithms of V and v for thoſe of $e+t$ and e; for AC : BD = OD : OC, and therefore log. $\frac{\text{AC}}{\text{BD}}$ = log. $\frac{\text{OD}}{\text{OC}}$, or log. $\frac{\text{V}}{v}$ = log. $\frac{e+t}{e}$.

Thus it is required to determine the diſtance in which the velocity 1780 of a 24-pound ball (which is the medium velocity of ſuch a ball diſcharged with 16 pounds of powder) will be reduced to 1500.

Here d is 5,68, and therefore the logarithm of $2\,a\,d$ is - - + 3.78671
Log. $\frac{\text{V}}{v}$ = 0,07433, of which the log. is + 8.87116
Log. 0,43429 - - — 9.63778

Log. 1047,3 feet, or 349 yards 3.02009

This reduction will be produced in about $\frac{7}{8}$ of a ſecond.

III. Another queſtion may be to determine the time which a ball, beginning to move with a certain velocity, employs in paſſing over a given ſpace, and the diminution of velocity which it ſuſtains from the reſiſtence of the air.

We may proceed thus:

$2\,a\,d : \text{S} = 0{,}43429$: log. $\frac{e+t}{e}$, $= t$. Then to log. $\frac{e+t}{e}$ add log. e and we obtain log. $e + t$, and $e + t$; from which if we take e we have t. Then to find v, ſay $e + t : e = \text{V} : v$.

We ſhall conclude theſe examples by applying this laſt rule to Mr. Robin's experiment on a muſket bullet of $\frac{3}{4}$ of an inch in diameter, which had its velocity reduced from 1670 to 1425 by paſſing through 100 feet of air (ſee Robins's Math. Works, vol. i. p. 135. This we do in order to diſcover the reſiſtance which it ſuſtained, and compare it with the reſiſtance to a velocity of 1 foot *per* ſecond.

We muſt firſt aſcertain the firſt term of our analogy. The ball was of lead, and therefore 2 a muſt be multiplied by d and by m, which expreſſes the ratio of the denſity of lead to that of caſt iron. d is 0,75, and m is $\frac{11,37}{7,21} = 1,577$.

$$\begin{array}{rr} \text{Therefore log. } 2\,a & 3.03236 \\ d & 9.87506 \\ m & 0.19782 \\ \hline \text{Log, } 2\,a\,d\,m & 3.10524 \end{array}$$

and $2\,a\,d\,m = 1274,2$.

Now $1274,2 : 100 = 0,43429 : 0,03408 = \log. \frac{e+t}{e}$. But $e = \frac{2\,a\,d\,m}{V} = 0,763$, and its logarithm $= 9.88252$, which, added to 0.03408, gives 9.91660, which is the log. of $e+t$, $= 0,825$, from which take e, and there remains $t =, 0'',062$, or $\frac{62}{1000}$ of a ſecond, for the time of paſſage. Now, to find the remaining velocity, ſay $825 : ,763 = 1670 : 1544, = v$.

But in Mr. Robins's experiment the remaining velocity was only 1425, the ball having loſt 245; whereas by this computation it ſhould have loſt only 126. It appears, therefore, that the reſiſtance is double of what it would have been if the reſiſtance increaſed in the duplicate proportion of the velocity. Mr. Robins ſays it is nearly triple. But he ſuppoſes the reſiſtance to ſlow motions much ſmaller than his own experiment, ſo often mentioned, fully warrants.

The time e, in which the reſiſtance of the air would extinguiſh the velocity is $0'',763$. Gravity, or the weight of the bullet, would have done it in $\frac{1670}{32}$ or $52''$; therefore the reſiſtance is $\frac{52}{0,763}$ times, or nearly 68 times its weight, by this theory, or 5.97 pounds. If we calculate from Mr. Robins's experiment we muſt ſay $\log. \frac{V}{v} : 0,43429 = 100 : e\,V$, which will be 630,23, and $e = \frac{630,23}{1670} = 0'',3774$, and $\frac{52}{0,3774}$ gives 138 for the proportion of the reſiſtance to the weight, and makes the reſiſtance 12,07 pounds, fully double of the other.

It is to be obſerved, that with this velocity, which greatly exceeds that with which the air can ruſh into a void, there muſt be a ſtatical preſſure of the atmoſphere equal to $6\frac{1}{2}$ pounds. This will make up the difference, and allows us to conclude that that the reſiſtance ariſing ſolely from the motion communicated to the air follows very nearly the duplicate proportion of the velocity.

The next experiment, with a velocity of 1690 feet, gives a reſiſtance equal to 157 times the weight of the bullet, and this bears a much greater proportion to the former than 1690 does to 1670^2 which ſhows, that although theſe experiments clearly demonſtrate a prodigious augmentation of reſiſtance, yet they are by no means ſuſceptible of the preciſion which is neceſſary for diſcovering the law of this augmentation, or for a good foundation of practical rules; and it is ſtill greatly to be wiſhed that a more accurate mode of inveſtigation could be diſcovered.

Thus we have explained, in great detail, the principles and the proceſs of calculation for the ſimple caſe of the motion of projectiles through the air. The learned reader will think that we have been unreaſonably prolix, and that the whole might have been compriſed in leſs room by taking the algebraic method. We acknowledge that it might have been done even in a few lines. But we have obſerved, and our obſervation has been confirmed by perſons well-verſed in ſuch ſubjects, that in all caſes where the fluxionary proceſs introduces the fluxion of a logarithm, there is a great want of diſtinct ideas to accompany the hand and eye. The ſolution comes out by a ſort of magic or legerdemain, we cannot tell either *how* or *why*. We therefore thought it our duty to furniſh the reader with diſtinct conceptions of the things and quantities treated of. For this reaſon, after ſhowing in Sir Iſaac Newton's manner, how the ſpaces deſcribed in the retarded motion of a projectile followed the proportion of the hyperbolic areas, we ſhowed the nature of another curve, where lines could be found which increaſe in the very ſame manner as the path of the projectile increaſes; ſo that a point deſcribing the abſciſſa MI of this curve moves preciſely as the projectile does. Then, diſcovering that this line is the ſame with the line of logarithms on a Gunter's ſcale, we ſhowed how the logarithm of a number really repreſents the path or ſpace deſcribed by the projectile. And we were the more diſpoſed to do this, becauſe in the articles LOGARITHMS and LOGARITHMIC *Curve*, there has not been that notice taken of it which would have been proper.

Having thus, we hope, enabled the reader to conceive diſtinctly the quantities employed, we ſhall leave the geometrical method, and proſecute the reſt of the ſubject in a more compendious manner.

We are, in the next place, to conſider the perpendicular aſcents and deſcents of *heavy* projectiles, where the reſiſtance of the air is combined with the action of gravity: and we ſhall begin with the deſcents.

Let u, as before, be the terminal velocity, and g the accelerating power of gravity: When the body moves with the velocity u, the reſiſtance is equal to g; and in every other velocity v, we muſt have $u^2 : v^2 = g : \frac{g\,v^2}{u^2}, = r$, for the reſiſtance to that velocity. In the deſcent the body is urged by gravity g, and oppoſed by the reſiſtance $\frac{g\,v^2}{u^2}$: therefore the remaining accelerating force, which we ſhall call f, is $g - \frac{g\,v^2}{u^2}$, or $\frac{gu^2 - gv^2}{u^2}$, or $\frac{g(u^2 - v^2)}{u^2}, = f$.

Now the fundamental theorem for varied motions is $f\dot{s} = u\dot{v}$, and $\dot{s} = \frac{v\dot{v}}{f}, = \frac{u^2}{g} \times \frac{v\dot{v}}{u^2 - v^2}$, and $s = \frac{u^2}{g} \times \int \frac{v\dot{v}}{u^2 - v^2} + \text{C}$. Now the fluent of $\frac{v\dot{v}}{u^2 - v^2}$ is $= -$ hyperb. log. of $\sqrt{u^2 - v^2}$. For the fluxion of $\sqrt{u^2 - v^2}$ is $\frac{-v\dot{v}}{\sqrt{u^2 - v^2}}$, and this divided by the quantity $\sqrt{u^2 - v^2}$, of which it is the fluxion, gives preciſely $\frac{v\dot{v}}{u^2 - v^2}$, which is therefore the fluxion of its hyperbolic logarithm. Therefore $\text{S} = -\frac{u^2}{g} \times \text{L}\,\sqrt{u^2 - v^2} + \text{C}$. Where L means the hyperbolic logarithm of the quantity annexed to it, and λ may be uſed to expreſs its common logarithm. (See article FLUXIONS.)

The conſtant quantity C for completing the fluent is determined from this conſideration, that the ſpace deſcribed is o, when the velocity is o: therofore $\text{C} - \frac{u^2}{g} \times \text{L}\,\sqrt{u^2} = o$, and $\text{C} = \frac{u^2}{g} \times \text{L}\,\sqrt{u^2}$, and the complete fluent $\text{S} = \frac{u^2}{g} \times$

$\overline{\mathrm{L}\sqrt{u^2}-\mathrm{L}\sqrt{u^2-v^2}}, = \frac{u^2}{g} \times \mathrm{L}\sqrt{\frac{u^2}{u^2-v^2}}. = \frac{u^2}{0,43429\,g} \times \lambda\sqrt{\frac{u^2}{u^2-v^2}},$ or (putting M for 0,43429, the modulus or ſubtangent of the common logiſtic curve) $= \frac{u^2}{\mathrm{M}g} \times \lambda \sqrt{\frac{u^2}{u^2-v^2}}.$

This equation eſtabliſhes the relation between the ſpace fallen through, and the velocity acquired by the fall. We obtain by it $\frac{g\mathrm{S}}{u^2} = \mathrm{L}\sqrt{\frac{u^2}{u^2-v^2}},$ and $\frac{2g\mathrm{S}}{u^2} = \mathrm{L}.\frac{u^2}{u^2-v^2},$ or, which is ſtill more convenient for us, $\frac{\mathrm{M} \times 2g\mathrm{S}}{u^2} = \lambda \frac{u^2}{u^2-v^2},$ that is, equal to the logarithm of a certain number: therefore having found the natural number correſponding to the fraction $\frac{\mathrm{M} \times 2g\mathrm{S}}{u^2}$, conſider it as a logarithm, and take out the number correſponding to it: call this n. Then, ſince n is equal to $\frac{u^2}{u^2-v^2},$ we have $nu^2 - nv^2 = u^2$, and $nu^2 - u^2 = nv^2$, or $nv^2 = u^2 \times \overline{n-v}$, and $v^2 = \frac{u^2 \times \overline{n-1}}{n}$.

To expedite all the computations on this ſubject, it will be convenient to have multipliers ready computed for M × $2g$, and its half,

viz. 27,794, whoſe log. is	-	1.44396
and 13,897	- - -	1.14293

But v may be found much more expeditiouſly by obſerving, that $\sqrt{\frac{u^2}{u^2-v^2}}$ is the ſecant of an arch of a circle whoſe radius is u, and whoſe ſine is v, or whoſe radius is unity and ſine $= \frac{v}{u}$: therefore, conſidering the above fraction as a logarithmic ſecant, look for it in the tables, and then take the ſine of the arc of which this is the ſecant, and multiply it by u; the product is the velocity required.

We ſhall take an example of a ball whoſe terminal velocity is $689\frac{1}{3}$ feet, and aſcertain its velocity after a fall of 1848 feet,

Here,	$u^2 = 475200$	and its log. -	$= 5.67688$
	$u = 689\frac{1}{3}$	- - -	2.83844
	$g = 32$	- - - -	1.50515
	$\mathrm{S} = 1848$	- - - -	3.26670
Then	log. 27,794	- - - -	+ 1.44396
	log. S	- - - -	+ 3.26670
	log. u^2	- - - -	− 5.67688
	Log. of 0,10809 = log. n	- -	9.03378

0,10809 is the logarithm of $1,2826 = n$, and $n - 1 = 0,2826$, and $\frac{u^2 \times \overline{n-1}}{n} = 323,6^2, = v^2$, and $v = 323,6$.

In like manner, 0,054045 (which is half of 0,10809) will be found to be the logarithmic ſecant of 28°, whoſe ſine 0,46947 multiplied by $689\frac{1}{3}$ gives 324 for the velocity.

The proceſs of this ſolution ſuggeſts a very perſpicuous manner of conceiving the law of deſcent; and it may be thus expreſſed:

M is to the logarithm of the ſecant of an arch whoſe ſine is $\frac{v}{u}$, and radius 1, as $2a$ is to the height through which the body muſt fall in order to acquire the velocity v. Thus, to take the ſame example:

1. Let the height b be ſought which will produce the velocity 323,62, the terminal velocity of the ball being 689,34. Here $2a$, or $\frac{u^2}{g}$ is 14850, and $\frac{323,62}{689,34} = 0,46947$, which is the ſine of 28°. The logarithmic ſecant of this arch is 0,05407. Now M or 0,43429 : 0,05407 = 14850 : 1848, the height wanted.

2. Required the velocity acquired by the body by falling 1848 feet. Say 14850 : 1848 = 0,43429 : 0,05407. Look for this number among the logarithmic ſecants. It will be found at 28°, of which the logarithmic ſine is

found at 28°, of which the logarithmic ſine is	-	9.67161
Add to this the log. of u	- - -	2.83844
The ſum	- - - - -	2.51005

is the logarithm of 323,62, the velocity required.

We may obſerve, from theſe ſolutions, that the acquired velocity continually approaches to, but never equals the terminal velocity. For it is always expreſſed by the ſine of an arch of which the terminal velocity is the radius. We cannot help taking notice here of a very ſtrange aſſertion of Mr. Muller, late profeſſor of mathematics and director of the royal academy at Woolwich. He maintains, in his Treatiſe on Gunnery, his Treatiſe of Fluxions, and in many of his numerous works, that a body cannot poſſibly move through the air with a greater velocity than this; and he makes this a fundamental principle, on which he eſtabliſhes a theory of motion in a reſiſting medium, which he aſſerts with great confidence to be the only juſt theory; ſaying, that all the inveſtigations of Bernoulli, Euler, Robins, Simpſon, and others, are erroneous. We uſe this ſtrong expreſſion, becauſe, in his criticiſms on the works of thoſe celebrated mathematicians, he lays aſide good manners, and taxes them not only with ignorance, but with diſhoneſty; ſaying, for inſtance, that it required no ſmall dexterity in Robins to confirm by his experiments a theory founded on falſe principles; and that Thomas Simpſon, in attempting to conceal his obligations to him for ſome valuable propoſitions, by changing their form, had ignorantly fallen into groſs errors.

Nothing can be more palpably abſurd than this aſſertion of Mr. Muller. A blown bladder will have but a ſmall terminal velocity; and when moving with this velocity, or one very near it, there can be no doubt that it will be made to move much ſwifter by a ſmart ſtroke. Were the aſſertion true, it would be impoſſible for a portion of air to be put into motion through the reſt, for its terminal velocity is nothing. Yet this author makes this aſſertion a principle of argument, ſaying, that it is impoſſible that a ball can iſſue from the mouth of a cannon with a greater velocity than this; and that Robins and others are groſly miſtaken, when they give them velocities three or four times greater, and reſiſtances which are 10 or 20 times greater than is poſſible; and by thus compenſating his ſmall velocities by ſtill ſmaller reſiſtances, he confirms his theory by many experiments adduced in ſupport of the others. No reaſon whatever can be given for the aſſertion. Newton, or perhaps Huygens, was the firſt who obſerved that there was a limit to the velocity which gravity could communicate to a body; and this limit was found by his commentators to be a term to which it was vaſtly convenient to refer all its other motions. It therefore became an object of attention; and Mr. Muller, through inadvertency, or want of diſcernment, has fallen into this miſtake, and with that arrogance and ſelf-conceit which mark all his writings, has made this miſtake a fundamental principle, becauſe it led him to eſtabliſh a novel ſet of doctrines on this ſubject. He was fretted at the ſuperior knowledge and talents of Mr. Simpſon, his inferior in the academy, and was guilty of ſeveral mean attempts to hurt his reputation. But they were unſucceſsful.

We might proceed to conſider the motion of a body projected downwards. While the velocity of projection is leſs than the terminal velocity, the motion is determined by what we have already ſaid: for we muſt compute the height neceſſary for acquiring this velocity in the air, and ſuppoſe the motion to have begun there. But if the velocity of projection be greater, this method fails. We paſs it over (though not in the leaſt more difficult than what has gone before), becauſe it is of mere curioſity, and never occurs in any intereſting caſe. We may juſt obſerve, that ſince the motion is ſwifter than the terminal velocity, the reſiſtance muſt be greater than the weight, and the motion will be retarded. The very ſame proceſs will give us for the ſpace deſcribed $S = \frac{u^2}{g} \times L\sqrt{\frac{V^2 - u^2}{v^2 - u^2}}\Big|$, V being the velocity of projection, greater than u. Now as this ſpace evidently increaſes continually (becauſe the body always falls), but does not become infinite in any finite time, the fraction $\frac{V^2 - u^2}{v^2 - u^2}$ does not become infinite; that is, v^2 does not become equal to u^2: therefore, although the velocity V is continually diminiſhed, it never becomes ſo ſmall as u. Therefore u is a limit of diminution as well as of augmentation.

We muſt now aſcertain the relation between the time of the deſcent and the ſpace deſcribed, or the velocity acquired. For this purpoſe we may uſe the other fundamental propoſition of varied motions $f\dot{t} = \dot{v}$, which, in the preſent caſe, becomes $\frac{g\overline{u^2 - v^2}}{u^2}\dot{t} = \dot{v}$; therefore $\dot{t} = \frac{u^2}{g} \times \frac{\dot{v}}{u^2 - v^2}, = \frac{u}{g} \times \frac{u\dot{v}}{u^2 - v^2}$, and $t = \frac{u}{g} \times \int \frac{u\dot{v}}{u^2 - v^2}$.

Now (art. FLUXIONS) $\int \frac{u\dot{v}}{u^2 - v^2} = L\sqrt{\frac{u+v}{u-v}}$. Therefore $t = \frac{u}{g} \times L\sqrt{\frac{u+v}{u-v}}, = \frac{u}{Mg} \times \lambda\sqrt{\frac{u+v}{u-v}}$. This fluent needs no conſtant quantity to complete it, or rather $C = 0$; for t muſt be $= 0$ when $v = 0$. This will evidently be the caſe: for then $L\sqrt{\frac{u+v}{u-v}}$ is $L\sqrt{\frac{u}{u}}, = L\,1, = 0$.

But how does this quantity $\frac{u}{Mg} \times \lambda\sqrt{\frac{u+v}{u-v}}$ ſignify a time? Obſerve, that in whatever numbers, or by whatever units of ſpace and time, u and g are expreſſed, $\frac{u}{g}$ expreſſes the number of units of time in which the velocity u is communicated or extinguiſhed by gravity; and $L\sqrt{\frac{u+v}{u-v}}$, or $\frac{\lambda}{M}\sqrt{\frac{u+v}{u-v}}$, is always an abſtract number, multiplying this time.

We may illuſtrate this rule by the ſame example. In what time will the body acquire the velocity 323,62? Here $u + v = 1012{,}96$, $u - v = 365{,}72$; therefore $\lambda\sqrt{\frac{u+v}{u-v}} = 0{,}22122$, and $\frac{u}{g}$ (in feet and ſeconds) is 21″,542. Now, for greater perſpicuity, convert the equation $t = \frac{u}{Mg} \times \lambda\sqrt{\frac{u+v}{u-v}}$ into a proportion: thus $M : \lambda\sqrt{\frac{u+v}{u-v}} = \frac{u}{g} : t$, and we have 0,43429 : 0,22122 = 21″,542 : 10″,973, the time required.

This is by far the moſt diſtinct way of conceiving the ſubject; and we ſhould always keep in mind that the numbers or ſymbols which we call logarithms are really parts of the line MI in the figure of the logiſtic curve, and that the motion of a point in this line is preciſely ſimilar to that of the body. The Marquis Poleni, in a diſſertation publiſhed at Padua in 1725, has with great ingenuity conſtructed logarithmics ſuited to all the caſes which can occur. Herman, in his *Phoronomia* has borrowed much of Poleni's methods; but has obſcured them by an affectation of language geometrically preciſe, but involving the very obſcure notion of abſtract ratios.

It is eaſy to ſee that $\sqrt{\frac{u+v}{u-v}}$ is the cotangent of the $\frac{1}{2}$ complement of an arch, whoſe radius is 1, and whoſe ſine is $\frac{v}{u}$: For let KC (pl. 22. fig. 6.) be $= u$, and BE $= v$; then KD $= u + v$, and DA $= u - v$. Join KB and BA, and draw CG parallel to KB. Now GA is the tangent of $\frac{1}{2}$ BA $= \frac{1}{2}$ complement of HB. Then by ſimilarity of triangles, GA : AC = AB : BK, $= \sqrt{AD} : \sqrt{DK} = \sqrt{u - v} : \sqrt{u + v}$ and $\frac{AC}{GA}$ (= cotan. $\frac{1}{2}$BA) $= \sqrt{\frac{u+v}{u-v}}$; therefore look for $\frac{v}{u}$ among the natural ſines, or for log. $\frac{v}{u}$ among the logarithmic ſines, and take the logarithmic cotangent of the half complement of the correſponding arch. This, conſidered as a common number, will be the ſecond term of our proportion. This is a ſhorter proceſs than the former.

By reverſing this proportion we get the velocity correſponding to a given time.

To compare this deſcent of 1848 feet in the air with the fall of the body *in vacuo* during the ſame time, ſay $\overline{21'',542}^2 : \overline{10'',973}^2 = 1848 : 1926{,}6$, which makes a difference of 79 feet.

Cor. 1. The time in which the body acquires the velocity u by falling through the air, is to the time of acquiring the ſame velocity by falling *in vacuo*, as $u\,L\sqrt{\frac{u+v}{u-v}}$ to v: for it would acquire this velocity *in vacuo* during the time $\frac{v}{g}$, and it acquires it in the air in the time $\frac{u}{g}L\sqrt{\frac{u+v}{u-v}}$.

2. The velocity which the body acquires by falling through the air in the time $\frac{u}{g}L\sqrt{\frac{u+v}{u-v}}$, is to the velocity which it would acquire *in vacuo* during the ſame time, as v to $u\,L\sqrt{\frac{u+v}{u-v}}$: For the velocity which it would acquire *in vacuo* during the time $\frac{u}{g}L\sqrt{\frac{u+v}{u-v}}$ muſt be $u\,L\sqrt{\frac{u+v}{u-v}}$ (becauſe in any time $\frac{w}{g}$ the velocity w is acquired).

In the next place, let a body, whoſe terminal velocity is u, be projected perpendicularly upwards, with any velocity V. It is required to determine the height to which it aſcends, ſo as to have any remaining velocity v, and the time of its aſcent; as alſo the height and time in which its whole motion will be extinguiſhed.

We have now $\frac{g(u^2+v^2)}{u^2}$ for the expreſſion of f; for both gravity and reſiſtance act now in the ſame direction, and retard the motion of the aſcending body: therefore $\frac{g(u^2+v^2)}{u^2}\dot{s} = -v\dot{v}$, and $\dot{s} = -\frac{u^2}{g} \times \frac{v\dot{v}}{u^2+v^2}$, and $s = -\frac{u^2}{g} \times \int \frac{v\dot{v}}{u^2+v^2} + \mathrm{C}, = -\frac{u^2}{g} \times \mathrm{L}\sqrt{u^2+v^2} + \mathrm{C}$ (ſee art. FLUXIONS.) This muſt be $= o$ at the beginning of the motion, that is, when $v = \mathrm{V}$, that is, $-\frac{u^2}{g} \times \mathrm{L}\sqrt{u^2+\mathrm{V}^2} + \mathrm{C} = o$, or $\mathrm{C} = \frac{u^2}{g} \times \mathrm{L}\sqrt{u^2+\mathrm{V}^2}$, and the complete fluent will be $s = \frac{u^2}{g} \times \left(\mathrm{L}\sqrt{u^2+\mathrm{V}^2} - \mathrm{L}\sqrt{u^2+v^2}\right) = \frac{u^2}{g} \times \mathrm{L}\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v^2}}, = \frac{u^2}{\mathrm{M}g} \times \lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v^2}}$.

Let b be the greateſt height to which the body will riſe. Then $s = b$ when $v = o$; and $b = \frac{u^2}{g} \times \mathrm{L}\sqrt{\frac{u^2+\mathrm{V}^2}{u^2}} = \frac{u^2}{\mathrm{M}g} \times \lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2}}$. We have $\lambda\sqrt{\frac{u^2+\mathrm{V}^2}{u^2+v^2}} = s\frac{mg}{u^2}$; therefore $\lambda\left(\frac{u^2+\mathrm{V}^2}{u^2+v^2}\right) = \frac{2\mathrm{M}gs}{u^2}$. Therefore let n be the number whoſe common logarithm is $\frac{2\mathrm{M}gs}{u^2}$; we ſhall have $n = \frac{u^2+\mathrm{V}^2}{u^2+v^2}$, and $v^2 = \frac{u^2+\mathrm{V}^2}{n} - u^2$; and thus we obtain the relation of s and v, as in the caſe of deſcents: but we obtain it ſtill eaſier by obſerving that $\sqrt{u^2+\mathrm{V}^2}$ is the ſecant of an arch whoſe radius is u, and whoſe tangent is V, and that $\sqrt{u^2+v^2}$ is the ſecant of another arch of the ſame circle, whoſe tangent is v.

Let the ſame ball be projected upwards with the velocity 411,05 feet per ſecond. Required the whole height to which it will riſe?

Here $\frac{\mathrm{V}}{u}$ will be found the tangent of $30.48\frac{1}{3}$, the logarithmic ſecant of which is 0,06606. This, multiplied by $\frac{u^2}{\mathrm{M}g}$, gives 2259 feet for the height. It would have riſen 2640 feet in a void.

Suppoſe this body to fall down again. We can compare the velocity of projection with the velocity with which it again reaches the ground. The aſcent and deſcent are equal: therefore $\sqrt{\frac{u^2+\mathrm{V}^2}{u^2}}$, which multiplies the conſtant factor in the aſcent, is equal to $\sqrt{\frac{u^2}{u^2-v^2}}$, the multiplier in the deſcent. The firſt is the ſecant of an arch whoſe tangent is V; the other is the ſecant of an arch whoſe ſine is v. Theſe ſecants are equal, or the arches are the ſame; therefore the velocity of projection is to the final returning velocity as the tangent to the ſine, or as the radius to the coſine of the arch. Thus, ſuppoſe the body projected with the terminal velocity, or $\mathrm{V} = u$; then $v = \frac{u}{\sqrt{2}}$. If $\mathrm{V} = 689$, $v = 487$.

We muſt in the laſt place aſcertain the relation of the ſpace and the time.

Here $\frac{g(u^2+v^2)}{u^2}\dot{t} = -\dot{v}$, and $\dot{t} = -\frac{u^2}{g} \times \frac{\dot{v}}{u^2+v^2}, = -\frac{u}{g} \times \frac{u\dot{v}}{u^2+v^2}$; and $t = \frac{-u}{g} \times \int \frac{u\dot{v}}{u^2+v^2} + \mathrm{C}$. Now (art. FLUXIONS) $\int \frac{u\dot{v}}{u^2+v^2}$ is an arch whoſe tangent $= \frac{v}{u}$ and radius 1; therefore $t = -\frac{u}{g} \times \text{arc. tan.}\frac{v}{u} + \mathrm{C}$. This muſt be $= o$ when $v = \mathrm{V}$, or $\mathrm{C} - \frac{u}{g} \times \text{arc. tan.}\frac{\mathrm{V}}{u} = o$, and $\mathrm{C} = \frac{u}{g} \times \text{arc. tan.}\frac{\mathrm{V}}{u}$, and the complete fluent is $t = \frac{u}{g} \times \left(\text{arc. tan.}\frac{\mathrm{V}}{u} - \text{arc. tan.}\frac{v}{u}\right)$. The quantities within the brackets expreſs a portion of the arch of a circle whoſe radius is unity; and are therefore abſtract numbers, multiplying $\frac{u}{g}$, which we have ſhown to be the number of units of time in which a heavy body falls *in vacuo* from the height a, or in which it acquires the velocity u.

We learn from this expreſſion of the time, that however great the velocity of projection, and the height to which this body will riſe, may be, the time of its aſcent is limited. It never can exceed the time of falling from the height a *in vacuo* in a greater proportion than that of a quadrantal arch to the radius, nearly the proportion of 8 to 5. A 24-pound iron ball cannot continue riſing above 14 ſeconds, even if the reſiſtance to quick motions did not increaſe faſter than the ſquare of the velocity. It probably will attain its greateſt height in leſs than 12 ſeconds, let its velocity be ever ſo great.

In the preceding example of the whole aſcent, $v = o$, and the time $t = \frac{u}{g} \times \text{arc. tan.}\frac{\mathrm{V}}{u}$, or $\frac{u}{g}$ arc. $30°.48'$. Now $30°.48' = 1848$, and the radius 1 contains 3438; therefore the arch $= \frac{1848}{3438}, = 0{,}5376$; and $\frac{u}{g} = 21'',54$. Therefore $t = 21'',54 \times 0{,}5376, = 11'',58$, or nearly $11\frac{1}{2}$ ſeconds. The body would have riſen to the ſame height in a void in $10\frac{3}{4}$ ſeconds.

Cor. 1. The time in which a body, projected in the air with any velocity V, will attain its greateſt height, is to that in which it would attain its greateſt height *in vacuo*, as the arch whoſe tangent expreſſes the velocity is to the tangent; for the time of the aſcent in the air is $\frac{u}{g} \times$ arch; the time of the aſcent *in vacuo* is $\frac{\mathrm{V}}{g}$. Now $\frac{\mathrm{V}}{u}$ is $=$ tan. and $\mathrm{V} = u \times$ tan. and $\frac{\mathrm{V}}{g} = \frac{u}{g} \times$ tan.

It is evident, by inſpecting fig. 6. that the arch AI is to the tangent AG as the ſector ICA to the triangle GCA; therefore the time of attaining the greateſt height in the air is to that of attaining the greateſt height *in vacuo* (the velocities of projection being the ſame), as the circular ſector to the correſponding triangle.

If therefore a body be projected upwards with the terminal velocity, the time of its aſcent will be to the time of acquiring this velocity *in vacuo* as the area of a circle to the area of the circumſcribed ſquare.

2. The height H to which a body will riſe in a void, is to the height h to which it would riſe through the air when projected with the ſame velocity V as $M \cdot V^2$ to $u^2 \times \lambda \dfrac{u^2 + V^2}{u^2}$: for the height to which it will riſe *in vacuo* is $\dfrac{V^2}{2g}$, and the height to which it riſes in the air is $\dfrac{u^2}{Mg} \lambda \sqrt{\dfrac{u^2 + V^2}{u^2}}$; therefore

$$H : h = \frac{V^2}{2g} : \frac{u^2}{Mg} \lambda \sqrt{\frac{u^2+V^2}{u^2}}, = V^2 : \frac{u^2}{M} \times 2\lambda \sqrt{\frac{u^2 + V^2}{u^2}}, = V^2 : \frac{u^2}{M} \times \lambda \frac{u^2 + V^2}{u^2} = M \cdot V^2 : u^2 \times \lambda \frac{u^2 + V^2}{u^2}.$$

Therefore, if the body be projected with its terminal velocity, ſo that $V = u$, the height to which it will riſe in the air is $\frac{30103}{43429}$ of the height to which it will riſe *in vacuo*, or $\frac{5}{7}$ in round numbers.

We have been thus particular in treating of the perpendicular aſcents and deſcents of heavy bodies through the air, in order that the reader may conceive diſtinctly the quantities which he is thus combining in his algebraic operations, and may ſee their connection in nature with each other. We ſhall alſo find that, in the preſent ſtate of our mathematical knowledge, this ſimple ſtate of the caſe contains almoſt all that we can determine with any confidence. On this account it were to be wiſhed that the profeſſional gentlemen would make many experiments on theſe motions. There is no way that promiſes ſo much for aſſiſting us in forming accurate notions of the air's reſiſtance. Mr. Robins's method with the pendulum is impracticable with great ſhot; and the experiments which have been generally reſorted to for this purpoſe, viz. the ranges of ſhot and ſhells on a horizontal plane, are ſo complicated in themſelves, that the utmoſt mathematical ſkill is neceſſary for making any inferences from them; and they are ſubject to ſuch irregularities, that they may be brought to ſupport almoſt any theory whatever on this ſubject. But the perpendicular flights are affected by nothing but the initial velocity and the reſiſtance of the air; and a conſiderable deviation from their intended direction does not cauſe any ſenſible error in the conſequences which we may draw from them for our purpoſe.

But we muſt now proceed to the general problem, to determine the motion of a body projected in any direction, and with any velocity. Our readers will believe beforehand that this muſt be a difficult ſubject, when they ſee the ſimpleſt caſes of rectilineal motion abundantly abſtruſe: it is indeed ſo difficult, that Sir Iſaac Newton has not given a ſolution of it, and has thought himſelf well employed in making ſeveral approximations, in which the fertility of his genius appears in great luſtre. In the tenth and ſubſequent propoſitions of the ſecond book of the *Principia*, he ſhows what ſtate of denſity in the air will comport with the motion of a body in any curve whatever: and then, by applying this diſcovery to ſeveral curves which have ſome ſimilarity to the path of a projectile, he finds one which is not very different from what we may ſuppoſe to obtain in our atmoſphere. But even this approximation was involved in ſuch intricate calculations, that it ſeemed impoſſible to make any uſe of it. In the ſecond edition of the *Principia*, publiſhed in 1713, Newton corrects ſome miſtakes which he had committed in the firſt, and carries his approximations much further, but ſtill does not attempt a direct inveſtigation of the path which a body will deſcribe in our atmoſphere. This is ſomewhat ſurpriſing. In prop. 14, &c. he ſhows how a body, actuated by a centripetal force, in a medium of a denſity varying according to certain laws, will deſcribe an eccentric ſpiral, of which he aſſigns the properties, and the law of deſcription. Had he ſuppoſed the denſity conſtant, and the difference between the greateſt and leaſt diſtances from the centre of centripetal force exceedingly ſmall in compariſon with the diſtances themſelves, his ſpiral would have coincided with the path of a projectile in the air of uniform denſity, and the ſteps of his inveſtigation would have led him immediately to the complete ſolution of the problem. For this is the real ſtate of the caſe. A heavy body is not acted on by equal and parallel gravity, but by a gravity inverſely proportional to the ſquare of the diſtance from the centre of the earth, and in lines tending to that centre nearly; and it was with the view of ſimplifying the inveſtigation, that mathematicians have adopted the other hypotheſis.

Soon after the publication of this ſecond edition of the *Principia*, the diſpute about the invention of the fluxionary calculus became very violent, and the great promoters of that calculus upon the continent were in the habit of propoſing difficult problems to exerciſe the talents of the mathematician. Challenges of this kind frequently paſſed between the Britiſh and foreigners. Dr. Keill of Oxford had keenly eſpouſed the claim of Sir Iſaac Newton to this invention, and had engaged in a very acrimonious altercation with the celebrated John Bernoulli of Baſle. Bernoulli had publiſhed in the *Acta Eruditorum Lipſiæ* an inveſtigation of the law of forces, by which a body moving in a reſiſting medium might deſcribe any propoſed curve, reducing the whole to the ſimpleſt geometry. This is perhaps the moſt elegant ſpecimen which he has given of his great talents. Dr. Keill propoſed to him the particular problem of the trajectory and motion of a body moving through the air, as one of the moſt difficult. Bernoulli very ſoon ſolved the problem in a way much more general that it had been propoſed, viz. without any limitation either of the law of reſiſtance, the law of the centripetal force, or the law of denſity, provided only that they were regular, and capable of being expreſſed algebraically. Dr. Brooke Taylor, the celebrated author of the Method of Increments, ſolved it at the ſame time, in the limited form in which it was propoſed. Other authors ſince that time have given other ſolutions. But they are all (as indeed they muſt be) the ſame in ſubſtance with Bernoulli's. Indeed they are all (Bernoulli's not excepted) the ſame with Newton's firſt approximations, modified by the ſteps introduced into the inveſtigation of the ſpiral motions mentioned above; and we ſtill think it moſt ſtrange that Sir Iſaac did not perceive that the *variation of curvature*, which he introduced in that inveſtigation, made the whole difference between his approximations and the complete ſolution. This we ſhall point out as we go along. And we now proceed to the problem itſelf, of which we ſhall give Bernoulli's ſolution, reſtricted to the caſe of uniform denſity and a reſiſtance proportional to the ſquare of the velocity. This ſolution is more ſimple and perſpicuous than any that has ſince appeared.

Problem. To determine the trajectory, and all the circumſtances of the motion, of a body projected through the air from A (fig. 7.) in the direction AB, and reſiſted in the duplicate ratio of the velocity.

Let the arch AM be put $= z$, the time of deſcribing it t, the abſciſſa $AP = x$, the ordinate $PM = y$. Let the velocity in the point $M = v$, and let $MN, = \dot{z}$, be deſcribed in the moment $\dot{t}$; let r be the reſiſtance of the air, g the force of gravity, meaſured by the velocity which it will generate in a ſecond; and let a be the height through which a heavy body muſt fall *in vacuo* to acquire the velocity which would render the reſiſtance of the air equal to its gravity: ſo that we have $r = \frac{v^2}{2a}$; becauſe, for any velocity u, and producing height b, we have $g = \frac{u^2}{2b}$.

Let Mm touch the curve in M; draw the ordinate pNm, and draw Mo, Nn perpendicular to Np and Mm. Then we have MN $= \dot{z}$, and M$o = \dot{x}$, alſo mo is ultimately $= \dot{y}$, and Mm is ultimately $=$ MN or $\dot{z}$. Laſtly, let us ſuppoſe $\dot{x}$ to be a conſtant quantity, the elementary ordinates being ſuppoſed equidiſtant.

The action of gravity during the time $\dot{t}$ may be meaſured by mN, which is half the ſpace which it would cauſe the body to deſcribe uniformly in the time $\dot{t}$ with the velocity which it generates in that time. Let this be reſolved into nN, by which it deflects the body into a curvilineal path, and mn, by which it retards the aſcent and accelerates the deſcent of the body along the tangent. The reſiſtance of the air acts ſolely in retarding the motion, both in aſcending and deſcending, and has no deflective tendency. The whole action of gravity then is to its accelerating or retarding tendency as mN to mn, or (by ſimilarity of triangles) as mM to mo. Or $\dot{z} : \dot{y} = g : \frac{g\dot{y}}{\dot{z}}$, and the whole retardation in the aſcent will be $r + \frac{g\dot{y}}{\dot{z}}$. The ſame fluxionary ſymbol will expreſs the retardation during the deſcent, becauſe in the deſcent the ordinates decreaſe, and $\dot{y}$ is a negative quantity.

The diminution of velocity is $-\dot{v}$. This is proportional to the retarding force and to the time of its action jointly, and therefore $-\dot{v} = \overline{r + \frac{g\dot{y}}{\dot{z}}} \times \dot{t}$; but the time $\dot{t}$ is as the ſpace $\dot{z}$ divided by velocity $-v$; therefore $-\dot{v} = r + \frac{g\dot{y}}{\dot{z}} \times \frac{\dot{z}}{v}, = -\frac{r\dot{z} + g\dot{y}}{v}$, and $-v\dot{v} = -r\dot{z} - g\dot{y}, = \frac{v^2\dot{z}}{2a} - g\dot{y}$. Becauſe mN is the deflection by gravity, it is as the force g and the ſquare of the time $\dot{t}$ jointly (the momentary action being held as uniform). We have therefore mN, or $-\ddot{y} = g\dot{t}^2$. (Obſerve that mN is in fact only the half of $-\ddot{y}$; but g being twice the fall of a heavy body in a ſecond, we have $-\ddot{y}$ ſtrictly equal to $g\dot{t}^2$). But $\dot{t}^2 = \frac{\dot{z}^2}{v^2}$, therefore $-\ddot{y} = \frac{g\dot{z}^2}{v^2}$, and $v^2 = \frac{g\dot{z}^2}{-\ddot{y}}$, and $-v^2\ddot{y} = g\dot{z}^2$. The fluxion of this equation is $-v^2\dddot{y} - 2v\ddot{y}\dot{v} = 2g\dot{z}\ddot{z}$; but, becauſe $\dot{z} : \dot{y} = m\text{M} : mo, = m\text{N} : mn, = \ddot{y} : \ddot{z}$, we have $\dot{z}\ddot{z} = \dot{y}\ddot{y}$. Therefore $2g\dot{y}\ddot{y} = 2g\dot{z}\ddot{z}, = -v^2\dddot{y} - 2v\ddot{y}\dot{v}$, and $-2v\dot{v}\ddot{y} = v^2\dddot{y}, - 2g\dot{y}\ddot{y}$, and $-v\dot{v} = \frac{v^2\dddot{y}}{2\ddot{y}} - g\dot{y}$. But we have already $-v\dot{v} = \frac{v^2\dot{z}}{2a} - g\dot{y}$; therefore $\frac{v^2\dddot{y}}{\ddot{y}} = \frac{v^2\dot{z}}{a}$, and finally $\frac{\dddot{y}}{\ddot{y}} = \frac{\dot{z}}{a}$, or $a\dddot{y} = \dot{z}\ddot{y}$, for the fluxionary equation of the curve.

If we put this into the form of a proportion, we have $a : \dot{z} = \ddot{y} : \dddot{y}$. Now this evidently eſtabliſhes a relation between the length of the curve and its variation of curvature; and between the curve itſelf and its evoluta, which are the very circumſtances introduced by Newton into his inveſtigation of the ſpiral motions. And the equation $\frac{\dot{z}}{a} = \frac{\dddot{y}}{\ddot{y}}$ is evidently an equation connected with the logarithmic curve and the logarithmic ſpiral. But we muſt endeavour to reduce it to a lower order of fluxions, before we can eſtabliſh a relation between z, x, and y.

Let p expreſs the ratio of $\dot{y}$ to $\dot{x}$, that is, let p be $= \frac{\dot{y}}{\dot{x}}$ or $p\dot{x} = \dot{y}$. It is evident that this expreſſes the inclination of the tangent at M to the horizon, and that p is the tangent of this inclination, radius being unity. Or it may be conſidered merely as a number, multiplying $\dot{x}$, ſo as to make it $= \dot{y}$. We now have $\dot{y}^2 = p^2\dot{x}^2$, and ſince $\dot{z}^2 = \dot{x}^2 + \dot{y}^2$, we have $\dot{z}^2 = \dot{x}^2 + p^2\dot{x}^2, = \overline{1 + p^2} \times \dot{x}^2$ and $\dot{z} = \dot{x}\sqrt{1 + p^2}$.

Moreover, becauſe we have ſuppoſed the abſciſſa x to increaſe uniformly, and therefore $\dot{x}$ to be conſtant, we have $\ddot{y} = \dot{x}\dot{p}$, and $\dddot{y} = \dot{x}\ddot{p}$. Now let q expreſs the ratio of $\dot{p}$ to $\dot{x}$, that is, make $\frac{\dot{p}}{\dot{x}} = q$, or $q\dot{x} = \dot{p}$. This gives us $\dot{x}\dot{q} = \ddot{p}$, and $\dot{x}^2\dot{q} = \dot{x}\ddot{p}, = \dddot{y}$.

By theſe ſubſtitutions our former equation $a\dddot{y} = \dot{z}\ddot{y}$ changes to $a\dot{x}^2\dot{q} = \dot{x}\sqrt{\overline{1 + p^2}|}\,\dot{x}\dot{p}$, or $a\dot{q} = \dot{p}\sqrt{1 + p^2}$, and taking the fluent on both ſides, we have $aq = \int \dot{p}\sqrt{1 + p^2} + \text{C}$, C being the conſtant quantity required for completing the fluent according to the limiting conditions of the caſe. Now $\dot{x} = \frac{\dot{p}}{q}$, and $\frac{1}{q} = \int, \frac{a}{\dot{p}\sqrt{1 + p^2}) + \text{C}}$. Therefore $\dot{x} = \int, \frac{a\dot{p}}{p\sqrt{1 + p^2}) + \text{C}}$.

Alſo ſince $\dot{y} = p\dot{x}, = \frac{p\dot{p}}{q}$, we have $y = \int, \frac{ap\dot{p}}{p\sqrt{1 + p^2}) + \text{C}}$.

Alſo $\dot{z} = \dot{x}\sqrt{1 + p^2} = \frac{a\dot{p}\sqrt{1 + p^2}}{\int, p\sqrt{1 + p^2}) + \text{C}}$

The values of $\dot{x}$, $\dot{y}$, $\dot{z}$, give us

$$x = \int, \frac{a\dot{p}}{\int, \dot{p}\sqrt{1 + p^2}) + \text{C}}, = a\int \frac{\dot{p}}{\int \dot{p}\sqrt{1 + p^2}) + \text{C}}.$$

$$y = \int \frac{ap\dot{p}}{\int \dot{p}\sqrt{1 + p^2}) + \text{C}}, = a\int \frac{p\dot{p}}{\int, \dot{p}\sqrt{1 + p^2}) + \text{C}}.$$

$$z = \int, \frac{a\sqrt{1 + p^2})\dot{p}}{\int \dot{p}\sqrt{1 + p^2}) + \text{C}}, = a\int \frac{\dot{p}\sqrt{1 + p^2}}{\int, \dot{p}\sqrt{1 + p^2}) + \text{C}}.$$

The proceſs, therefore, of deſcribing the trajectory is, 1ſt. To find q in terms of p by the area of the curve whoſe abſciſſa is p and the ordinate is $\sqrt{1 + p^2}$.

2d. We get x by the area of another curve whoſe abſciſſa is p, and the ordinate is $\frac{1}{q}$.

3d. We get y by the area of a third curve whoſe abſciſſa is p, and the ordinate is $\frac{p}{q}$.

The problem of the trajectory is therefore completely ſolved, becauſe we have determined the ordinate, abſciſſa, and arch of the curve for any given poſition of its tangent. It now only remains to compute the magnitudes of theſe ordinates and abſciſſæ, or to draw them by a geometrical conſtruction. But in this conſiſts the difficulty. The areas of theſe curves, which expreſs the lengths of x and y, can neither be computed nor exhibited geometrically, by any accurate method *yet* diſcovered, and we muſt content ourſelves with approximations. Theſe render the deſcription of the trajectory exceedingly difficult and tedious, ſo that little advantage has as yet been derived from the knowledge we have got of its properties. It will however greatly aſſiſt our conception of the ſubject to proceed ſome length in this conſtruction; for it muſt be acknowledged that very few diſtinct notions accompany a mere algebraic operation, eſpecially if in any degree complicated, which we confeſs is the caſe in the preſent queſtion.

Let B*m*NR (plate 23. fig. 8) be an equilateral hyperbola, of which B is the vertex, BA the ſemitranſverſe axis, which we ſhall aſſume for the unity of length. Let AV be the ſemiconjugate axis = B A, = unity, and AS the aſymptote, biſecting the right angle BAV. Let PN, $p\,n$ be two ordinates to the conjugate axis, exceedingly near to each other. Join BP, AN, and draw B β, N ν perpendicular to the aſymptote, and BC parallel to AP. It is well known that BP is equal to NP. Therefore $PN^2 = BA^2 + AP^2$. Now ſince $BA = 1$, if we make $AP = p$ of our formulæ, PN is $\sqrt{1+p^2}$, and Pp is $= \dot{p}$, and the area BAPNB $= \int, \dot{p}\sqrt{1+p^2}|$: That is to ſay, the number $\int, \dot{p}\sqrt{1+p^2}$ (for it is a number) has the ſame proportion to unity of number that the area BAPNB has to BCVA, the unit of ſurface. This area conſiſts of two parts, the triangle APN, and the hyperbolic ſector ABN. APN $= \frac{1}{2}AP \times PN = \frac{1}{2}p\sqrt{1+p^2}$, and the hyperbolic ſector ABN $=$ BN$\nu\beta$, which is equivalent to the hyperbolic logarithm of the number repreſented by Aν when Aβ is unity. Therefore it is equal to $\frac{1}{2}$ the logarithm of $p + \sqrt{1+p^2}$. Hence we ſee by the bye that $\int, \dot{p}\sqrt{1+p^2} = \frac{1}{2}p\sqrt{1+p^2} + \frac{1}{2}$ hyperbolic $\overline{\text{logarithm}\ p + \sqrt{1+p^2}}$.

Now let AMD be another curve, ſuch that its ordinates V*m*, PD, &c. may be proportional to the areas AB*m*V, ABNP, and may have the ſame proportion to AB, the unity of length, which theſe areas have to ABCV, the unity of ſurface. Then VM : VC = V*m*BA : VCBA and PD : Pδ = PNBA : VCBA, &c. Theſe ordinates will now repreſent $\int, \dot{p}\sqrt{1+p^2}$ with reference to a linear unit, as the areas to the hyperbola repreſented it in reference to a ſuperficial unit.

Again, in every ordinate make PD : Pδ = Pδ : PO, and thus we obtain a reciprocal to PD or to $\int, \dot{p}\sqrt{1+p^2}$, or equivalent to $\overline{\int, \dot{p}\sqrt{1+p^2}}$. This will evidently be $\frac{\dot{x}}{a\dot{p}}$, and POop will be $\frac{\dot{x}}{a}$, and the area contained between the lines AF, AW, and the curve GEOH, and cut off by the ordinate PO, will repreſent $\frac{x}{a}$.

Laſtly, make PO : PQ = AV : AP, = 1 : p; and then PQqp will repreſent $\frac{\dot{y}}{a}$, and the area ALEQP will repreſent $\frac{y}{a}$.

But we muſt here obſerve, that the fluents expreſſed by theſe different areas require what is called the *correction* to accommodate them to the circumſtances of the caſe. It is not indifferent from what ordinate we begin to reckon the areas. This depends on the initial direction of the projectile, and that point of the abſciſſa AP muſt be taken for the commencement of all the areas, which gives a value of p ſuited to the initial direction. Thus, if the projection has been made from A (pl. 23. fig. 7.) at an elevation of 45°, the ratio of the fluxions $\dot{x}$ and $\dot{y}$ is that of equality; and therefore the point E of fig. 8. pl. 23. where the two curves interſect and have a common ordinate, evidently correſponds to this condition. The ordinate EV paſſes through V, ſo that AV or $p = AB, = 1, =$ tangent 45°, as the caſe requires. The values of x and of y correſponding to any other point of the trajectory, ſuch as that which has AP for the tangent of the angle which it makes with the horizon, are now to be had by computing the areas VEOP, VEQP.

Another curve might have been added, of which the ordinates would exhibit the fluxions of the arch of the trajectory $\dot{z} = \frac{a\dot{p}\sqrt{1+p^2}}{\int, \dot{p}\sqrt{1+p^2}| + C}$, and of which the area would exhibit the arch itſelf. And this would have been very eaſy; for it is $\dot{z} = a\frac{\dot{p}\sqrt{1+p^2}}{\int, \dot{p}\sqrt{1+p^2}| + C}$, which is evidently the fluxion of the hyperbolic logarithm of $\int, \dot{p}\sqrt{1+p^2}|$. But it is needleſs, ſince $\dot{z} = \dot{x}\sqrt{1+p^2}$, and we have already got $\dot{x}$. It is only increaſing PO in the ratio of BA to BP.

And thus we have brought the inveſtigation of this problem a conſiderable length, having aſcertained the *form* of the trajectory. This is ſurely done when the ratio of the arch, abſciſs, and ordinate, and the poſition of its tangent, is determined in every point. But it is ſtill very far from a ſolution, and much remains to be done before we can make any practical application of it. The only general conſequence that we can deduce from the premiſes is, that in every caſe where the reſiſtance in any point bears the ſame proportion to the force of gravity, the trajectory will be ſimilar. Therefore two balls, of the ſame denſity, projected in the ſame direction, will deſcribe ſimilar trajectories if the velocities are in the ſubduplicate ratio of the diameters. This we ſhall find to be of conſiderable practical importance. But let us now proceed to determine the velocity in the different points of the trajectory, and the time of deſcribing its ſeveral portions.

Recollect, therefore, that $v^2 = \frac{-g\dot{z}^2}{\ddot{y}}$, and that $\dot{z}^2 = \dot{x}^2\,\overline{1+p^2}$ and $\ddot{y} — \dot{x}\dot{p}$. This gives $v^2 = \frac{-g\dot{x}\,\overline{1+p^2}}{\dot{p}}$.

But $\dot{p} = q\dot{x}$. Therefore $v^2 = \frac{-g \times \overline{1+p^2}}{q} = \frac{-ag\,\overline{1+p^2}}{\int, \dot{p}\sqrt{1+p^2} + C}$, and $v = \sqrt{\frac{-g\,\overline{1+p^2}}{q}}, = \frac{\sqrt{a\sqrt{-g}\sqrt{1+p^2}}}{\sqrt{\int \dot{p}\sqrt{1+p^2}| + C}}$.

Alſo $\dot{t}$ was found $= \frac{\dot{z}}{v}, = \frac{\dot{x}\sqrt{1+p^2}}{v}, = \frac{\dot{p}\sqrt{1+p^2}}{qv}$. If we now ſubſtitute for v its value juſt found, we obtain $\dot{t} = \frac{\dot{p}}{\sqrt{-gq}}$, and $t = \int\frac{\dot{p}}{\sqrt{-gq}}, = \int\frac{\dot{p}\sqrt{a}}{\sqrt{-g\int\dot{p}\sqrt{1+p^2}) + C}}$.

$$\pm \frac{\sqrt{a}}{\sqrt{-g}} \times \int \frac{\dot{p}}{\sqrt{\int \dot{p}\sqrt{1+p^2}| + \mathrm{C}}}.$$

The greateſt difficulty ſtill remains, viz. the accommodating theſe formulæ, which appear abundantly ſimple, to the particular caſes. It would appear at firſt ſight, that all trajectories are ſimilar; ſince the ratio of the fluxions of the ordinate and abſciſſa correſponding to any particular angle of inclination to the horizon ſeems the ſame in them all: but a due attention to what has been hitherto ſaid on the ſubject will ſhow us that we have as yet only been able to aſcertain the velocity in the point of the trajectory, which has a certain inclination to the horizon, indicated by the quantity p, and the time (reckoned from ſome aſſigned beginning) when the projectile is in that point.

To obtain abſolute meaſures of theſe quantities, the term of commencement muſt be fixed upon. This will be expreſſed by the conſtant quantity C, which is aſſumed for completing the fluent of $\dot{p}\sqrt{1+p^2}$, which is the baſis of the whole conſtruction. We there found $q = \int, \frac{\dot{p}\sqrt{1+p^2}}{a}$. This fluent is in general $q = \frac{\mathrm{C} + \int, \dot{p}\sqrt{1+p^2}}{a}$, and the conſtant quantity C is to be accommodated to ſome circumſtances of the caſe. Different authors have ſelected different circumſtances. Euler, in his Commentary on Robins, and in a diſſertation in the Memoirs of the Academy of Berlin publiſhed in 1753, takes the vertex of the curve for the beginning of his abſciſſa and ordinate. This is the ſimpleſt method of any, for C muſt then be ſo choſen that the whole fluent may vaniſh when $p = o$, which is the caſe in the vertex of the curve, where the tangent is parallel to the horizon. We ſhall adopt this method.

Therefore, let AP (fig. 9.) $= x$, PM $= y$, AM $= z$. Put the quantity C which is introduced into the fluent equal to $\frac{n}{a}$. It is plain that n muſt be a number; for it muſt be homologous with $\dot{p}\sqrt{1+p^2}$, which is a number. For brevity's ſake, let us expreſs the fluent of $\dot{p}\sqrt{1+p^2}$ by the ſingle letter P; and thus we ſhall have $x = a \times \int \frac{\dot{p}}{n+\mathrm{P}}$, $y = a \times \int \frac{p\dot{p}}{n+\mathrm{P}}$, $z = a \times \int \frac{\dot{p}\sqrt{1+p^2}}{n+\mathrm{P}}$. And $v^2 = \frac{-ag(1+p^2)}{n+\mathrm{P}}$. Now the height b neceſſary for communicating any velocity v is $\frac{v^2}{2g} = \frac{-ag(1+p^2)}{2g(n+\mathrm{P})}, = \frac{-\frac{1}{2}a(1+p^2)}{n+\mathrm{P}}$. And laſtly, $t = \frac{\sqrt{a}}{\sqrt{g}} \int \frac{\dot{p}}{\sqrt{n+\mathrm{P}}}$.

Theſe fluents, being all taken ſo as to vaniſh at the vertex, where the computation commences, and where p is $= o$ (the tangent being parallel to the horizon), we obtain in this caſe $b = \frac{\frac{1}{2}a}{n}, = \frac{a}{2n}$, and $n = \frac{a}{2b}$.

Hence we ſee that the circumſtance which modifies all the curves, diſtinguiſhing them from each other, is the velocity (or rather its ſquare) in the higheſt point of the curve. For b being determined for any body whoſe terminal velocity is u, n is alſo determined; and this is the modifying circumſtance. Conſidering it geometrically, it is the area which muſt be cut off from the area DMAP of fig. 8. in order to determine the ordinates of the other curves.

We muſt further remark, that the values now given relate only to that part of the area where the body is deſcending from the vertex. This is evident; for, in order that y may increaſe as we recede from the vertex, its fluxion muſt be taken in the oppoſite ſenſe to what it was in our inveſtigation. *There* we ſuppoſed y to increaſe as the body aſcended, and then to diminiſh during the deſcent; and therefore the fluxion of y was firſt poſitive and then negative.

The ſame equations, however, will ſerve for the aſcending branch CNA of the curve, only changing the ſign of P; for if we conſider y as decreaſing during the aſcent, we muſt conſider q as expreſſing $\frac{-\dot{p}}{\dot{x}}$, and therefore P, or $\int \dot{p}\sqrt{1+p^2}$, which is $= \frac{q}{a}$, muſt be taken negatively. Therefore, in the aſcending branch, we have AQ or x (increaſing as we recede from A) $= a \times \int \frac{\dot{p}}{n-\mathrm{P}}$, QN or $y = a \times \int \frac{p\dot{p}}{n-\mathrm{P}}$, AN or $z = a \times \int \frac{\dot{p}\sqrt{1+p^2}}{n-\mathrm{P}}$, $t = \frac{\sqrt{a}}{\sqrt{g}} \times \int \frac{\dot{p}}{\sqrt{1-\mathrm{P}}}$, and the height producing the velocity at N $= \frac{\frac{1}{2}a(1+p^2)}{n-\mathrm{P}}$.

Hence we learn by the bye, that in no part of the aſcending branch can the inclination of the tangent be ſuch that P ſhall be greater than n; and that if we ſuppoſe P equal to n in any point of the curve, the velocity in that point will be infinite. That is to ſay, there is a certain aſſignable elevation of the tangent which cannot be exceeded in a curve which has this velocity in the vertex. The beſt way for forming a conception of this circumſtance in the nature of the curve, is to invert the motion, and ſuppoſe an accelerating force equal and oppoſite to the reſiſtance, to act on the body in conjunction with gravity. It muſt deſcribe the ſame curve, and this branch ANC muſt have an aſymptote LO, which has this limiting poſition of the tangent. For, as the body deſcends in this curve, its velocity increaſes to infinity by the joint action of gravity and this *accelerating* force, and yet the tangent never approaches ſo near the perpendicular poſition as to make P$=n$. This remarkable property of the curve was known to Newton, as appears by his approximations, which all lead him to curves of a hyperbolic form, having one aſymptote inclined to the horizon. Indeed it is pretty obvious: for the reſiſtance increaſing faſter than the velocity, there is no velocity of projection ſo great but that the curve will come to deviate ſo from the tangent, that in a finite time it will become parallel to the horizon. Were the reſiſtance proportional to the velocity, then an infinite velocity would produce a rectilineal motion, or rather a deflection from it leſs than any that can be aſſigned.

We now ſee that the particular form and magnitude of this trajectory depends on two circumſtances, a and n. a affects chiefly the magnitude. Another circumſtance might indeed be taken in, viz. the diminution of the accelerating force of gravity by the ſtatical effect of the air's gravity. But, as we have already obſerved, this is too trifling to be attended to in military projectiles.

$\frac{\dot{y}}{\dot{x}}$ was made equal to p. Therefore the radius of curvature determined by the ordinary methods, is $\frac{\dot{x}(1+p^2)(\sqrt{1+p^2})}{\dot{p}}$, and becauſe $\frac{\dot{x}}{\dot{p}} = \frac{a}{n+\mathrm{P}}$ for the deſcending branch of the curve, the radius of curvature at M is $\frac{a \times \overline{1+p^2} \times \sqrt{1+p^2}}{n+\mathrm{P}}$, and, in the aſcending branch at N, it is $\frac{a \times \overline{1+p^2} \times \sqrt{1+p^2}}{n-\mathrm{P}}$.

On both ſides therefore, when the velocity is infinitely great, and P by this means ſuppoſed toequal or exceed n, the radius of curvature is alſo infinitely great. We alſo ſee that the two branches are unlike each other, and that when p is the ſame in both, that is, when the tangent is equally inclined to the horizon, the radius of curvature, the ordinate, the abſciſs, and the arch, are all greater in the aſcending branch. This is pretty obvious. For as the reſiſtance acts entirely in diminiſhing the velocity, and does not affect the deflection occaſioned by gravity, it muſt allow gravity to incurvate the path ſo much the more (with the ſame inclination of its line of action) as the velocity is more diminiſhed The curvature, therefore, in thoſe points which have the ſame inclination of the tangent, is greateſt in the deſcending branch, and the motion is ſwifteſt in the aſcending branch. It is otherwiſe in a void, where both ſides are alike. Here u becomes infinite, or there is no terminal velocity; and n alſo becomes infinite, being $= \frac{a}{2b}$.

It is therefore in the quantity P, or $\int \dot{p} \sqrt{1 + p^2}$, that the difference between the trajectory in a void and in a reſiſting medium conſiſts; it is this quantity which expreſſes the accumulated change of the ratio of the increments of the ordinate and abſciſs. In vacuo the ſecond increment of the ordinate is conſtant when the firſt increment of the abſciſſa is ſo, and the whole increment of the ordinate is as $1 + p$. And this difference is ſo much the greater as P is greater in reſpect of n. P is nothing at the vertex, and increaſes along with the angle MTP; and, when this is a right angle, P is infinite. The trajectory in a reſiſting medium will come therefore to deviate infinitely from a parabola, and may even deviate further from it than the parabola deviates from a ſtraight line. That is, the diſtance of the body in a given moment from that point of its parabolic path where it would have been in a void, is greater than the diſtance between that point of the parabola from the point of the ſtraight line where it would have been, independent of the action of gravity. This muſt happen whenever the reſiſtance is greater than the weight of the body, which is generally the caſe in the beginning of the trajectory in military projectiles; and this (were it now neceſſary) is enough to ſhow the inutility of the parabolic theory.

Although we have no method of deſcribing this trajectory, which would be received by the ancient geometers, we may aſcertain ſeveral properties of it, which will aſſiſt us in the ſolution of the problem. In particular, we can aſſign the abſolute length of any part of it by means of the logiſtic curve. For becauſe $P = \int \dot{p} \sqrt{1 + p^2}$, we have $\dot{p} \sqrt{1 + p^2} = \dot{P}$, and therefore z, which was $= a \times \int \frac{\dot{p} \sqrt{1 + p^2}}{\int \dot{p} \sqrt{1 + p^2}} + C$, or $= a \times \int \frac{\dot{P}}{n + P}$, may be expreſſed by logarithms; or $z = a \times$ hyp. log. of $\frac{n + P}{n}$, ſince at the vertex A, where z muſt be $= 0$, P is alſo $= 0$.

Being able, in this way, to aſcertain the length AM of the curve (counted from the vertex), correſponding to any inclination p of the tangent at its extremity M, we can aſcertain the length of any portion of it, ſuch as Mm, by firſt finding the length of the part Am, and then of the part AM. This we do more expeditiouſly thus: Let p expreſs the poſition of the tangent in M, and q its poſition at m; then AM $= a \times \log. \frac{n + P}{n}$ and Am $= a \times \log. \frac{n + Q}{n}$, and therefore M$m$ is $= a \times \log. \frac{n + Q}{n + P}$. Thus we can find the values of a great number of ſmall portions, and the inclination of the tangents at their extremities. Then to each of theſe portions we can aſſign its proportion of the abſciſſa and ordinate, without having recourſe to the values of x and y. For the portion of abſciſs correſponding to the arch Mm, whoſe middle point is inclined to the horizon in the angle b, will be M$m \times$ coſine b, and the correſponding portion of the ordinate will be M $m \times$ ſin. b. Then we obtain the velocity in each part of the curve by the equation $b = \frac{\frac{1}{2} a \times \overline{1 + p^2}}{n + p}$; or, more directly the velocity v at M will be $= \sqrt{\overline{a g}}\, \frac{\sqrt{1 + p^2}}{\sqrt{n + P}}$. Laſtly, divide the length of the little arch by this, and the quotient will be the time of deſcribing M m very nearly. Add all theſe together, and we obtain the whole time of deſcribing the arch AM, but a little too great, becauſe the motion in the ſmall arch is not perfectly uniform. The error, however, may be as ſmall as we pleaſe, becauſe we may make the arch as ſmall as we pleaſe; and for greater accuracy, it will be proper to take the p by which we compute the velocity, a medium between the p for the beginning and that for the end of the arch.

This is the method followed by Euler, who was one of the moſt expert analyſts, if not the very firſt in Europe. It is not the moſt elegant, and the methods of ſome other authors, who approximate directly to the areas of the curves which determine the values of x and y, have a more ſcientific appearance; but they are not ultimately very different: for, in ſome methods, theſe areas are taken piecemeal, as Euler takes the arch; and by the methods of others, who give the value of the areas by Newton's method of deſcribing a curve of the parabolic kind through any number of given points, the ordinates of theſe curves, which expreſs $\dot{x}$ and $\dot{y}$, muſt be taken ſingly, which amounts to the ſame thing, with the great diſadvantage of a much more complicated calculus, as any one may ſee by comparing the expreſſions of $\dot{x}$ and $\dot{y}$ with the expreſſion of z. As to thoſe methods which approximate directly to the areas or values of x and y by an infinite ſeries, they all, without exception, involve us in moſt complicated expreſſions, with coefficients of ſines and tangents, and ambiguous ſigns, and engage us in a calculation almoſt endleſs. And we know of no ſeries which converges faſt enough to give us tolerable accuracy, without ſuch a number of terms as is ſufficient to deter any perſon from the attempt. The calculation of the arches is very moderate, ſo that a perſon tolerably verſant in arithmetical operations may compute an arch with its velocity and time in about five minutes. We have therefore no heſitation in preferring this method of Euler's to all that we have ſeen, and therefore proceed to determine ſome other circumſtances which render its application more general.

If there were no reſiſtance, the ſmalleſt velocity would be at the vertex of the curve, and it would immediately increaſe by the action of gravity conſpiring (in however ſmall degree) with the motion of the body. But, in a reſiſting medium, the velocity at the vertex is diminiſhed by a quantity to which the acceleration of gravity in that point bears no aſſignable proportion. It is therefore diminiſhed, upon the whole, and the point of ſmalleſt velocity is a little way beyond the vertex. For the ſame reaſons, the greateſt curvature is a little way beyond the vertex. It is not very material for our preſent purpoſe to aſcertain the exact poſitions of thoſe points.

The velocity in the deſcending branch augments continually:

but it cannot exceed a certain limit, if the velocity at the vertex has been leſs than the terminal velocity; for when the curve is infinite, p is alſo infinite, and $b = \frac{\frac{1}{2} a p^2}{P}$, becauſe n in this caſe is nothing reſpect of P, which is infinite; and, becauſe p is infinite, the number hyp. log. $\overline{p + \sqrt{1 + p^2}}$, though infinite, vaniſhes in compariſon with $p \times \sqrt{1 + p^2}$; ſo that in this caſe $P = \frac{1}{2} p^2$, and $b = a$, and $v =$ the terminal velocity.

If, on the other hand, the velocity at the vertex has been greater than the terminal velocity, it will diminiſh continually, and when the curve has become infinite, v will be equal to the terminal velocity.

In either caſe we ſee that the curve on this ſide will have a perpendicular aſymptote. It would require a long and pretty intricate analyſis to determine the place of this aſymptote, and it is not material for our preſent purpoſe. The place and poſition of the other aſymptote LO is of the greateſt moment. It evidently diſtinguiſhes the kind of trajectory from any other. Its poſition depends on this circumſtance, that if p mark the poſition of the tangent, $n - P$, which is the denominator of the fraction expreſſing the ſquare of the velocity, muſt be equal to nothing, becauſe the velocity is infinite: therefore, in this place, $P = n$, or $n = \frac{1}{2} p \sqrt{1 + p^2} + \frac{1}{2} \log. \overline{p + \sqrt{1 + p^2}}$. In order, therefore, to find the point L, where the aſymptote LO cuts the horizontal line AL, put $P = n$, then will $AL = x - y\frac{\dot{x}}{\dot{y}}, = a \times \left(\int \frac{\dot{p}}{n - P} - \frac{1}{p} \int \frac{p \dot{p}}{n - P} \right)$.

It is evident that the logarithms uſed in theſe expreſſions are the natural or hyperbolic. But the operations may be performed by the common tables by making the value of the arch Mm of the curve $= \frac{a}{M} \times \log. \frac{n + Q}{n + P}$, &c. where M means the ſubtangent of the common logarithms, or 0,43429; alſo the time of deſcribing this arch will be expeditiouſly had by taking a medium μ between the values of $\frac{\sqrt{1 + p^2}}{\sqrt{n + P}}$ and $\frac{\sqrt{1 + q^2}}{\sqrt{n + Q}}$, and making the time $= \frac{\sqrt{a}}{M\mu \sqrt{g}} \times \log. \frac{n + Q}{n + P}$.

Such then is the proceſs by which the form and magnitude of the trajectory, and the motion in it, may be determined. But it does not yet appear how this is to be applied to any queſtion in practical artillery. In this proceſs we have only learned how to compute the motion from the vertex in the deſcending branch till the ball has acquired a particular direction, and the motion to the vertex from a point of the aſcending branch where the ball has another direction, and all this depending on the greateſt velocity which the body can acquire by falling, and the velocity which it has in the vertex of the curve. But the uſual queſtion is, "What will be the motion of the ball projected in a certain direction with a certain velocity?"

The mode of application is this: Suppoſe a trajectory computed for a particular terminal velocity, produced by the fall a, and for a particular velocity at the vertex, which will be characterized by n, and that the velocity at that point of the aſcending branch where the inclination of the tangent is 30° is 900 feet *per* ſecond. Then, we are certain that if a ball, whoſe terminal velocity is that produced by the fall a, be projected with the velocity of 900 feet per ſecond, and an elevation of 30°, it will deſcribe this very trajectory, and the velocity and time correſponding to every point will be ſuch as is here determined.

Now this trajectory will, in reſpect to form, anſwer an infinity of caſes; for its characteriſtic is the proportion of the velocity in the vertex to the terminal velocity. When this proportion is the ſame, the number n will be the ſame. If therefore we compute the trajectories for a ſufficient variety of theſe proportions, we ſhall find a trajectory that will nearly correſpond to any caſe that can be propoſed; and an approximation ſufficiently exact will be had by taking a proportional medium between the two trajectories which come neareſt to the caſe propoſed.

Accordingly, a ſet of tables or trajectories have been computed by the Engliſh tranſlator of Euler's Commentary on Robins's Gunnery. They are in number 18, diſtinguiſhed by the poſition of the aſymptote of the aſcending branch. This is given for 5°, 10°, 15°, &c. to 85°, and the whole trajectory is computed as far as it can ever be ſuppoſed to extend in practice. The following table gives the value of the number n correſponding to each poſition of the aſymptote.

OLB	n	OLB	n
0	0,00000	45	1,14779
5	0,08760	50	1,43236
10	0,17724	55	1,82207
15	0,27712	60	2,39033
20	0,37185	65	3,29040
25	0,48269	70	4,88425
30	0,60799	75	8.22357
35	0,75382	80	17,54793
40	0,92914	85	67,12291

Since the path of a projectile is much leſs incurvated, and more rapid in the aſcending than in the deſcending branch, and the difference is ſo much the more remarkable in great velocities; it muſt follow, that the range on a horizontal or inclined plane depends moſt on the aſcending branch: therefore the greateſt range will not be made with that elevation which biſects the angle of poſition, but with a lower elevation; and the deviation from the biſecting elevation will be greater as the initial velocities are greater. It is very difficult to frame an exact rule for determining the elevation which gives the greateſt range. We have ſubjoined a little table which gives the proper elevations (nearly) correſponding to the different initial velocities.

It was computed by the following approximation, which will be found the ſame with the ſeries uſed by Newton in his approximations.

Let e be the angle of elevation, a the height producing the terminal velocity, b the height producing the initial velocity, and c the number whoſe hyperbolic logarithm is 1 (*i. e.* the number 2,718). Then,

$$y = x \times \left(\text{tan.}\, e + \frac{a}{2\, b.\, \text{coſ.}\, e} \right) - \frac{a^2}{2b} \left(C^{\frac{x}{a\, \text{coſ.}\, e}} - 1 \right),$$

&c. Make $y = v$, and take the maximum by varying e, we obtain $\frac{1}{\text{Sin.}^2\, e + \frac{a\, \text{ſin.}\, e}{2\, b}} = \text{hyperbol. log.} \left(1 + \frac{2\, b}{a\, \text{ſine}\, c} \right)$, which gives us the angle e.

The numbers in the firſt column, multiplied by the terminal velocity of the projectile, give us the initial velocity; and the numbers in the laſt column, being multiplied by the height producing the terminal velocity, and by 2,3026, give us the greateſt ranges. The middle column contains the elevation. The table is not computed with ſcrupulous exactneſs, the queſtion not requiring it. It may however be depended on within one part of 2000.

To make uſe of this table, divide the initial velocity by the terminal velocity u, and look for the quotient in the firſt column. Oppoſite to this will be found the elevation giving the greateſt range; and the number in the laſt column being multiplied by 2,3026 × *a* (the height producing the terminal velocity) will give the range.

TABLE *of Elevations giving the greateſt Range.*

$\frac{\text{Initial vel.}}{u}$.	Elevation	$\frac{\text{Range.}}{2{,}3026a}$,
0,6909	43°.40′	0,1751
0,7820	43 .20	0,2169
0,8645	42 .50	0,2518
1,3817	41 .40	0,4999
1.5641	40 .20	0,5789
1,7291	40 .10	0,6551
2,0726	39 .50	0,7877
2,3461	37 .20	0,8967
2,5036	35 .50	0,9752
2.7635	35 .—	1,0319
3,1281	34 .40	1,1411
3,4544	34 .20	1,2298
3,4581	34 .20	1,2277
3.9101	33 .50	1,3371
4,1452	33 .30	1,3901
4.3227	33 .30	1,4274
4,6921	31 .50	1,5050
4,8361	31 .50	1,5341

Such is the ſolution which the preſent ſtate of our mathematical knowledge enables us to give of this celebrated problem. It is exact in its principle. and the application of it is by no means difficult, or even operoſe. But let us ſee what advantage we are likely to derive from it.

In the firſt place, it is very limited in its application. There are few circumſtances of general coincidence, and almoſt every caſe requires an appropriated calculus. Perhaps the only general rules are the two following:

1. Balls of equal denſity, projected with the ſame elevation, and with velocities which are as the ſquare-roots of their diameters, will deſcribe ſimilar curves. This is evident, becauſe, in this caſe, the reſiſtance will be in the ratio of their quantities of motion. Therefore all the homologous lines of the motion will be in the proportion of the diameters.

2. If the initial velocities of balls projected with the ſame elevation are in the inverſe ſubduplicate ratio of the whole reſiſtances, the ranges, and all the homologous lines of their track, will be inverſely as thoſe reſiſtances.

Theſe theorems are of conſiderable uſe: for, by means of a proper ſeries of experiments on one ball projected with different elevations and velocities, tables may be conſtructed which will aſcertain the motions of an infinity of others.

But when we take a retroſpective view of what we have done, and conſider the conditions which were aſſumed in the ſolution of the problem, we ſhall find that much yet remains before it can be rendered of great practical uſe, or even ſatisfy the curioſity of the man of ſcience. The reſiſtance is all along ſuppoſed to be in the duplicate ratio of the velocity; but even theory points out many cauſes of deviation from this law, ſuch as the preſſure and condenſation of the air, in the caſe of very ſwift motions; and Mr. Robins's experiments are ſufficient to ſhow us that the deviations muſt be exceedingly great in ſuch caſes. Mr. Euler and all ſubſequent writers have allowed that it may be three times greater, even in caſes which frequently occur; and Euler gives a rule for aſcertaining with tolerable accuracy what this increaſe and the whole reſiſtance may amount to. Let H be the height of a column of air whoſe weight is equivalent to the reſiſtance taken in the duplicate ratio of the velocity. The whole reſiſtance will be expreſſed by $H + \frac{H^2}{28845}$. This number 28845 is the height in feet of a column of air whoſe weight balances its elaſticity. We ſhall not at preſent call in queſtion his reaſons for aſſigning this preciſe addition. They are rather reaſons of arithmetical conveniency than of phyſical import. It is enough to obſerve, that if this meaſure of the reſiſtance is introduced into the proceſs of inveſtigation, it is totally changed; and it is not too much to ſay, that with this complication it requires the knowledge and addreſs of a Euler to make even a partial and very limited approximation to a ſolution.—Any law of the reſiſtance, therefore, which is more complicated than what Bernoulli has aſſumed, namely, that of a ſimple power of the velocity, is abandoned by all the mathematicians, as exceeding their abilities; and they have attempted to avoid the error ariſing from the aſſumption of the duplicate ratio of the velocity, either by ſuppoſing the reſiſtance throughout the whole trajectory to be greater than what it is in general, or they have divided the trajectory into different portions, and aſſigned different reſiſtances to each, which vary, through the whole of that portion, in the duplicate ratio of the velocities. By this kind of patch-work they make up a trajectory and motion which correſponds, in ſome tolerable degree, with what? With an accurate theory? No; but with a ſeries of experiments. For, in the firſt place, every theoretical computation that we make, proceeds on a ſuppoſed initial velocity; and this cannot be aſcertained with any thing approaching to preciſion, by any theory of the action of gun-powder that we are yet poſſeſſed of. In the next place, our theories of the reſiſting power of the air are entirely eſtabliſhed on the experiments on the flights of ſhot and ſhells, and are corrected and amended till they tally with the moſt approved experiments we can find. We do not learn the ranges of a gun by theory, but the theory by the range of the gun. Now the variety and irregularity of all the experiments which are appealed to are ſo great, and the acknowledged difference between the reſiſtance to ſlow and ſwift motions is alſo ſo great, that there is hardly any ſuppoſition which can be made concerning the reſiſtance, that will not agree in its reſults with many of thoſe experiments. It appears from the experiments of Dr. Hutton of Woolwich, in 1784, 1785, and 1786, that the ſhots frequently deviated to the right or left of their intended track 200, 300, and ſometimes 400 yards. This deviation was quite accidental and anomalous, and there can be no doubt but that the ſhot deviated from its intended and *ſuppoſed* elevation as much as it deviated from the intended vertical plane, and this without any opportunity of meaſuring or diſcovering the deviation. Now, when we have the whole range from one to three to chooſe among for our meaſure of reſiſtance, it is evident that the confirmations which have been drawn from the ranges of ſhot are but feeble arguments for the truth of any opinion. Mr. Robins finds his meaſures fully confirmed by the experiments at Metz and at Minorca. Mr. Muller finds the ſame. Yet Mr. Robins's meaſure both of the initial velocity and of the reſiſtance are at leaſt treble of Mr. Muller's; but by compenſation they give the ſame reſults. The chevalier Borda, a very expert mathematician, has adduced the very ſame experiments in ſupport of his theory, in which he abides by the Newtonian meaſure of the reſiſtance, which is about $\frac{1}{3}$ of Mr. Robins's, and about $\frac{3}{2}$ of Muller's.

What are we to conclude from all this? Simply this, that we have hardly any knowledge of the air's reſiſtance, and that even the ſolution given of this problem has not as yet greatly increaſed it. Our knowledge conſiſts only in thoſe experiments, and mathematicians are attempting to patch up ſome notion of the motion of a body in a reſiſting medium, which ſhall tally with them.

There is another eſſential defect in the conditions aſſumed in the ſolution. The denſity of the air is ſuppoſed uniform; whereas we are certain that it is leſs by one-fifth or one-ſixth towards the vertex of the curve, in many caſes which frequently occur, than it is at the beginning and end of the flight. This is another latitude given to authors in their aſſumptions of the air's reſiſtance. The chevalier de Borda has, with conſiderable ingenuity, accommodated his inveſtigation to this circumſtance, by dividing the trajectory into portions, and, without much trouble, has made one equation anſwer them all. We are diſpoſed to think that his ſolution of the problem (in the Memoirs of the Academy of Paris for 1769) correſponds better with the phyſical circumſtances of the caſe than any other. But his proceſs is there delivered in too conciſe a manner to be intelligible to a perſon not perfectly familiar with all the reſources of modern analyſis. We therefore preferred John Bernoulli's, becauſe it is elementary and rigorous.

After all, the practical artilleriſt muſt rely chiefly on the records of experiments contained in the books of practice at the academies, or thoſe made in a more public manner. Even a perfect theory of the air's reſiſtance can do him little ſervice, unleſs the force of gunpowder were uniform. This is far from being the caſe even in the ſame powder. A few hours of a damp day will make a greater difference than occurs in any theory; and, in ſervice, it is only by trial that every thing is performed. If the firſt ſhell falls very much ſhort of the mark, a little more powder is added; and, in cannonading, the correction is made by varying the elevation.

We hope to be forgiven by the eminent mathematicians for theſe obſervations on their theories. They by no means proceed from any diſreſpect for their labours. We are not ignorant of the almoſt inſuperable difficulty of the taſk, and we admire the ingenuity with which ſome of them have contrived to introduce into their analyſis reaſonable ſubſtitutions for thoſe terms which would render the equations intractable. But we muſt ſtill ſay upon their own authority, that theſe are but ingenious gueſſes, and that experiment is the touchſtone by which they mould theſe ſubſtitutions; and when they have found a coincidence, they have no motive to make any alteration. Now, when we have ſuch a latitude for our meaſure of the air's reſiſtance, that we may take it of any value, from one to three, it is no wonder that compenſations of errors ſhould produce a coincidence; but where is the coincidence? The theoriſt *ſuppoſes* the ball to ſet out with a certain velocity, and his theory gives a certain range; and this range agrees with obſervation—but how? Who knows the velocity of the ball in the experiment? This is concluded from a theory incomparably more uncertain that of the motion in a reſiſting medium.

The experiments of Mr. Robins and Dr. Hutton ſhow, in the moſt incontrovertible manner, that the reſiſtance to a motion exceeding 1100 feet in a ſecond, is almoſt *three times* greater than in the duplicate ratio to the reſiſtance to moderate velocities. Euler's tranſlator, in his compariſon of the author's trajectories with experiment, ſuppoſes it to be *no* greater. Yet the coincidence is very great. The ſame may be ſaid of the chevalier de Borda's. Nay, the ſame may be ſaid of Mr. Robins's own practical rules; for he makes his F, which correſponds to our *a*, almoſt double of what theſe authors do, and yet his rules are confirmed by practice. Our obſervations are therefore well founded.

But it muſt not be inferred from all this, that the phyſical theory is of no uſe to the practical artilleriſt. It plainly ſhows him the impropriety of giving the projectile an enormous velocity. This velocity is of no effect after 200 or 300 yards at furtheſt, becauſe it is ſo rapidly reduced by the prodigious reſiſtance of the air. Mr. Robins has deduced ſeveral practical maxims of the greateſt importance from what we already know of this ſubject, and which could hardly have been even conjectured without this knowledge. See GUNNERY.

And it muſt ſtill be acknowledged, that this branch of phyſical ſcience is highly intereſting to the philoſopher; nor ſhould we deſpair of carrying it to greater perfection. The defects ariſe almoſt entirely from our ignorance of the law of variation of the air's reſiſtance. Experiments may be contrived much more conducive to our information here than thoſe commonly reſorted to. The oblique flights of projectiles are, as we have ſeen, of very complicated inveſtigation, and ill fitted for inſtructing us; but numerous and well contrived experiments on the perpendicular aſcents are of great ſimplicity, being affected by nothing but the air's reſiſtance. To make them inſtructive, we think that the following plan might be purſued. Let a ſet of experiments be premiſed for aſcertaining the initial velocities. Then let ſhells be diſcharged perpendicularly with great varieties of denſity and velocity, and let nothing be attended to but the height and the time; even a conſiderable deviation from the perpendicular will not affect either of theſe circumſtances, and the effect of this circumſtance can eaſily be computed. The height can be aſcertained with ſufficient preciſion for very valuable information by their light or ſmoke. It is evident that theſe experiments will give *direct* information of the air's retarding force; and every experiment gives us two meaſures, viz. the aſcent and deſcent: and the compariſon of the times of aſcent and deſcent, combined with the obſerved height in one experiment made with a great initial velocity, will give us more information concerning the air's reſiſtance than 50 ranges. If we ſhould ſuppoſe the reſiſtance as the ſquare of the velocity, this compariſon will give in each experiment an exact determination of the initial and final velocities, which no other method can give us. Theſe, with experiments on the *time* of horizontal flights, with known initial velocities, will give us more inſtruction on this head than any thing that has yet been done; and till ſomething of this kind is carefully done, we preſume to ſay that the motion of bodies in a reſiſting medium will remain in the hands of the mathematicians as a matter of curious ſpeculation. In the mean time, the rules which Mr. Robins has delivered in his Gunnery are very ſimple and eaſy in their uſe, and ſeem to come as near the truth as any we have met with. He has not informed us upon what principles they are founded, and we are diſpoſed to think that they are rather empirical than ſcientific. But we profeſs great deference for his abilities and penetration, and doubt not but that he had framed them by means of as ſcientific a diſcuſſion as his knowledge of this new and difficult ſubject enabled him to give it.

We ſhall conclude this article by giving two or three tables, computed from the principles eſtabliſhed above, and which ſerve to bring into one point of view the chief circumſtances of the motion in a reſiſting medium. Although the reſult of much calculation, as any perſon who conſiders the ſubject will readily ſee, they muſt not be conſidered as offering any very accurate reſults; or that, in compariſon with one or two experiments, the differences ſhall not be conſiderable. Let any perſon peruſe the publiſhed regiſters of experiments which have been made with every attention, and he will ſee ſuch enormous irregularities, that all expectations of perfect agreement with them muſt ceaſe. In the experiments at Woolwich 1735, which were continued for ſeveral days, not only do the experiments of one day differ among themſelves, but the mean of all the experiments of one day differs from the mean of all the experiments of another no leſs than one fourth of the whole. The experiments in which the greateſt regularity may be expected. are thoſe made with great elevations. When the elevation is ſmall, the range is more affected by a change of velocity, and ſtill more by any deviation from the ſuppoſed or intended direction of the ſhot.

The firſt table ſhows the diſtance in yards to which a ball projected with the velocity 1600 will go, while its velocity is reduced one tenth, and the diſtance at which it drops 16 feet from the line of its direction. This table is calculated by the reſiſtance obſerved in Mr. Robins's experiments. The firſt column is the weight of the ball in pounds. The ſecond column remains the ſame whatever be the initial velocity; but the third column depends on the velocity. It is here given for the velocity which is very uſual in military ſervice, and its uſe is to aſſiſt us in directing the gun to the mark.—If the mark at which a ball of 24 pounds is directed be 474 yards diſtant, the axis of the piece muſt be pointed 16 feet higher than the mark. Theſe deflections from the line of direction are nearly as the ſquares of the diſtances.

I.	II	III.
2	92	420
4	121	428
9	159	456
18	200	470
32	272	479

The next table contains the ranges in yards of a 24-pound ſhot, projected at an elevation of 45°, with the different velocities in feet per ſecond, expreſſed in the firſt column. The ſecond column contains the diſtances to which the ball would go in vacuo in a horizontal plane; and the third contains the diſtances to which it will go through the air. The fourth column is added, to ſhow the height to which it riſes in the air; and the fifth ſhows the ranges corrected for the diminution of the air's denſity as the bullet aſcends, and may therefore be called the *corrected range.*

I.	II.	III.	IV.	V.
200	416	349	106	360
400	1664	1121	338	1150
600	3740	1812	606	1859
800	6649	2373	866	2435
1000	10390	2845	1138	2919
1200	14961	3259	1378	3343
1400	20364	3640	1606	3734
1600	26597	3950	1814	4050
1800	33663	4235	1992	4345
2000	41559	4494	2168	4610
2200	50286	4720	2348	4842
2400	59846	4917	2460	5044
2600		5106	2630	5238
2800		5293	2762	5430
3000		5455	2862	5596
3200				5732

The initial velocities can never be puſhed as far as we have calculated for in this table; but we mean it for a table of more extenſive uſe than appears at firſt ſight. Recollect, that while the proportion of the velocity at the vertex to the terminal velocity remains the ſame, the curves will be ſimilar: therefore, if the initial velocities are as the ſquare-roots of the diameters of the balls, they will deſcribe ſimilar curves, and the ranges will be as the diameters of the balls.

Therefore, to have the range of a 12-pound ſhot, if projected at an elevation of 45, with the velocity 1500; ſuppoſe the diameter of the 12 pounder to be *d*, and that of the 24 pounder D; and let the velocities be *v* and V: Then ſay, $\sqrt{d} : \sqrt{D} = 1500$, to a fourth proportional V. If the 24 pounder be projected with the velocity V, it will deſcribe a curve ſimilar to that deſcribed by the 12 pounder, having the initial velocity 1500. Therefore find (by interpolation) the range of the 24 pounder having the initial velocity V. Call this R. Then $D : d = R : r$, the range of the 12 pounder which was wanted, and which is nearly 3380 yards.

We ſee by this table the immenſe difference between the motions through the air and in a void. We ſee that the ranges through the air, inſtead of increaſing in the duplicate ratio of the initial velocities, really increaſe ſlower than thoſe velocities in all caſes of military ſervice; and in the moſt uſual caſes, viz. from 800 to 1600, they increaſe nearly as the ſquare-roots of the velocities.

A ſet of ſimilar tables, made for different elevations, would almoſt complete what can be done by theory, and would be much more expeditious in their uſe than Mr. Euler's Trajectories computed with great labour by his Engliſh tranſlator.

The ſame table may alſo ſerve for computing the ranges of bomb-ſhells. We have only to find what muſt be the initial velocity of the 24-pound ſhot which correſponds to the propoſed velocity of the ſhell. This muſt be deduced from the diameter and weight of the ſhell, by making the velocity of the 24 pounder ſuch, that the ratio of its weight to the reſiſtance may be the ſame as in the ſhell.

That the reader may ſee with one glance the relation of thoſe different quantities, we have given this table, expreſſed in a figure (fig. 10). The abſciſſa, or axis DA, is the ſcale of the initial velocities in feet per ſecond, meaſured on a ſcale of 400 equal parts in an inch. The ordinates to the curve ACG expreſs the yards of the range on a ſcale containing 800 yards in an inch. The ordinates to the curve A $x\,y$ expreſs (by the ſame ſcale) the height to which the ball riſes in the air.

The ordinate BC (drawn through the point of the abſciſſa which correſponds to the initial velocity 2000) is divided in the points 4, 9, 12, 18, 24, 32, 42, in the ratio of the diameters of cannon ſhot of different weights; and the ſame ordinate is produced on the other ſide of the axis, till BO be equal to BA; and then BO is divided in the ſubduplicate ratio of the ſame diameters. Lines are drawn from the point A, and from any point D of the abſciſſa, to theſe diviſions.

We ſee diſtinctly by this figure how the effect of the initial velocity gradually diminiſhes, and that in very great velocities the range is very little increaſed by its augmentation. The dotted curve APQR ſhows what the ranges in vacuo would be.

By this figure may the problems be ſolved. Thus, to find the range of the 12 pounder, with the initial velocity 1500. Set off 1500 from B to F; draw FH parallel to the axis, meeting the line 12 A in H; draw the ordinate HK; draw KL parallel to the axis, meeting 24 B in L; draw the ordinate LM, cutting 12 B in N. MN is the range required.

If curves, ſuch as ACG, were laid down in the ſame manner for other elevations, all the problems might be ſolved with great diſpatch and with much more accuracy than the theory by which the curves are drawn can pretend to.

PROJECTILES.

PL. 22. VOL. VIII.

Fig. 1.

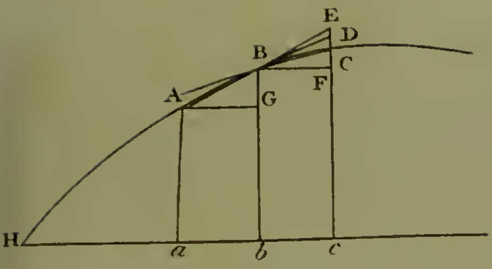


Fig. 3.

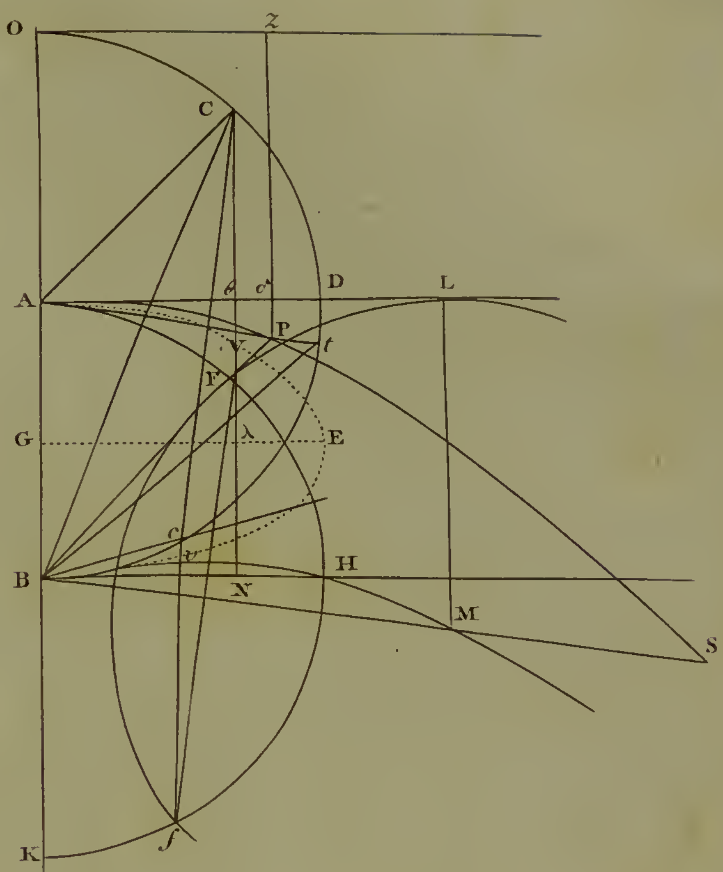


Fig. 2.

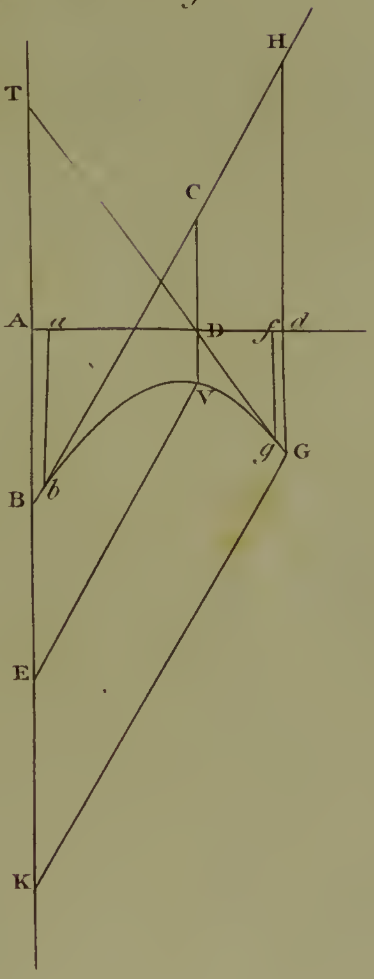


Fig. 4.

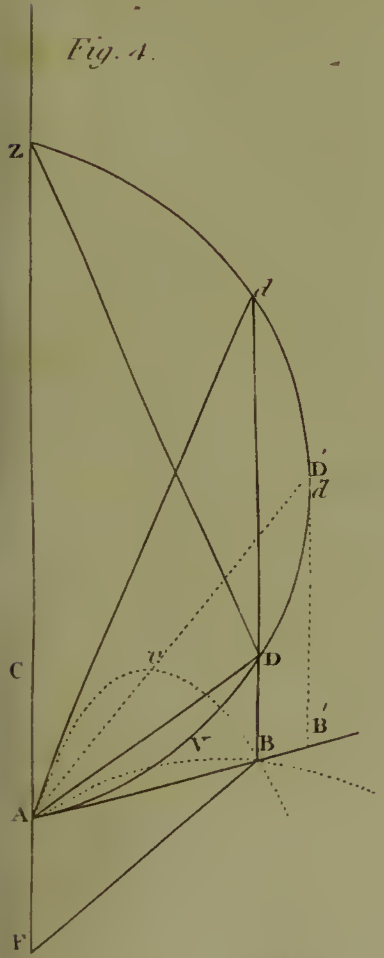


Fig. 5.

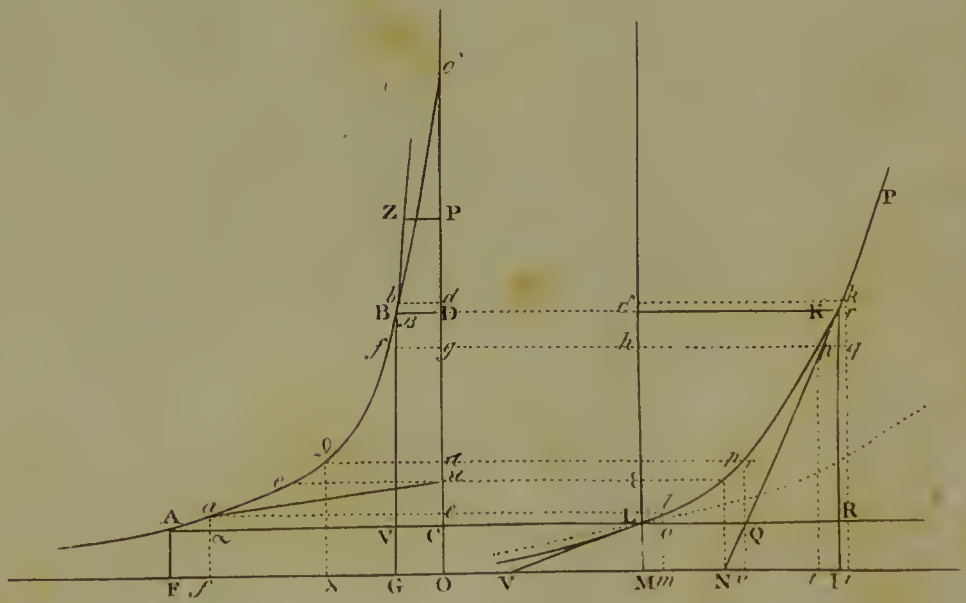


Fig. 6.

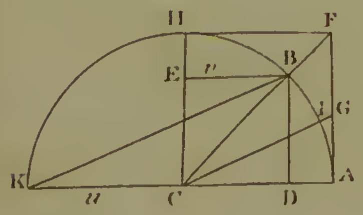
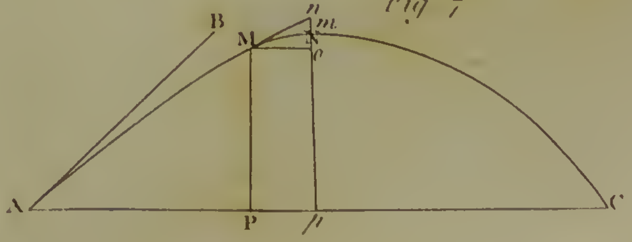


Fig. 7.



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PROJECTILES.

Fig. 8.

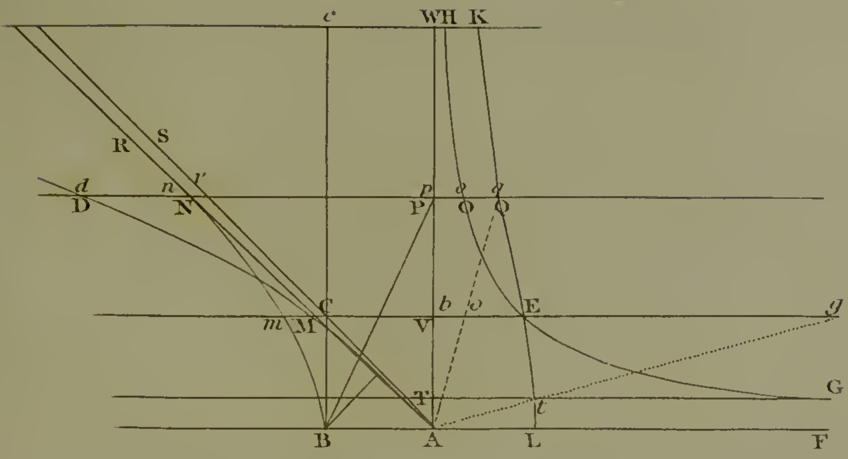


Fig. 9.

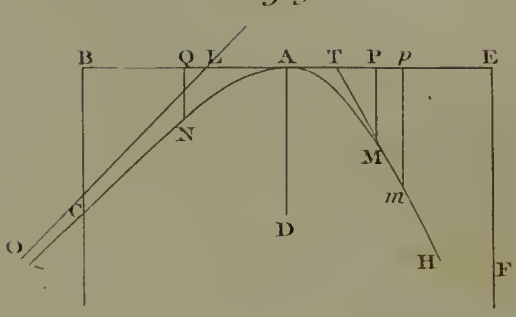
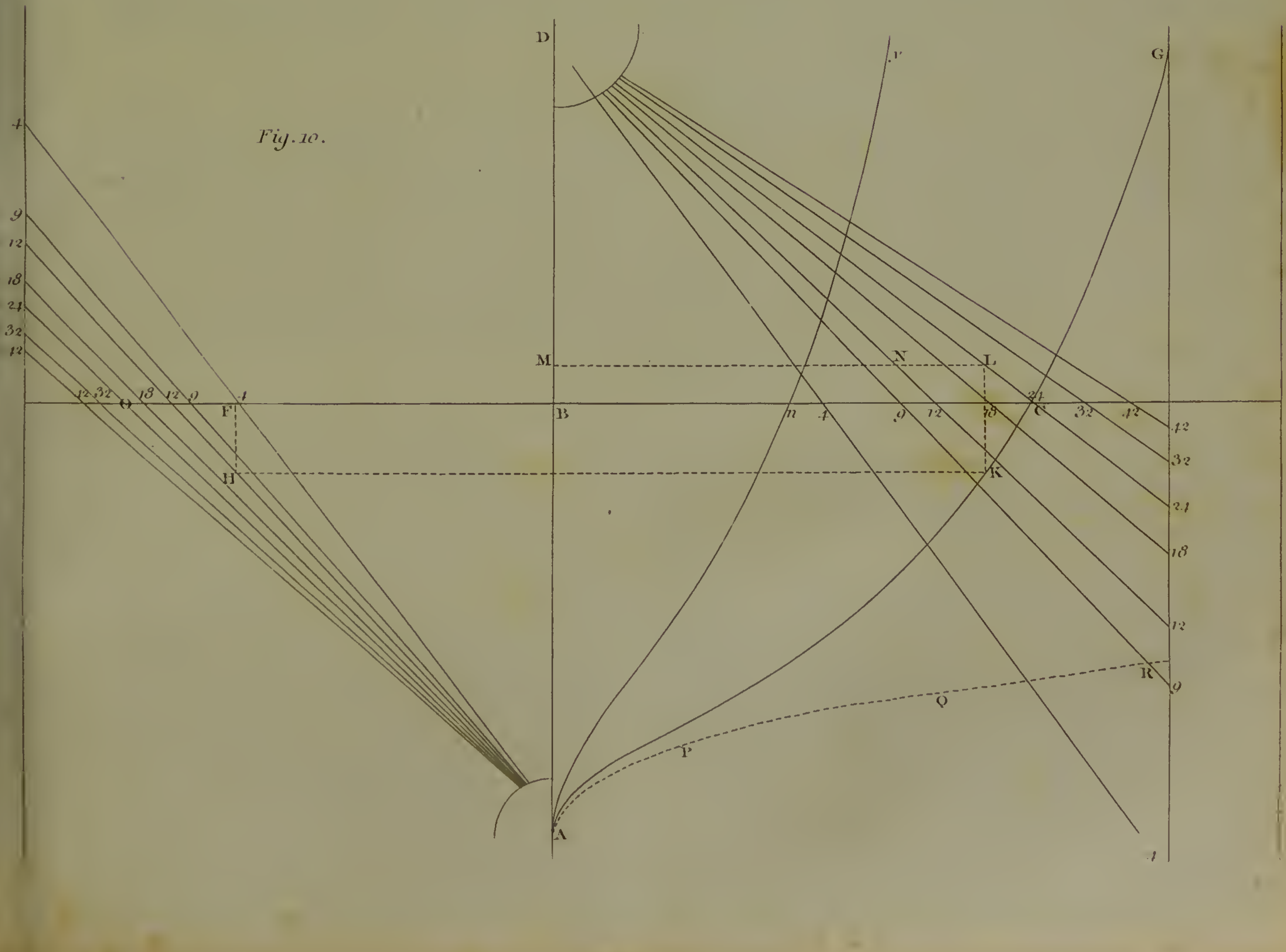


Fig. 10.



PROJECTION OF THE SPHERE.

THE PROJECTION of the SPHERE is a perſpective repreſentation of the circles on the ſurface of the ſphere; and is variouſly denominated according to the different poſitions of the eye and plane of projection.

There are three principal kinds of projection; the *ſtereographic*, the *orthographic*, and *gnomonic*. In the ſtereographic projection the eye is ſuppoſed to be placed on the ſurface of the ſphere; in the orthographic it is ſuppoſed to be at an infinite diſtance; and in the gnomonic projection the eye is placed at the centre of the ſphere. Other kinds of projection are, the *globular*, *Mercator's*, *ſcenographic*, &c. for which ſee the articles GEOGRAPHY, NAVIGATION, PERSPECTIVE, &c.

DEFINITIONS.

1. The plane upon which the circles of the ſphere are deſcribed, is called the *plane of projection*, or the *primitive circle*. The pole of this circle is the *pole of projection*, and the place of the eye is the *projecting point*.

2. The *line of meaſures* of any circle of the ſphere is that diameter of the primitive, produced indefinitely, which paſſes through the centre of the projected circle.

AXIOM.

The projection, or repreſentation of any point, is where the ſtraight line drawn from it to the projecting point interſects the plane of projection.

SECTION I.

Of the Stereographic Projection of the Sphere.

IN the ſtereographic projection of the ſphere, the eye is placed on the ſurface of the ſphere in the pole of the great circle upon which the ſphere is to be projected. The projection of the hemiſphere oppoſite to the eye falls within the primitive, to which this projection is generally limited: it, however, may be extended to the other hemiſphere, or that wherein the eye is placed, the projection of which falls without the primitive.

As all circles in this projection are projected either into circles or ſtraight lines, which are eaſily deſcribed, it is therefore more generally underſtood, and by many preferred to the other projections.

PROPOSITION I. THEOREM I.

Every great circle which paſſes through the projecting point is projected into a ſtraight line paſſing through the centre of the primitive; and every arch of it, reckoned from the other pole of the primitive, is projected into its ſemitangent.

Let ABCD (pl. 23, fig. 1.) be a great circle paſſing through A, C, the poles of the primitive, and interſecting it in the line of common ſection BED, E being the centre of the ſphere. From A, the projecting point, let there be drawn ſtraight lines AP, AM, AN, AQ, to any number of points P, M, N, Q, in the circle ABCD: theſe lines will interſect BED, which is in the ſame plane with them. Let them meet it in the points p, m, n, q; then p, m, n, q, are the projections of P, M, N, Q: hence the whole circle ABCD is projected into the ſtraight line BED, paſſing through the centre of the primitive.

Again, becauſe the pole C is projected into E, and the point M into m; therefore the arch CM is projected into the ſtraight line E m, which is the ſemitangent of the arch CM to the radius AE. In like manner the arch CP is projected into its ſemitangent E p, &c.

COROLLARIES.

1. Each of the quadrants contiguous to the projecting point is projected into an indefinite ſtraight line, and each of thoſe that are remote into a radius of the primitive.

2. Every ſmall circle which paſſes through the projecting point is projected into that ſtraight line which is its common ſection with the primitive.

3. Every ſtraight line in the plane of the primitive, and produced indefinitely, is the projection of ſome circle on the ſphere paſſing through the projecting point.

4. The projection of any point in the ſurface of the ſphere, is diſtant from the centre of the primitive, by the ſemitangent of the diſtance of that point from the pole oppoſite to the projecting point.

PROPOSITION II. THEOREM II.

Every circle on the ſphere which does not paſs through the projecting point is projected into a circle.

If the given circle be parallel to the primitive, then a ſtraight line drawn from the projecting point to any point in the circumference, and made to revolve about the circle, will deſcribe the ſurface of a cone; which being cut by the plane of projection parallel to the baſe, the ſection will be a circle. See CONIC-*Sections*.

But if the circle MN (fig. 2.) be not parallel to the primitive circle BD, let the great circle ABCD, paſſing through the projecting point, cut it at right angles in the diameter MN, and the primitive in the diameter BD. Through M, in the plane of the great circle, let MF be drawn parallel to BD; let AM, AN be joined, and meet BD in m, n. Then, becauſe AB, AD are quadrants, and BD, MF parallel, the arch AM is equal to AF, and the angle AMF or Amn is equal to ANM. Hence the conic ſurface deſcribed by the revolution of AM about the circle MN is cut by the primitive in a ſubcontrary poſition; therefore the ſection is in this caſe likewiſe a circle.

COROLLARIES.

1. The centres and poles of all circles parallel to the primitive have their projections in its centre.

2. The centre and poles of every circle inclined to the primitive have their projections in the line of meaſures.

3. All projected great circles cut the primitive in two points diametrically oppoſite; and every circle in the plane of projection, which paſſes through the extremities of a diameter of the primitive, or through the projections of two points that are diametrically oppoſite on the ſphere, is the projection of ſome great circle.

4. A tangent to any circle of the ſphere, which does not paſs through the projecting point, is projected into a tangent to that circle's projection: alſo, the circular projections of tangent circles touch one another.

5. The extremities of the diameter, on the line of meaſures of any projected circle, are diſtant from the centre of the primitive by the ſemitangents of the leaſt and greateſt diſtances of the circle on the ſphere, from the pole oppoſite to the projecting point.

6. The extremities of the diameter, on the line of meaſures of any projected great circle, are diſtant from the centre of the

primitive by the tangent and cotangent of half the great circle's inclination to the primitive.

7. The radius of any projected circle is equal to half the ſum, or half the difference of the ſemitangents of the leaſt and greateſt diſtances of the circle from the pole oppoſite to the projecting point, according as that pole is within or without the given circle.

PROPOSITION III. THEOREM III.

An angle formed by two tangents at the ſame point in the ſurface of the ſphere, is equal to the angle formed by their projections.

Let FGI and GH (fig. 3.) be the two tangents, and A the projecting point; let the plane AGF cut the ſphere in the circle AGL, and the primitive in the line BML. Alſo, let MN be the line of common ſection of the plane AGH with the primitive: then the angle FGH = LMN. If the plane FGH be parallel to the primitive BLD, the propoſition is manifeſt. If not, through any point K in AG produced, let the plane FKH, parallel to the primitive, be extended to meet FGH in the line FH. Then, becauſe the plane AGF meets the two parallel planes BLD, FKH, the lines of common ſection LM, FK are parallel; therefore the angle AML = AKF. But ſince A is the pole of BLD, the chords, and conſequently the arches AB AL, are equal, and the arch ABG is the ſum of the arches AL, BG; hence the angle AML is equal to an angle at the circumference ſtanding upon AG, and therefore equal to AGI or FGK; conſequently the angle FGK = FKG, and the ſide FG = FK. In like manner HG = HK; hence the triangles GHF, KHF are equal, and the angle FGH = FKH = LMN.

COROLLARIES.

1. An angle contained by any two circles of the ſphere is equal to the angle formed by their projections. For the tangents to theſe circles on the ſphere are projected into ſtraight lines, which either coincide with, or are tangents to, their projections on the primitive.

2. An angle contained by any two circles of the ſphere is equal to the angle formed by the radii of their projections at the point of interſection.

PROPOSITION IV. THEOREM IV.

The centre of a projected great circle is diſtant from the centre of the primitive; the tangent of the inclination of the great circle to the primitive, and its radius, is the ſecant of its inclination.

Let MNG (fig. 4.) be the projection of a great circle meeting the primitive in the extremities of the diameter MN, and let the diameter BD, perpendicular to MN, meet the projection in F, G. Biſect FG in H, and join NH. Then, becauſe any angle contained by two circles of the ſphere is equal to the angle formed by the radii of their projections at the point of interſection; therefore the angle contained by the propoſed great circle and the primitive is equal to the angle ENH, of which EH is the tangent, and NH the ſecant, to the radius of the primitive.

COROLLARIES.

1. All circles which paſs through the points M, N are the projections of great circles, and have their centres in the line BG; and all circles which paſs through the points F, G are the projections of great circles, and have their centres in the line HI, perpendicular to BG.

2. If NF, NH be continued to meet the primitive in L, F; then BL is the meaſure of the great circle's inclination to the primitive; and MT = 2BL.

PROPOSITION V. THEOREM V.

The centre of projection of a leſs circle perpendicular to the primitive, is diſtant from the centre of the primitive, the ſecant of the diſtance of the leſs circle from its neareſt pole; and the radius of projection is the tangent of that diſtance.

Let MN (fig. 5.) be the given leſs circle perpendicular to the primitive, and A the projecting point. Draw AM, AN to meet the diameter BD produced in G and H; then GH is the projected diameter of the leſs circle: biſect GH in C, and C will be its centre; join NE, NC. Then becauſe AE, NI are parallel, the angle INE = NEA; but NEA = 2NMA = 2NHG = NCG: hence ENC = INE + INC = NCG + INC = a right angle; and therefore NC is a tangent to the primitive at N; but the arch ND is the diſtance of the leſs circle from its neareſt pole D: hence NC is the tangent, and EC the ſecant of the diſtance of the leſs circle from its pole to the radius of the primitive.

PROPOSITION VI. THEOREM VI.

The projection of the poles of any circle, inclined to the primitive, are, in the line of meaſures, diſtant from the centre of the primitive, the tangent, and cotangent, of half its inclination.

Let MN (fig. 6.) be a great circle perpendicular to the primitive ABCD, and A the projecting point; then P, *p* are the poles of MN, and of all its parallels *m m*, &c. Let AP, A *p* meet the diameter BD in F *f* which will therefore be the projected poles of MN and its parallels. The angle BEM is the inclination of the circle MEN, and its parallels, to the primitive: and becauſe BC and MP are quadrants, and MC common to both; therefore PC = BM: and hence PEC is alſo the inclination of MN and its parallels. Now EF is the tangent of EAF, or of half the angle PEC the inclination; and E *f* is the tangent of the angle EA *f* but EA *f* is the complement of EAF, hence E *f* is the cotangent of half the inclination.

COROLLARIES.

1. The projection of that pole which is neareſt to the projecting point is without the primitive, and the projection of the other within.

2. The projected centre of any circle is always between the projection of its neareſt pole and the centre of the primitive; and the projected centres of all circles are contained between their projected poles.

PROPOSITION VII. THEOREM VII.

Equal arches of any two great circles of the ſphere will be intercepted between two other circles drawn on the ſphere through the remote poles of thoſe great circles.

Let AGB, CFD (fig. 7.) be two great circles of the ſphere, whoſe remote poles are E, P; through which draw the great circle PBEC, and leſs circle PGE, interſecting the great circles AGB, CFD, in the points B, G, and D, F; then the arch BG is equal to the arch DF.

Becauſe E is the pole of the circle AGB, and P the pole of CFD, therefore the arches EB, PD are equal; and ſince BD is common to both, hence the arch ED is equal to the arch PB. For the ſame reaſon, the arches EF, PG are equal; but the angle DEF is equal to the angle BPG: hence theſe triangles are equal, and therefore the arch DF is equal to the arch BG.

PROPOSITION VIII. THEOREM VIII.

If from either pole of a projected great circle, two ſtraight lines be drawn to meet the primitive and the projection, they will intercept ſimilar arches of theſe circles.

On the plane of projection AGB (fig. 7.) let the great circle CFD be projected into $c f d$ and its pole P into p; through p draw the ſtraight lines $p\ d$, $p f$, then are the arches GB, $f d$ ſimilar.

Since pd lies both in the plane AGB and APBE, it is in their common ſection, and the point B is alſo in their common ſection; therefore pd paſſes through the point B. In like manner it may be ſhown that the line $p f$ paſſes through G. Now the points D, F are projected into $d f$: hence the arches FD, $f d$ are ſimilar; but GB is equal to FD, therefore the intercepted arch of the primitive GB is ſimilar to the projected arch $f d$.

COROLLARY.

Hence, if from the angular point of a projected ſpherical angle two ſtraight lines be drawn through the projected poles of the containing ſides, the intercepted arch of the primitive will be the meaſure of the ſpherical angle.

PROPOSITION IX. PROBLEM I.

To deſcribe the projection of a great circle through two given points in the plane of the primitive.

Let P and B be given points, and C the centre of the primitive.

1. When one point P (fig. 8.) is the centre of the primitive, a diameter drawn through the given points will be the great circle required.

2. When one point P (fig. 9.) is in the circumference of the primitive. Through P draw the diameter PD; and an oblique circle deſcribed through the three points P, B, D, will be the projection of the required great circle.

3. When the given points are neither in the centre nor circumference of the primitive. Through either of the given points P (fig. 10) draw the diameter ED, and at right angles thereto draw the diameter FG. From F through P draw the ſtraight line FPH, meeting the circumference in H: draw the diameter HI and draw the ſtraight line FIK, meeting ED produced in D; then an arch, terminated by the circumference, being deſcribed through the three points P, B, K, will be the great circle.

PROPOSITION X. PROBLEM II.

To deſcribe the repreſentation of a great circle about any given point as a pole.

Let P be the given pole, and C the centre of the primitive.

1. When P (fig. 8) is in the centre of the primitive, then the primitive will be the great circle required.

2. When the pole P (fig. 11.) is in the circumference of the primitive. Through P draw the diameter PE, and the diameter AB drawn at right angles to PE will be the projected great circle required.

3. When the given pole is neither in the centre nor circumference of the primitive. Through the pole P (pl. 24. fig. 12.) draw the diameter AB, and draw the diameter DE perpendicular to AB; through E and P draw the ſtraight line EPF, meeting the circumference in F. Make FG equal to FD; through E and G draw the ſtraight line EGH, meeting the diameter AB produced if neceſſary in H; then from the centre H, with the radius HE, deſcribe the oblique circle DIE, and it will be the projection of the great circle required.

Or, make DK equal to FA; join EK, which interſects the diameter AB in I; then through the three points D, I, E, deſcribe the oblique circle DIE.

PROPOSITION XI. PROBLEM III.

To find the poles of a great circle.

1. When the given great circle is the primitive, its centre is the pole.

2. To find the pole of the right circle ACB (fig. 11.) Draw the diameter PE perpendicular to the given circle AB; and its extremities P, E are the poles of the circle ACB.

3. To find the pole of the oblique circle DEF (fig. 13.). Join DF, and perpendicular thereto draw the diameter AB, cutting the given oblique circle DEF in E. Draw the ſtraight line FEG, meeting the circumference in G. Make GI, GH, each equal to AD; then FI being joined, cuts the diameter AB in P, the lower pole; through F and H draw the ſtraight line FHp, meeting the diameter AB produced in p, which will be the oppoſite or exterior pole.

PROPOSITION XII. PROBLEM IV.

To deſcribe a leſs circle about any given point as a pole, and at any given diſtance from that pole.

1. When the pole of the leſs circle is in the centre of the primitive; then from the centre of the primitive, with the ſemitangent of the diſtance of the given circle from its pole, deſcribe a circle, and it will be the projection of the leſs circle required.

2. If the given pole is in the circumference of the primitive, from C (fig. 14.), the centre of the primitive, ſet off CE the ſecant of the diſtance of the leſs circle from its pole P; then from the centre E, with the tangent of the given diſtance, deſcribe a circle, and it will be the leſs circle required. Or, make PG, PF each equal to the chord of the diſtance of the leſs circle from its pole. Through B, G, draw the ſtraight line BGD meeting CP produced in D: biſect GD in H, and draw HE perpendicular to GD; and meeting PD in E, then E is the centre of the leſs circle.

3. When the given pole is neither in the centre nor circumference of the primitive. Through P (fig. 15.) the given pole, and C the centre of the primitive, draw the diameter AB, and draw the diameter DE perpendicular to AB; join EP, and produce it to meet the primitive in p; make p F, p G, each equal to the chord of the diſtance of the leſs circle from its pole; join EF which interſects the diameter AB in H; from E through G draw the ſtraight line EGI, meeting the diameter AB produced in I; biſect HI in K: Then a circle deſcribed from the centre K, at the diſtance KH or KI, will be the projection of the leſs circle.

PROPOSITION XIII. PROBLEM V.

To find the poles of a given leſs circle.

The poles of a leſs circle are alſo thoſe of its parallel great circle. If therefore the parallel great circle be given, then its poles being found by Prob. III. will be thoſe of the leſs circle. But if the parallel great circle be not given, let HMIM (fig. 15.) be the given leſs circle. Through its centre, and C the centre of the primitive, draw the line of meaſures IAHB; and draw the diameter DE perpendicular to it, alſo draw the ſtraight line EHF meeting the primitive in F; make F p equal to the chord of the diſtance of the leſs circle from its pole; join E p, and its interſection P with the diameter AB is the interior pole. Draw the diameter p CL through E and L, draw FL q meeting the diameter AB produced in q; then q is the external pole. Or thus: Join EI interſecting the primitive in G; join alſo EH, and produce it to meet the primitive in F, biſect the arch GF in p; from E to p draw the ſtraight line EP p, and P is the pole of the given leſs circle.

PROPOSITION XIV. PROBLEM VI.

To meaſure any arch of a great circle.

1. Arches of the primitive are meaſured on the line of chords.

2. Right circles are meaſured on the line of ſemitangents, beginning at the centre of the primitive. Thus, the meaſure of the portion AC (fig. 16.) of the right circle DE, is found by applying it to the line of ſemitangents. The meaſure of the arch DB is found by ſubtracting that of BC from 90° : the meaſure of the arch AF, lying partly on each ſide of the centre, is obtained by adding the meaſures of AC and CF. Laſtly, To meaſure the part AB, which is neither terminated at the centre or circumference of the primitive, apply CA to the line of ſemitangents; then CB, and the difference between the meaſures of theſe arches, will be that of AB.

Or thus, Draw the diameter GH perpendicular to DE; then from either extremity, as D, of this diameter, draw lines through the extremities of the arch intended to be meaſured; and the intercepted portion of the primitive applied to the line of chords will give the meaſure of the required arch. Thus IK applied to the line of chords will give the meaſure of AB.

3. To meaſure an arch of an oblique circle: draw lines from its pole through the extremities of the arch to meet the primitive, then the intercepted portion of the primitive applied to the line of chords will give the meaſure of the arch of the oblique circle. Thus, let AB (fig. 17.) be an arch of an oblique circle to be meaſured, and P its pole; from P draw the lines PAD, PBE meeting the primitive in B and E; then the arch DE applied to the line of chords will give the meaſure of the arch of the oblique circle AB.

Proposition XV. Problem VII.

To meaſure any arch of a leſs circle.

Let DEG (fig. 18.) be the given leſs circle, and DE the arch to be meaſured: find its internal pole P; and deſcribe the circle AFI parallel to the primitive, and whoſe diſtance from the projecting point may be equal to the diſtance of the given leſs circle from its pole P: then join PD, PE, which produce to meet the parallel circle in A and F. Now AF applied to a line of chords will give the meaſure of the arch DE of the given leſs circle.

Proposition XVI. Problem VIII.

To meaſure any ſpherical angle.

1. If the angle is at the centre of the primitive, it is meaſured as a plane angle.

2. When the angular point is in the circumference of the primitive; let A (fig. 19.) be the angular point, and ABE an oblique circle inclined to the primitive. Through P, the pole of ABE, draw the line AP*p* meeting the circumference in *p*: then the arch E*p* is the meaſure of the angle BAD, and the arch AF*p* is the meaſure of its ſupplement BAF; alſo *p*F is the meaſure of the angle BAC, and *p*ED that of its ſupplement.

3. If the angular point is neither at the centre nor circumference of the primitive. Let A (fig. 20.) be the angular point, and DAH, or GAF the angle to be meaſured, P the pole of the oblique circle DAF, and *p* the pole of GAH: then from A, through the points P*p*, draw the ſtraight lines APM, A*p*N, and the arch MN will be the meaſure of the angle DHA; and the ſupplement of MN will be the meaſure of the angle HAF or DAG.

Proposition XVII. Problem IX.

To draw a great circle perpendicular to a projected great circle, and through a point given in it.

Find the pole of the given circle, then a great circle deſcribed through that pole and the given point will be perpendicular to the given circle. Hence if the given circle be the primitive, then a diameter drawn through the given point will be the required perpendicular. If the given circle is a right one, draw a diameter at right angles to it; then through the extremities of this diameter and the given point deſcribe an oblique circle, and it will be perpendicular to that given. If the given circle is inclined to the primitive, let it be repreſented by BAD (fig. 21.), whoſe pole is P, and let A be the point through which the perpendicular is to be drawn: then, by Prob. I. deſcribe a great circle through the points P and A, and it will be perpendicular to the oblique circle BAD.

Proposition XVIII. Problem X.

Through a point in a projected great circle, to deſcribe another great circle to make a given angle with the former, provided the meaſure of the given angle is not leſs than the diſtance between the given point and circle.

Let the given circle be the primitive, and let A (fig. 19.) be the angular point. Draw the diameters AE, DF perpendicular to each other; and make the angle CAG equal to that given, or make CG equal to the tangent of the given angle; then from the centre G, with the diſtance GC, deſcribe the oblique circle ABE, and it will make with the primitive an angle equal to that given.

If the given circle be a right one, let it be APB (fig. 22.) and let P be the given point. Draw the diameter GH perpendicular to AB; join GP, and produce it to *a*; make H*b* equal to twice A*a*; and G*b* being joined interſects AB in C. Draw CD perpendicular to AB, and equal to the cotangent of the given angle to the radius PC; or make the angle CPD equal to the complement of that given: then from the centre D, with the radius DP, deſcribe the great circle FPE, and the angle APF, or BPE, will be equal to that given.

If APB (fig. 23.) is an oblique circle. From the angular point P, draw the lines PG, PC through the centres of the primitive and given oblique circle. Through C, the centre of APB, draw GCD at right angles to PG; make the angle GPD equal to that given; and from the centre D, with the radius DP, deſcribe the oblique circle FPE, and the angle APF, or BPE, will be equal to that propoſed.

Proposition XIX. Problem XI.

Any great circle cutting the primitive being given, to deſcribe another great circle which ſhall cut the given one in a propoſed angle, and have a given arch intercepted between the primitive and given circles.

If the given circle be a right one, let it be repreſented by APC (pl. 25. fig. 24.); and at right angles thereto draw the diameter BPM; make the angle BF equal to the complement of the given angle, and PF equal to the tangent of the given arch; and from the centre of the primitive with the ſecant of the ſame arch deſcribe the arch G*g*. Through F draw FG parallel to AC, meeting G*g* in G; then from the centre G, with the tangent PF, deſcribe an arch *n o*, cutting APC in I, and join GI. Through G, and the centre P, draw the diameter HK; draw PL perpendicular to HK, and IL perpendicular to GI, meeting PL in L; then L will be the centre of the circle HIK, which is that required.

But if the given great circle be inclined to the primitive, let it be ADB (fig. 25.), and E its centre: make the angle BDF equal to the complement of that given, and DF equal to the tangent of the given arch, as before. From P, the centre of the primitive, with the ſecant of the ſame arch, deſcribe the arch G*g*, and from E, the centre of the oblique circle, with the extent EF, deſcribe an arch interſecting G*g* in G. Now G being determined, the remaining part of the operation is performed as before.

When the given arch exceeds 90°, the tangent and ſecant of its ſupplement are to be applied on the line DF the contrary way, or towards the right; the former conſtruction being reckoned to the left.

Proposition XX. Problem XII.

Any great circle in the plane of projection being given to deſcribe another great circle, which ſhall make given angles with the primitive and given circles.

Let ADC (fig. 26.) be the given circle, and Q its pole. About P, the pole of the primitive, deſcribe an arch *m n*, at the diſtance of as many degrees as are in the angle which the required circle is to make with the primitive. About Q the pole of the circle ADC, and at a diſtance equal to the meaſure of the angle which the required circle is to make with the given circle ADC, deſcribe an arch *on*, cutting *m n* in *n*. Then about *n* as a pole, deſcribe the great circle EDF, cutting the primitive and given circle in E and D, and it will be the great circle required.

Scholium.

It will hence be an eaſy matter to conſtruct all the various ſpherical triangles. The reader is, however, referred to the article *Spherical* Trigonometry, for the method of conſtructing them agreeably to this projection; and alſo for the application to the reſolution of problems of the ſphere. For the method of projecting the ſphere upon the plane of the meridian, and of the horizon, according to the ſtereographic projection, ſee the article Geography.

SECTION II.

Of the Orthographic Projection of the Sphere.

The orthographic projection of the ſphere is that in which the eye is placed in the axis of the plane of projection, at an infinite diſtance with reſpect to the diameter of the ſphere; ſo that at the ſphere all the viſual rays are aſſumed parallel, and therefore perpendicular to the plane of projection.

Hence the orthographic projection of any point is where a perpendicular from that point meets the plane of projection: and the orthographic repreſentation of any object is the figure formed by perpendiculars drawn from every point of the object to the plane of projection.

This method of projection is uſed in the geometrical delineation of eclipſes, occultations, and tranſits. It is alſo particularly uſeful in various other projections, ſuch as the analemma. See Geography, &c.

Proposition I. Theorem I.

Every ſtraight line is projected into a ſtraight line. If the given line be parallel to the plane of projection, it is projected into an equal ſtraight line; but if it is inclined to the primitive, then the given ſtraight line will be to its projection in the ratio of the radius to the coſine of inclination.

Let AB (fig. 27.) be the plane of projection, and let CD be a ſtraight line parallel thereto: from the extremities C, D of the ſtraight line CD, draw the lines CE, DF perpendicular to AB; then by 3. of XI. of Eucl. the interſection EF, of the plane CEFD, with the plane of projection, is a ſtraight line: and becauſe the ſtraight lines CD, EF are parallel, and alſo CE, DF; therefore, by 34. of I. of Eucl. the oppoſite ſides are equal; hence the ſtraight line CD, and its projection EF, are equal. Again, let GH be the propoſed ſtraight line inclined to the primitive; then the lines GE, HF being drawn perpendicular to AB, the intercepted portion EF will be the projection of GH. Through G draw GI parallel to AB, and the angle IGH will be equal to the inclination of the given line to the plane of projection. Now GH being the radius, GI, or its equal EF, will be the coſine of IGH; hence the given line GH is to its projection EF as radius to the coſine of inclination.

Corollaries.

1. A ſtraight line perpendicular to the plane of projection is projected into a point.

2. Every ſtraight line in a plane parallel to the primitive is projected into an equal and parallel ſtraight line.

3. A plane angle parallel to the primitive is projected into an equal angle.

4. Any plane rectilineal figure parallel to the primitive is projected into an equal and ſimilar figure.

5. The area of any rectilineal figure is to the area of its projection as radius to the coſine of its inclination.

Proposition II. Theorem II.

Every great circle, perpendicular to the primitive, is projected into a diameter of the primitive; and every arch of it, reckoned from the pole of the primitive, is projected into its ſine.

Let BFD (fig. 28.) be the primitive, and ABCD a great circle perpendicular to it, paſſing through its poles A, C; then the diameter BED, which is their line of common ſection, will be the projection of the circle ABCD. For if from any point, as G, in the circle ABC, a perpendicular GH fall upon BD, it will alſo be perpendicular to the plane of the primitive: therefore H is the projection of G. Hence the whole circle is projected into BD, and any arch AG into EH equal to GI its ſine.

Corollaries.

1. Every arch of a great circle, reckoned from its interſection with the primitive, is projected into its verſed ſine.

2. Every leſs circle perpendicular to the primitive is projected into its line of common ſection with the primitive, which is alſo its own diameter; and every arch of the ſemicircle above the primitive, reckoned from the middle point, is projected into its ſine.

3. Every diameter of the primitive is the projection of a great circle; and every chord the projection of a leſs circle.

4. A ſpherical angle at the pole of the primitive is projected into an equal angle.

Proposition III. Theorem III.

A circle parallel to the primitive is projected into a circle equal to itſelf, and concentric with the primitive.

Let the leſs circle FIG (fig. 29.) be parallel to the plane of the primitive BND. The ſtraight line HE, which joins their centre, is perpendicular to the primitive; therefore E is the projection of H. Let any radii HI and IN perpendicular to the primitive be drawn. Then IN, HE being parallel, are in the ſame plane; therefore IH, NE, the lines of common ſection of the plane IE, with two parallel planes, are parallel; and the figure IHEN is a parallelogram. Hence NE = IH, and conſequently FIG is projected into an equal circle KNL, whoſe centre is E.

Corollary.

The radius of the projection is the coſine of the diſtance of the parallel circle from the primitive, or the ſine of its diſtance from the pole of the primitive.

Proposition IV. Theorem IV.

An inclined circle is projected into an ellipſe, whoſe tranſverſe axis is the diameter of the circle.

1. Let ELF (fig. 30.) be a great circle inclined to the primitive EBF, and EF their line of common ſection. From the centre C, and any other point K, in EF, let the perpendiculars CB, KI be drawn in the plane of the primitive, and CL, KN, in the plane of the great circle, meeting the circumference in

L, N. Let LG, ND be perpendicular to CB, KI; then G, D are the projections of L, N. And becauſe the triangles LCG, NKD are equiangular, $CL^2 : CG^2 :: NK^2 : DK^2$; or $EC^2 : CG^2 :: EKF : DK^2$; therefore the points G, D are in the curve of an ellipſe, of which EF is the tranſverſe axis, and CG the ſemiconjugate axis.

Corollaries.

1. In a projected great circle, the ſemiconjugate axis is the coſine of the inclination of the great circle to the primitive.

2. Perpendiculars to the tranſverſe axis intercept correſponding arches of the projection and the primitive.

3. The eccentricity of the projection is the ſine of the inclination of the great circle to the primitive.

Caſe 2. Let AQB (fig. 31.) be a leſs circle, inclined to the primitive, and let the great circle LBM, perpendicular to both, interſect them in the lines AB, LM. From the centre O, and any other point N in the diameter AB, let the perpendiculars TOP, NQ, be drawn in the plane of the leſs circle, to meet its circumference in T, P, Q. Alſo, from the points A, N, O, B, let AG, NI, OC, BH, be drawn perpendicular to LM; and from P, Q, T, draw PE, QD, TF perpendicular to the primitive; then G, I, C, H, E, D, F, are the projections of theſe points. Becauſe OP is perpendicular to LBM, and OC, PE, being perpendicular to the primitive, are in the ſame plane, the plane COPE is perpendicular to LBM. But the primitive is perpendicular to LBM; therefore the common ſection EC is perpendicular to LBM, and to LM. Hence CP is a parallelogram, and EC = OP. In like manner, FC, DI, are proved perpendicular to LM, and equal to OT, NQ. Thus, ECF is a ſtraight line, and equal to the diameter PT. Let QR, DK be parallel to AB, LM; then RO = NQ = DI = KC, and PR × RT = EK × KF. But AO : CG :: NO : CI; therefore $AO^2 : CG^2 :: QR^2 : DK^2$ and $EC^2 : CG^2 :: EKF : DK^2$.

Corollaries.

1. The tranſverſe axis is to the conjugate as radius to the coſine of the circle's inclination to the primitive.

2. Half the tranſverſe axis is the coſine of half the ſum of the greateſt and leaſt diſtances of the leſs circle from the primitive.

3. The extremities of the conjugate axis are in the line of meaſures, diſtant from the centre of the primitive by the coſines of the greateſt and leaſt diſtances of the leſs circle from the primitive.

4. If from the extremities of the conjugate axis of any elliptical projection perpendiculars be drawn (in the ſame direction if the circle do not interſect the primitive, but if otherwiſe in oppoſite directions), they will interſect an arch of the primitive, whoſe chord is equal to the diameter of the circle.

Proposition V. Theorem V.

The projected poles of an inclined circle are in its line of meaſures diſtant from the centre of the primitive the ſine of the inclination of the circle to the primitive.

Let ABCD (fig. 32.) be a great circle, perpendicular both to the primitive and the inclined circle, and interſecting them in the diameters AC, MN. Then ABCD paſſes through the poles of the inclined circle; let theſe be P, Q; and let Pp, Qq, be perpendicular to AC; p, q are the projected poles; and it is evident that pO = ſine of BP, or MA, the inclination.

Corollaries.

1. The centre of the primitive, the centre of the projection, the projected poles, and the extremities of the conjugate axis, are all in one and the ſame ſtraight line.

2. The diſtance of the centre of projection from the centre of the primitive, is to the coſine of the diſtance of the circle from its own pole, as the ſine of the circle's inclination to the primitive is to the radius.

Proposition VI. Problem I.

To deſcribe the projection of a circle perpendicular to the primitive, and whoſe diſtance from its pole is equal to a given quantity.

Let PA p B (fig. 33.) be the primitive circle, and P, p the poles of the right circle to be projected. Then if the circle to be projected is a great circle, draw the diameter AB at right angles to the axis Pp, and it will be that required. But if the required projection is that of a leſs circle, make PE, PF each equal to the chord of the diſtance of the leſs circle from its pole; join EF, and it will be the projection of the leſs circle required.

Proposition VII. Problem II.

Through a given point in the plane of the primitive to deſcribe the projection of a great circle, having a given inclination to the primitive.

1. When the given inclination is equal to a right angle, a ſtraight line drawn through the centre of the primitive and the given point will be the projection required.

2. When the given inclination is leſs than a right angle, and the given point in the circumference of the primitive. Let R (fig. 34.) be a point given in the circumference of the primitive, through which it is required to draw the projection of a great circle, inclined to the primitive in an angle meaſured by the arch QP of the primitive.

Through the given point R draw the diameter RCS, and draw GC g at right angles to it. Make the arch GV of the primitive equal to QP, and draw VA at right angles to GC; and in Gg, towards the oppoſite parts of C, take CB equal to AC; then, with the greater axis RS, and leſs axis AB, deſcribe an ellipſe, and it will be the projection of the oblique circle required.

3. When the diſtance of the given point from the primitive is equal to the coſine of the given inclination.

Every thing remaining as in the preceding caſe; let A be the given point, and AC the coſine of an arch GV, equal to the given arch QP; then, drawing the diameter RCS at right angles to ACB, the ellipſe deſcribed with the given axis RS, AB will be the projection of the inclined circle.

4. When the diſtance of the given point from the centre of the primitive is leſs than the ſemidiameter of the primitive, but greater than the coſine of the given inclination.

Let D be the given point, through which draw the diameter IC i; and at the point D draw DL perpendicular to DC meeting the primitive in L; alſo draw LK, making with LD the angle DLK equal to the complement of the given inclination. Let LK meet DC in K; then will DK be leſs than DC. On DC as a diameter deſcribe a circle, and make DH equal to DK; through H draw a diameter of the primitive RCS, and deſcribe an ellipſe through the points R, D, S, and it will be the projection of the inclined circle.

Proposition VIII. Problem III.

Through two given points in the plane of the primitive to deſcribe the projection of a great circle.

1. If the two given points and the centre of the primitive be in the ſame ſtraight line, then a diameter of the primitive being drawn through theſe points will be the projection of the great circle required.

2. When the two given points are not in the ſame ſtraight line with the centre of the primitive; and one of them is in the circumference of the primitive.

Let D, R, (fig. 34.) be the two given points, of which

R is in the circumference of the primitive. Draw the diameter RCS, and GCg, FDH perpendicular to it, meeting the primitive in Gg F. Divide GC, gC, in A, B, in the ſame proportion as FH is divided in D; and deſcribe the ellipſe whoſe axes are RS, AB, and centre C; and it will be the projection required.

3. When the given points are within the primitive, and not in the ſame ſtraight line with its centre.

Let D, E, (fig. 35.) be the two given points; through C the centre of the primitive draw the ſtraight lines IDi, KEi; draw DL perpendicular to Ii, and EO perpendicular to Kk, meeting the primitive in L, O. Through E, and towards the ſame parts of C, draw EP parallel to DC, and in magnitude a fourth proportional to LD, DC, OE. Draw the diameter CP meeting the primitive in R, S; and deſcribe an ellipſe through the points D and R or S, and it will alſo paſs through E. This ellipſe will be the projection of the propoſed inclined circle.

Proposition IX. Problem IV.

To deſcribe the projection of a leſs circle parallel to the primitive, its diſtance from the pole of the primitive being given.

From the pole of the primitive, with the ſine of the given diſtance of the circle from its pole, deſcribe a circle, and it will be the projection of the given leſs circle.

Proposition X. Problem V.

About a given point as a projected pole to deſcribe the projection of an inclined circle, whoſe diſtance from its pole is given.

Let P (fig. 36.) be the given projected pole, through which draw the diameter Gg, and draw the diameter Hh perpendicular thereto. From P draw PL perpendicular to GP meeting the circumference in L; through which draw the diameter Ll. Make LT, LK each equal to the chord of the diſtance of the leſs circle from its pole, and join TK, which interſects Ll, in Q. From the points T, Q, K draw the lines FA, QS, KB, perpendicular to Gg; and make OR, OS, each equal to QT, or QK. Then an ellipſe deſcribed through the points A, S, B, R will be the projection of the propoſed leſs circle.

Proposition XI. Problem VI.

To find the poles of a given projected circle.

1. If the projected circle be parallel to the primitive, the centre of the primitive will be its pole.

2. If the circle be perpendicular to the primitive, then the extremities of a diameter of the primitive drawn at right angles to the ſtraight line repreſenting the projected circle, will be the poles of that circle.

3. When the projected circle is inclined to the primitive.

Let ARBS (fig. 36, 37.) be the elliptical projection of any oblique circle; through the centre of which, and C the centre of the primitive, draw the line of meaſures CBA, meeting the ellipſe in B, A; and the primitive in G, g. Draw CH, BK, AT perpendicular to Gg, meeting the primitive in H, K, T. Biſect the arch KT in L, and draw LP perpendicular to Gg; then P will be the projected pole of the circle, of which ARBS is the projection.

Proposition XII. Problem VII.

To meaſure any portion of a projected circle, and converſely.

1. When the given projection is that of a great circle.

Let ADEB (fig. 38.) be the given great circle, either perpendicular or inclined to the primitive, of which the portion DE is to be meaſured, and let Mm be the line of meaſures of the given circle. Through the points D, E draw the lines EG, DF parallel to Mm; and the arch FG of the primitive will be be the meaſure of the arch DE of the great circle, and converſely.

2. When the projection is that of a leſs circle parallel to the primitive.

Let DE (pl. 26. fig. 39.) be the portion to be meaſured, of the leſs circle DEH parallel to the primitive. From the centre C draw the lines CD, CE, and produce them to meet the primitive in the points B, F. Then the intercepted portion BF of the primitive will be the meaſure of the given arch DE of the leſs circle DEH.

3. If the given leſs circle, of which an arch is to be meaſured, is perpendicular to the primitive.

Let ADEB (fig. 40.) be the leſs circle, of which the meaſure of the arch DE is required. Through C, the centre of the primitive, draw the line of meaſures Mm, and from the interſection O of the given right circle, and the line of meaſures, with the radius OA, or OB, deſcribe the ſemicircle AFGB; through the points D, E draw the lines DF, EG parallel to the line of meaſures, and the arch FG will be the meaſure of DE, to the radius AO. In order to find a ſimilar arch in the circumference of the primitive, join OF, OG, and at the centre C of the primitive, make the angle mCH equal to FOG, and the arch mH to the radius Cm will be the meaſure of the arch DE.

4. When the given projection is of a leſs circle inclined to the primitive.

Let RDS (fig. 41.) be the projection of a leſs circle inclined to the primitive, and DE a portion of that circle to be meaſured. Through O the centre of the projected circle, and C the centre of the primitive, draw the line of meaſures Mm; and from the centre O, with the radius OR, or OS, deſcribe the ſemicircle RGFS; through the points D, E draw the lines DF, EG parallel to the line of meaſures, and FG will be the meaſure of the arch DE to the radius OR, or OS. Join OF, OG, and make the angle mCH equal to FOG, and the arch mH of the primitive will be the meaſure of the arch DE of the inclined circle RDS.

The converſe of this propoſition, namely, to cut off an arch from a given projected circle equal to a given arch of the primitive, is obvious.

The above operation would be greatly ſhortened by uſing the line of ſines in the ſector.

It ſeems unneceſſary to inſiſt further on this projection, eſpecially as the reader will ſee the application of it to the projection of the ſphere on the planes of the *Meridian*, *Equator*, and *Horizon* in the article GEOGRAPHY; and to the delineation of *Eclipſes* in the article ASTRONOMY.

SECTION III.

Of the Gnomonic Projection of the Sphere.

In this projection the eye is in the centre of the ſphere, and the plane of projection touches the ſphere in a given point parallel to a given circle. It is named *gnomonic*, on account of its being the foundation of dialling: the plane of projection may alſo repreſent the plane of a dial, whoſe centre being the projected pole, the ſemiaxis of the ſphere will be the ſtyle or gnomon of the dial.

As the projection of great circles are repreſented by ſtraight lines, and leſs circles parallel to the plane of projection are projected into concentric circles; therefore many problems of the ſphere are very eaſily reſolved. Other problems, however, become more intricate on account of ſome of the circles being projected into ellipſes, parabolas, and hyperbolas.

Proposition I. Theorem I.

Every great circle is projected into a ſtraight line perpendicular to the line of meaſures; and whoſe diſtance from the centre is equal to the cotangent of its inclination, or to the tangent of its neareſt diſtance from the pole of the projection.

Let BAD (fig. 42.) be the given circle, and let the circle CBED be perpendicular to BAD, and to the plane of projection; whoſe interſection CF with this laſt plane will be the line of meaſures. Now ſince the circle CBED is perpendicular both to the given circle BAD and to the plane of projection, the common ſection of the two laſt planes produced will therefore be perpendicular to the plane of the circle CBED produced, and conſequently to the line of meaſures: hence the given circle will be projected into that ſection; that is, into a ſtraight line paſſing through *d*, perpendicular to C *d*. Now C *d* is the cotangent of the angle C *d* A, the inclination of the given circle, or the tangent of the arch CD to the radius AC.

Corollaries.

1. A great circle perpendicular to the plane of projection is projected into a ſtraight line paſſing through the centre of projection; and any arch is projected into its correſpondent tangent.

2. Any point, as D, or the pole of any circle, is projected into a point *d*, whoſe diſtance from the pole of projection is equal to the tangent of that diſtance.

3. If two great circles be perpendicular to each other, and one of them paſs through the pole of projection, they will be projected into two ſtraight lines perpendicular to each other.

4. Hence if a great circle be perpendicular to ſeveral other great circles, and its repreſentation paſs through the centre of projection; then all theſe circles will be repreſented by lines parallel to one another, and perpendicular to the line of meaſures, for repreſentation of that firſt circle.

Proposition II. Theorem II.

If two great circles interſect in the pole of projection, their repreſentations will make an angle at the centre of the plane of projection, equal to the angle made by theſe circles on the ſphere.

For ſince both theſe circles are perpendicular to the plane of projection, the angle made by their interſections with this plane is the ſame as the angle made by theſe circles.

Proposition III. Theorem III.

Any leſs circle parallel to the plane of projection is projected into a circle whoſe centre is the pole of projection, and its radius is equal to the tangent of the diſtance of the circle from the pole of projection.

Let the circle PI (fig. 42.) be parallel to the plane GF, then the equal arches PC, CI are projected into the equal tangents GC, CH; and therefore C, the point of contact and pole of the circle PI and of the projection, is the centre of the repreſentation G, H.

Corollary.

If a circle be parallel to the plane of projection, and 45 degrees from the pole, it is projected into a circle equal to a great circle of the ſphere; and therefore may be conſidered as the primitive circle, and its radius the radius of projection.

Proposition IV. Theorem IV.

A leſs circle not parallel to the plane of projection is projected into a conic ſection, whoſe tranſverſe axis is in the line of meaſures; and the diſtance of its neareſt vertex from the centre of the plane of projection is equal to the tangent of its neareſt diſtance from the pole of projection; and the diſtance of the other vertex is equal to the tangent of the greateſt diſtance.

Any leſs circle is the baſe of a cone whoſe vertex is at A (fig. 43.); and this cone being produced, its interſection with the plane of projection will be a conic ſection. Thus the cone DAF, having the circle DF for its baſe, being produced, will be cut by the plane of projection in an ellipſe whoſe tranſverſe diameter is *df*; and C *d* is the tangent of the angle CAD, and C*f* the tangent of CAF. In like manner, the cone AFE, having the ſide AE parallel to the line of meaſures *df*, being cut by the plane of projection, the ſection will be a parabola, of which *f* is the neareſt vertex, and the point into which E is projected is at an infinite diſtance. Alſo the cone AFG, whoſe baſe is the circle FG, being cut by the plane of projection, the ſection will be a hyperbola; of which *f* is the neareſt vertex; and GA being produced gives *d* the other vertex.

Corollaries.

1. A leſs circle will be projected into an ellipſe, a parabola, or hyperbola, according as the diſtance of its moſt remote point is leſs, equal to, or greater than, 90 degrees.

2. If H be the centre, and K, *k*, *l* the focus of the ellipſe, hyperbola, or parabola; then $HK = \frac{Ad - Af}{2}$ for the ellipſe; $Hk = \frac{Ad + Af}{2}$ for the hyperbola; and fn being drawn perpendicular to AE $fl = \frac{nE + Ff}{2}$ for the parabola.

Proposition V. Theorem V.

Let the plane TW (fig. 44.) be perpendicular to the plane of projection TV, and BCD a great circle of the ſphere in the plane TW. Let the great circle BED be projected into the ſtraight line *b e k*, Draw CQS perpendicular to *b k*, and C *m* parallel to it and equal to CA, and make QS equal to Q *m*; then any angle QS*t* is the meaſure of the arch Q *t* of the projected circle.

Join AQ: then becauſe C*m* is equal to CA, the angle QC*m* equal to QCA, each being a right angle, and the ſide QC common to both triangles; therefore Q*m*, or its equal QS, is equal QA. Again, ſince the plane ACQ is perpendicular to the plane TV, and *b*Q to the interſection CQ; therefore *b*Q is perpendicular both to AQ and QS: hence, ſince AQ and QS are equal, all the angles at S cut the line *b*Q in the ſame points as the equal angles at A. But by the angles at A the circle BED is projected into the line *b*Q. Therefore the angles at S are the meaſures of the parts of the projected circle *b*Q; and S is the dividing centre thereof.

Corollaries.

1. Any great circle *b*Q*t* is projected into a line of tangents to the radius SQ.

2. If the circle *b*C paſs through the centre of projection, then the projecting point A is the dividing centre thereof, and C*b* is the tangent of its correſpondent arch CB to CA the radius of projection.

Proposition VI. Theorem VI.

Let the parallel circle GLH (fig. 44.) be as far from the pole of projection C as the circle FNI is from its pole; and let the diſtance of the poles C, P be biſected by the radius AO; and draw *b*AD perpendicular to AO; then any ſtraight line *b*Q*t* drawn through *b* will cut off the arches *b l*, F*n* equal to each other in the repreſentations of theſe equal circles in the plane of projection.

Let the projections of the leſs circles be deſcribed. Then, becauſe BD is perpendicular to AO, the arches BO, DO are equal; but ſince the leſs circles are equally diſtant each from its reſpective pole, therefore the arches FO, OH are equal; and hence the arch BF is equal to the arch DH. For the ſame reaſon the arches BN, DL are equal; and the angle FBN is equal to the angle LDH; therefore, on the ſphere, the arches FN, HL are equal. And ſince the great circle BNLD is projected into the ſtraight line $bQnl$, &c. therefore n is the projection of N, and l that of L; hence fn, bl, the projections of FN, HL reſpectively, are equal.

Proposition VII. Theorem VII.

If Fnk, blg (fig. 45) be the projections of two equal circles, whereof one is as far from its pole P as the other from its pole C, which is the centre of projection; and if the diſtance of the projected poles C, p be divided in o, ſo that the degrees in Co, op be equal, and the perpendicular oS be erected to the line of meaſures gb. Then the line pn, Cl drawn from the poles C, p, through any point Q in the line oS, will cut off the arches Fn, bl equal to each other, and to the angle QCp.

The great circle Ao perpendicular to the plane of the primitive is projected into the ſtraight line oS perpendicular to gb, by Prop. i. Cor. 3. Let Q be the projection of q; and ſince pQ, CQ are ſtraight lines, they are therefore the repreſentations of the arches Pq, Cq of great circles. Now ſince PqC is an iſoſceles ſpherical triangle, the angles PCQ, CPQ are therefore equal; and hence the arches Pq, Cq produced will cut off equal arches from the given circles FI, GH, whoſe repreſentations Fn, bl are therefore equal: and ſince the angle QCp is the meaſure of the arch bl, it is alſo the meaſure of its equal Fn.

Corollary.

Hence, if from the projected pole of any circle a perpendicular be erected to the line of meaſures, it will cut off a quadrant from the repreſentation of that circle.

Proposition VIII. Theorem VIII.

Let Fnk (fig. 45.) be the projection of any circle FI, and p the projection of its pole P. If Cg be the cotangent of CAP, and gB perpendicular to the line of meaſures gC, let CAP be biſected by AO, and the line oB drawn to any point B, and alſo pB cutting Fnk in d; then the angle goB is the meaſures of the arch Fd.

The arch PG is a quadrant, and the angle $goA = gPA + oAP = gAC + oAP = gAC + CAo = gAo$; therefore $gA = go$; conſequently o is the dividing centre of gB, the repreſentation of GA; and hence, by Prop. v. the angle goB is the meaſure of gB. But ſince pg repreſents a quadrant, therefore p is the pole of gB; and hence the great circle pdB paſſing through the pole of the circles gB and Fn will cut off equal arches in both, that is, $Fd = gB =$ angle goB.

Corollary.

The angle goB is the meaſure of the angle gpB. For the triangle gpB repreſents a triangle on the ſphere, wherein the arch which gB repreſents is equal to the angle which the angle p repreſents; becauſe gp is a quadrant; therefore goB is the meaſure of both.

Proposition IX. Problem I.

To draw a great circle through a given point, and whoſe diſtance from the pole of projection is equal to a given quantity.

Let ADB (fig. 46.) be the projection, C its pole or centre, and P the point through which a great circle is to be drawn: through the points P, C draw the ſtraight line PCA, and draw CE perpendicular to it: make the angle CAE equal to the given diſtance of the circle from the pole of projection C; and from the centre C, with the radius CE, deſcribe the circle EFG: through P draw the ſtraight line PIK, touching the circle EFG in I, and it will be the projection of the great circle required.

Proposition X. Problem II.

To draw a great circle perpendicular to a great circle which paſſes through the pole of projection, and at a given diſtance from that pole.

Let ADB (fig. 46.) be the primitive, and CI the given circle: draw CL perpendicular to CI, and make the angle CLI equal to the given diſtance: then the ſtraight line KP, drawn through I parallel to CL, will be the required projection.

Proposition XI. Problem III.

At a given point in a projected great circle, to draw another great circle to make a given angle with the former; and, converſely, to meaſure the angle contained between two great circles.

Let P (fig. 47) be the given point in the given great circle PB and C the centre of the primitive: through the points P, C, draw the ſtraight line PCG; and draw the radius of the primitive CA perpendicular thereto; join PA; to which draw AG perpendicular: through G draw BGD at right angles to GP, meeting PB in B; biſect the angle CAP by the ſtraight line AO; join BO, and make the angle BOD equal to that given; then DP being joined, the angle BPD will be that required.

If the meaſure of the angle BPD be required, from the points B, D draw the lines BO, DO, and the angle BOD is the meaſure of BPD.

Proposition XII. Problem IV.

To deſcribe the projection of a leſs circle parallel to the plane of projection, and at a given diſtance from its pole.

Let ADB (fig. 46.) be the primitive, and C its centre: ſet the diſtance of the circle from its pole, from B to H, and from H to D; and draw the ſtraight line AED, interſecting CE perpendicular to BC, in the point E: with the radius CE deſcribe the circle EFG, and it is the projection required.

Proposition XIII. Problem V.

To draw a leſs circle perpendicular to the plane of projection.

Let C (pl. 27. fig. 48.) be the centre of projection, and TI a great circle parallel to the propoſed leſs circle: at C make the angles ICN, TCO each equal to the diſtance of the leſs circle from its parallel great circle TI: let CL be the radius of projection, and from the extremity L draw LM perpendicular thereto; make CV equal to LM: or CF equal to CM: then with the vertex V and aſymptotes CN, CO deſcribe the hyperbola WVK; or, with the focus F and CV deſcribe the hyperbola, and it will be the perpendicular circle deſcribed.

Proposition XIV. Problem VI.

To deſcribe the projection of a leſs circle inclined to the plane of projection.

Draw the line of meaſures dp (fig. 49.) and at C, the centre of projection, draw CA perpendicular to dp, and equal to the radius of projection: with the centre A, and radius AC, deſcribe the circle DCFG; and draw RAE parallel to dp: then take the greateſt and leaſt diſtances of the circle from the pole of projection, and ſet them from C to D and F reſpectively, for the circle DF; and from A, the projecting point, draw the ſtraight lines AFf, and ADd; then df will be the tranſverſe axis of the ellipſe: but if D fall beyond the line RE, as at G, then from G draw the line GADd, and df is the tranſverſe axis of a hyperbola: and if the point D fall in the line RE, as at E, then the line AE will not meet the line of meaſures, and the circle will be projected into a parabola whoſe vertex is f: biſect df in H, the centre, and for the ellipſe take half the difference of the lines Ad, Af, which laid from H will give K the focus: for the hyperbola, half the ſum of Ad, Af being laid from H, will give k its focus: then with the tranſverſe axis df, and focus K, or k, deſcribe the ellipſe dMf, or hyperbola fm, which will be the projection of the inclined circle: for the parabola, make EQ equal to Ff, and draw fn perpendicular to AQ, and make fk equal to one half of nQ: then with the vertex f, and focus k, deſcribe the parabola fm, for the projection of the given circle FE.

Proposition XV. Problem VII.

To find the pole of a given projected circle.

Let DMF (fig. 50.) be the given projected circle, whoſe line of meaſures is DF, and C the centre of projection; from C draw the radius of projection CA, perpendicular to the line of meaſures, and A will be the projecting point: join AD, AF, and biſect the angle DAF by the ſtraight line AP; hence P is the pole. If the given projection be a hyperbola, the angle fAG (fig. 49), biſected, will give its pole in the line of meaſures; and in a parabola, the angle fAE biſected will give its pole.

Proposition XVI. Problem VIII.

To meaſure any portion of a projected great circle, or to lay off any number of degrees thereon.

Let EP (fig. 51.) be the great circle, and IP a portion thereof to be meaſured: draw ICD perpendicular to IP; let C be the centre, and CB the radius of projection, with which deſcribe the circle EBD; make IA equal to IB; then A is the dividing centre of EP: hence AP being joined, the angle IAP is the meaſure of the arch IP.

Or, if IAP be made equal to any given angle, then IP is the correſpondent arch of the projection.

Proposition XVII. Problem IX.

To meaſure any arch of a projected leſs circle, or to lay off any number of degrees on a given projected leſs circle.

Let Fn (fig. 52.) be the given leſs circle, and P its pole: from the centre of projection C draw CA perpendicular to the line of meaſures GH, and equal to the radius of projection; join AP, and biſect the angle CAP by the ſtraight line AO, to which draw AD perpendicular: deſcribe the circle GlH, as far diſtant from the pole of projection C as the given circle is from its pole P; and through any given point n, in the projected circle Fn, draw Dnl, then Hl is the meaſure of the arch Fn.

Or let the meaſure be laid from H to l, and the line Dl joined will cut off Fn equal thereto.

Proposition XVIII. Problem X.

To deſcribe the gnomonic projection of a ſpherical triangle, when three ſides are given; and to find the meaſures of either of its angles.

Let ABC (fig. 53.) be a ſpherical triangle whoſe three ſides are given: draw the radius CD (fig. 54.) perpendicular to the diameter of the primitive EF; and at the point D make the angles CDA, CDG, ADI, equal reſpectively to the ſides AC, BC, AB, of the ſpherical triangle ABC (fig. 53.), the lines DA, DG interſecting the diameter EF, produced if neceſſary in the points A and G: make DI equal to DG; then from the centre C, with the radius CG, deſcribe an arch; and from A, with the diſtance AI, deſcribe another arch, interſecting the former in B; join AB, CB, and ACB will be the projection of the ſpherical triangle (fig. 53.); and the rectilineal angle ACB is the meaſure of the ſpherical angle ACB (fig. 53.)

Proposition XIX. Problem XI.

The three angles of a ſpherical triangle being given, to project it, and to find the meaſures of the ſides.

Let ABC (fig. 55.) be the ſpherical triangle of which the angles are given: conſtruct another ſpherical triangle EFG, whoſe ſides are the ſupplements of the given angles of the triangle ABC; and with the ſides of this ſupplemental triangle deſcribe the gnomonic projection, &c. as before.

It may be obſerved, that the ſupplemental triangle EFG has alſo a ſupplemental part EFg; and when the ſides GE, GF, which are ſubſtituted in place of the angles A, B, are obtuſe, their ſupplements gE, gF are to be uſed in the gnomonic projection of the triangle.

Proposition XX. Problem XII.

Given two ſides, and the included angle of a ſpherical triangle, to deſcribe the gnomonic projection of that triangle, and to find the meaſures of the other parts.

Let the ſides AC, CB, and the angle ACB (fig. 53.), be given: make the angles CDA, CDG (fig. 50.) equal reſpectively to the ſides AC, CB (fig. 53.); alſo make the angle ACB (fig. 56.) equal to the ſpherical angle ACB (fig. 53.), and CB equal to CG, and ABC will be the projection of the ſpherical triangle.

To find the meaſure of the ſide AB: from C draw CL perpendicular to AB, and CM parallel thereto, meeting the circumference of the primitive in M; make LN equal to LM; join AN, BN, and the angle ANB will be the meaſure of the ſide AB.

To find the meaſure of either of the ſpherical angles, as BAC: from D draw DK perpendicular to AD, and make KH equal to KD: from K draw KI perpendicular to CK, and let AB produced meet KI in I, and join HI: then the rectilineal angle KHI is the meaſure of the ſpherical angle BAC. By proceeding in a ſimilar manner, the meaſure of the other angle will be found.

Proposition XXI. Problem XIII.

Two angles and the intermediate ſide given, to deſcribe the gnomonic projection of the triangle; and to find the meaſures of the remaining parts.

Let the angles CAB, ACB, and the ſide AC of the ſpherical triangle ABC (fig. 53.), be given: make the angle CDA (fig. 56.) equal to the meaſure of the given ſide AC (fig. 53.); and the angle ACB (fig. 56.) equal to the angle ACB (fig. 53.); produce AC to H, draw DK perpendicular to AD, and make KH equal to KD; draw KI perpendicular to CK, and make the angle KHI equal to the ſpherical angle CAB: from I, the interſection of KI, HI, to A draw IA, and let it interſect CB in B, and ACB will be the gnomonic projection of the ſpherical triangle ACB (fig. 53). The unknown parts of this triangle may be meaſured by laſt problem.

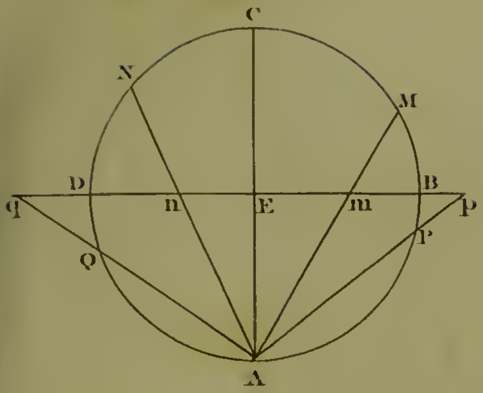
Proposition XXII. Problem XIV.

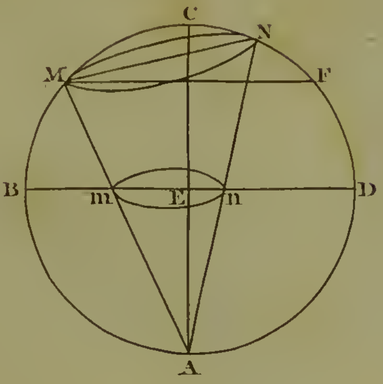
Two ſides of a ſpherical triangle, and an angle oppoſite to one of them given, to deſcribe the projection of the triangle; and to find the meaſure of the remaining parts.

Let the ſides AC, CB, and the angle BAC of the ſpherical triangle ABC (fig. 53.) be given: make the angles CDA, CDG (fig. 56.) equal reſpectively to the meaſures of the given ſides AC, BC: draw DK perpendicular to AD, make KH equal to DK, and the angle KHI equal to the given ſpherical

PROJECTION of the SPHERE.

Fig. 1.





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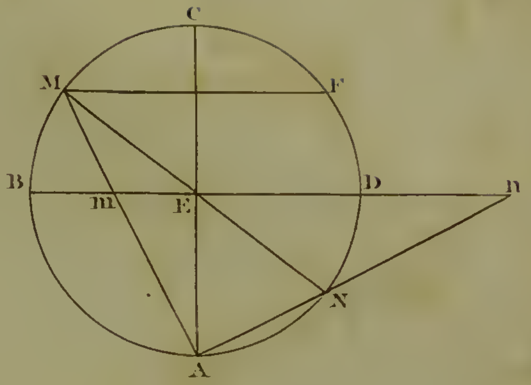

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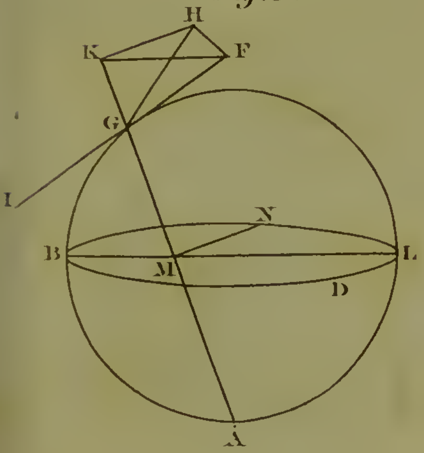

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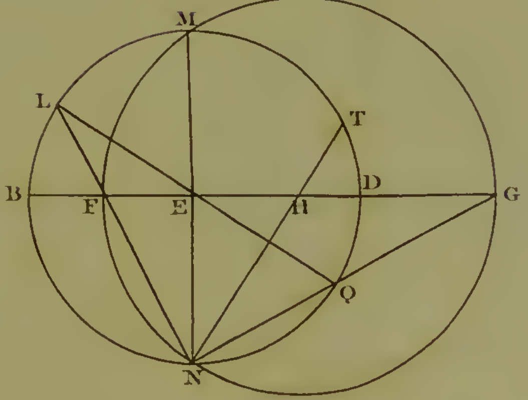

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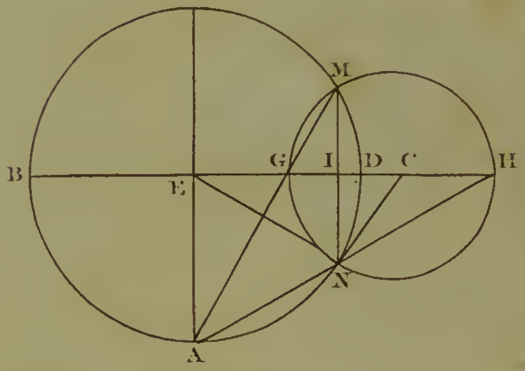

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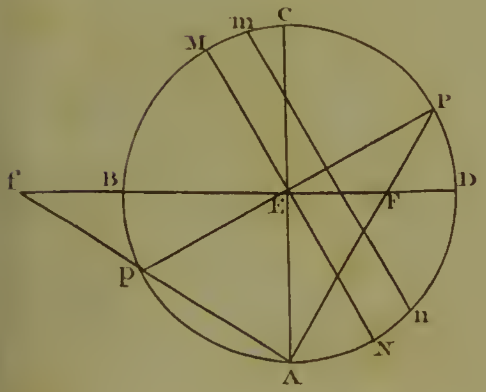

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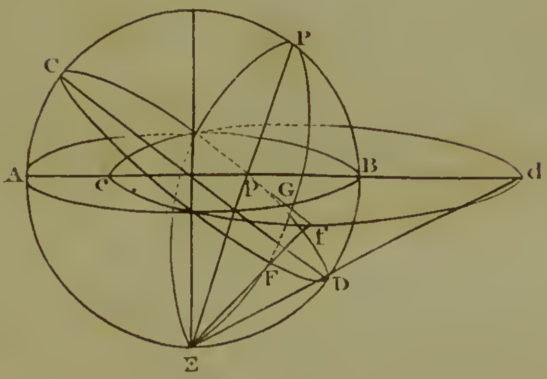

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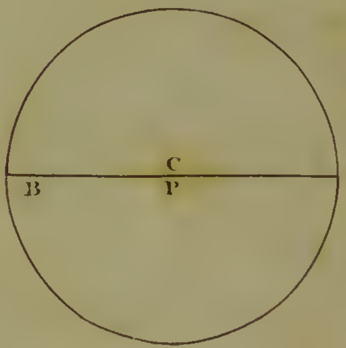

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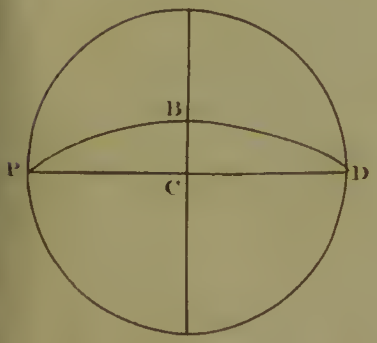

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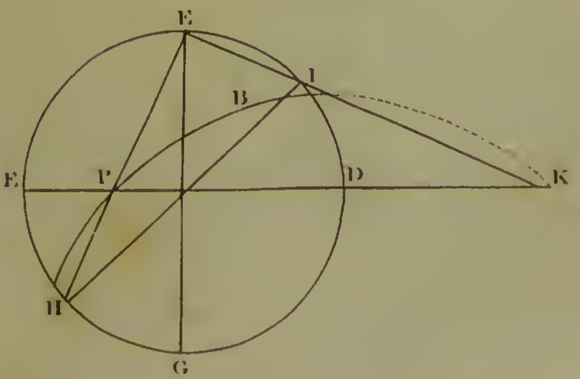

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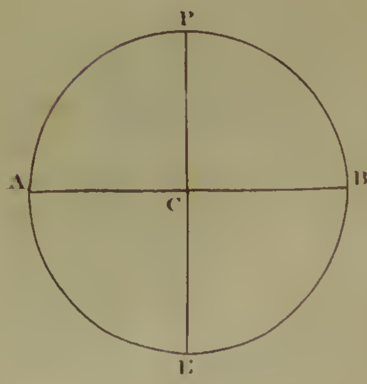
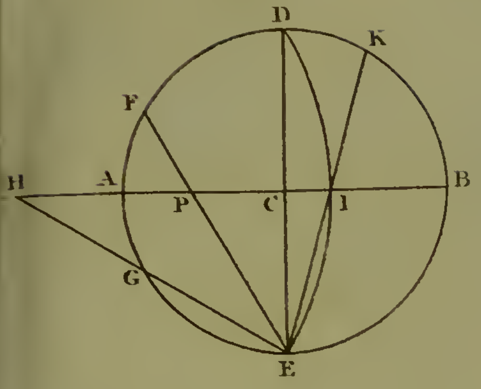


PROJECTION of the SPHERE.

Fig. 12.



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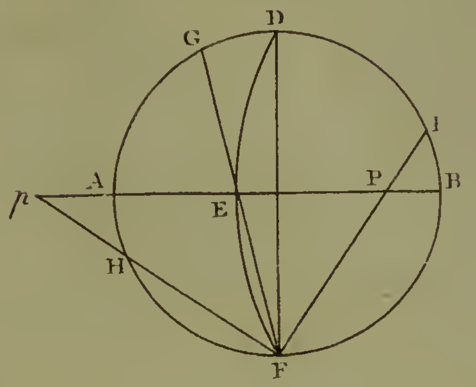

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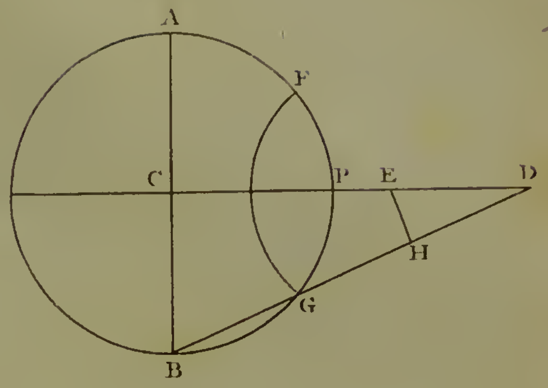

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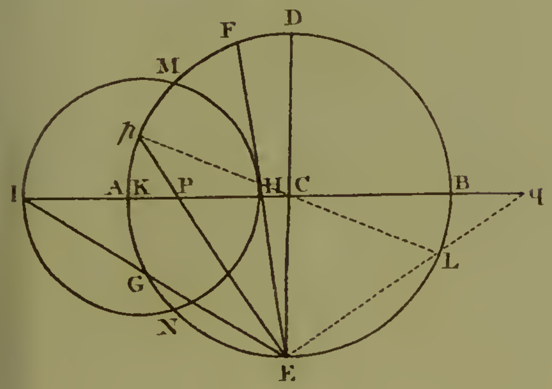

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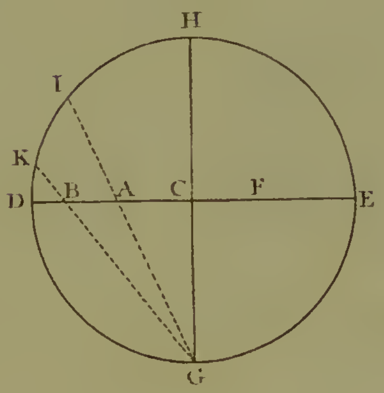

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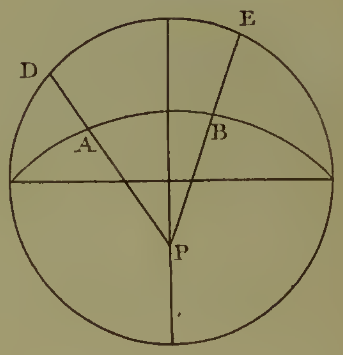

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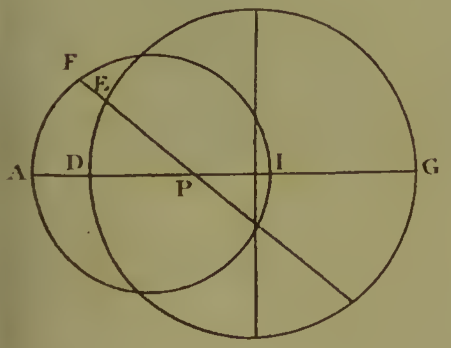

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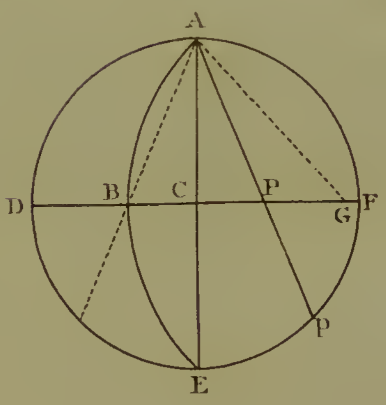

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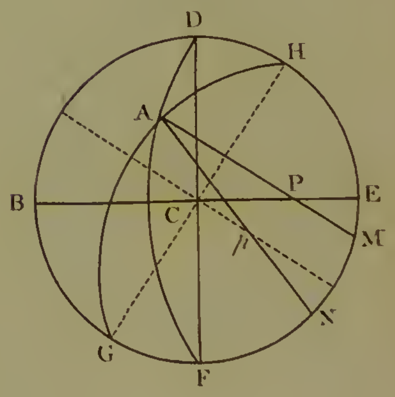
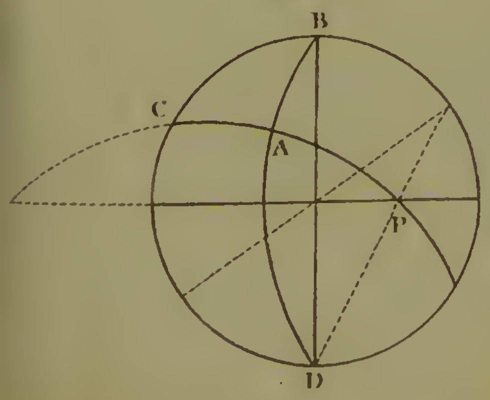


Fig. 21



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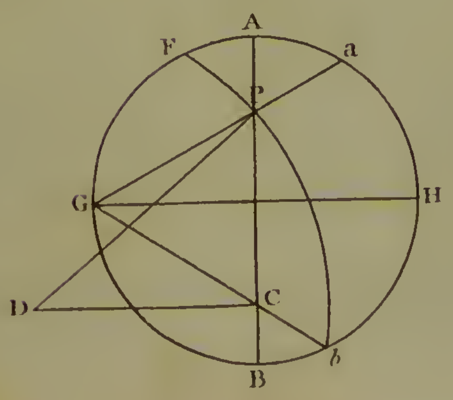

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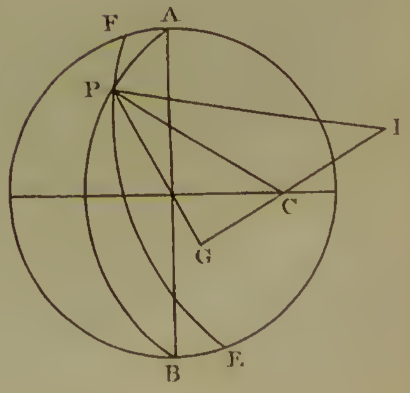
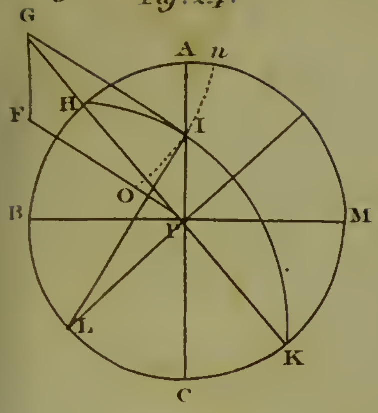


PROJECTION of the SPHERE.

Fig. 24.



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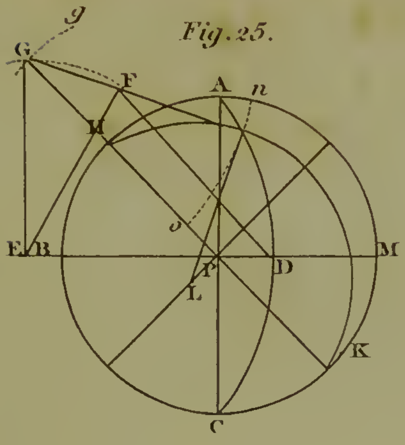

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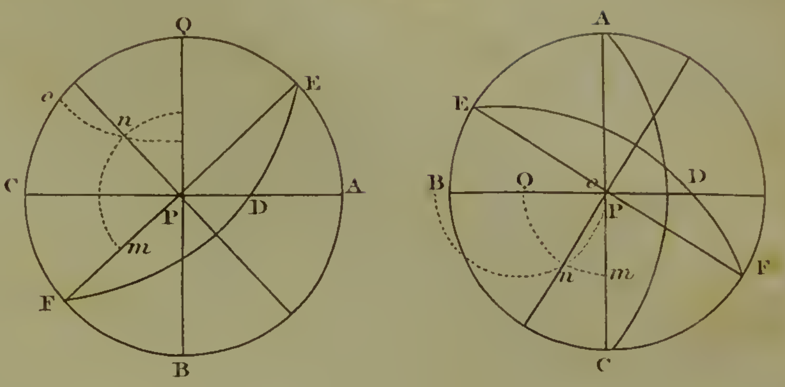

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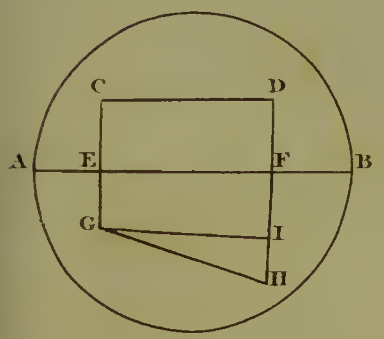

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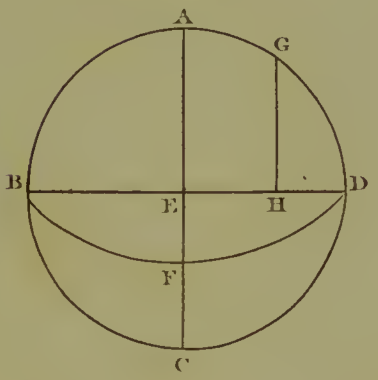

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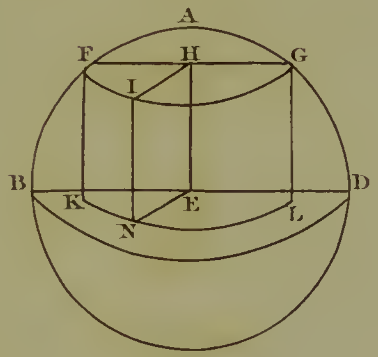

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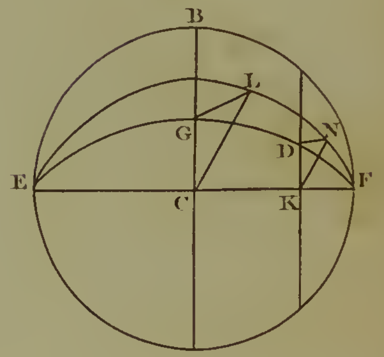

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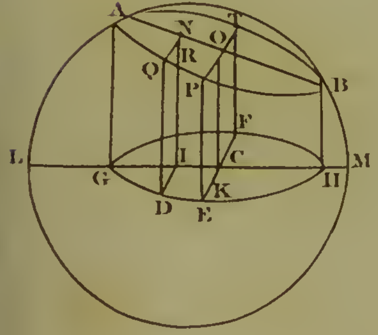

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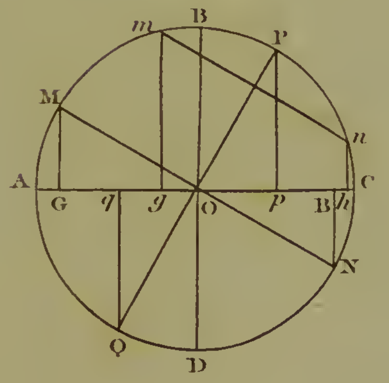

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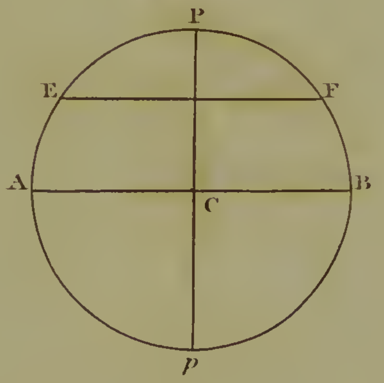

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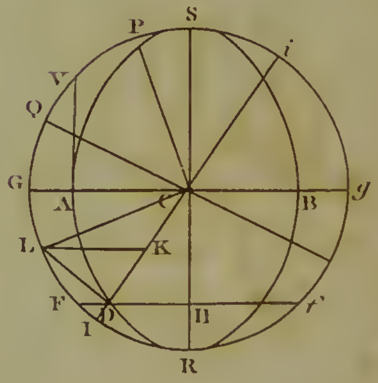

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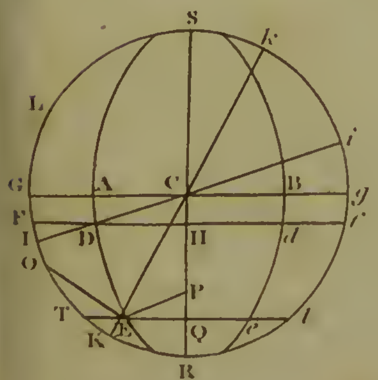

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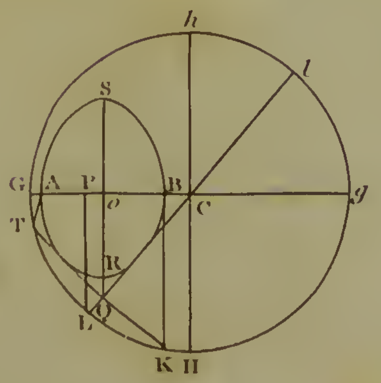

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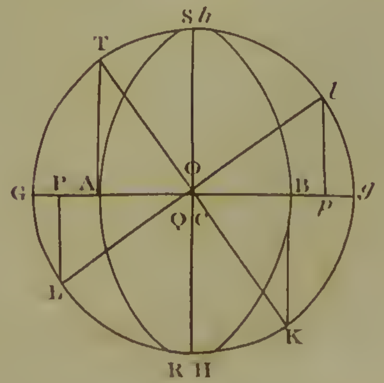

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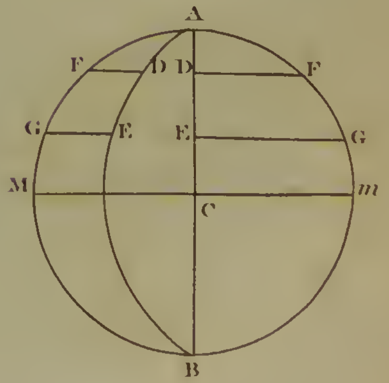
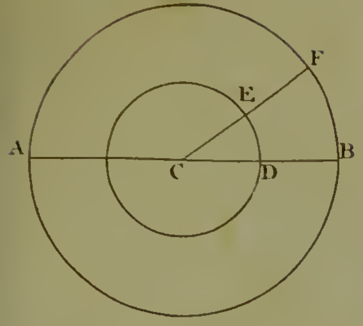


Mutlow Sculp.

PROJECTION of the SPHERE.

Fig. 39.



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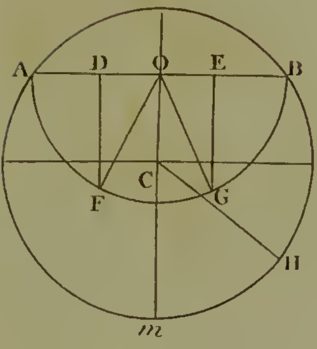

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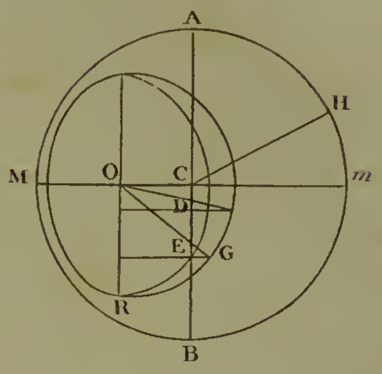

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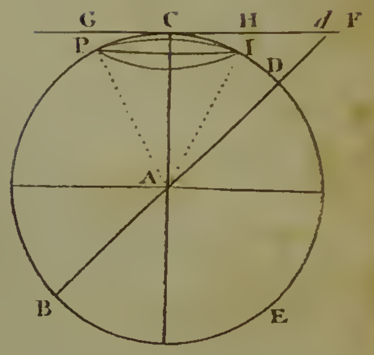

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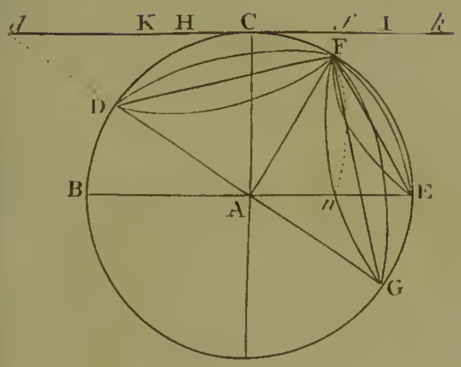

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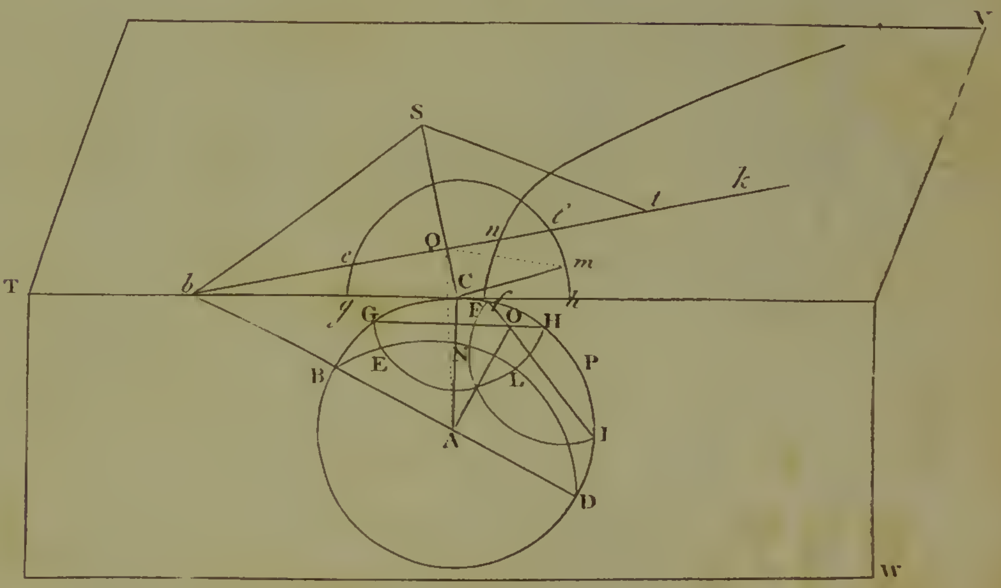

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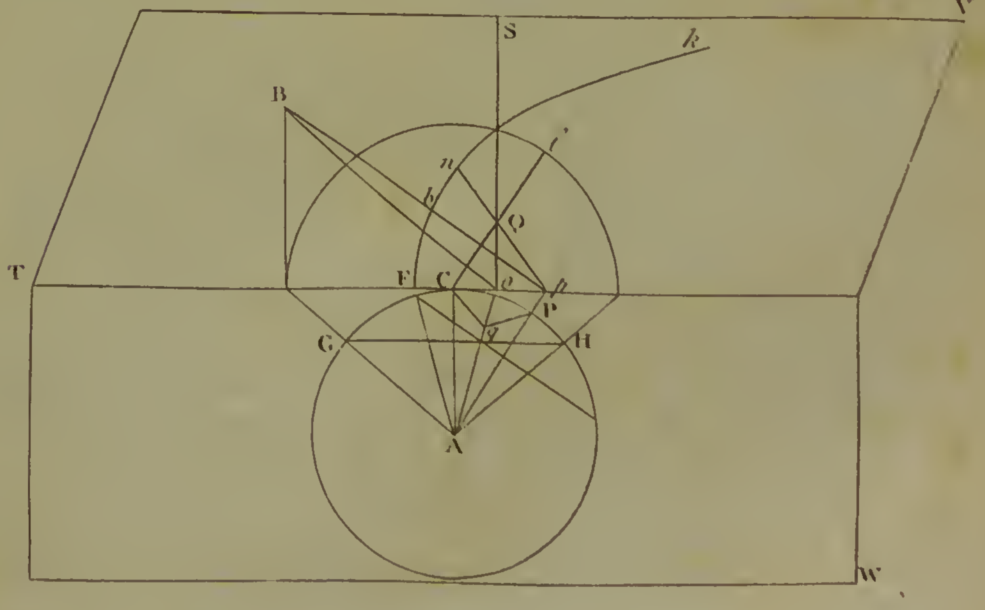

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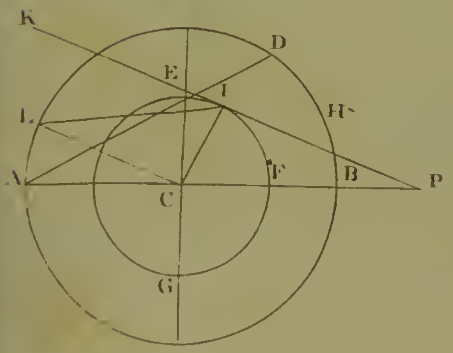

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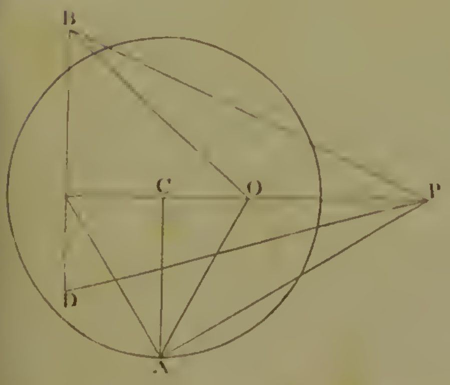
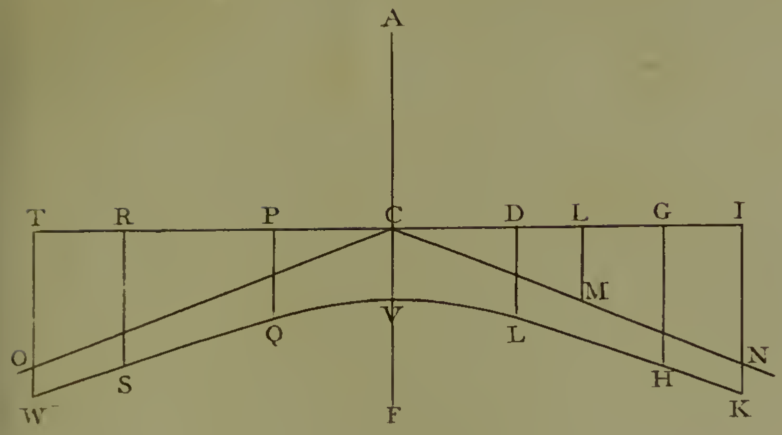


Hudson ſculp.

PROJECTION of the SPHERE.

Fig. 48.



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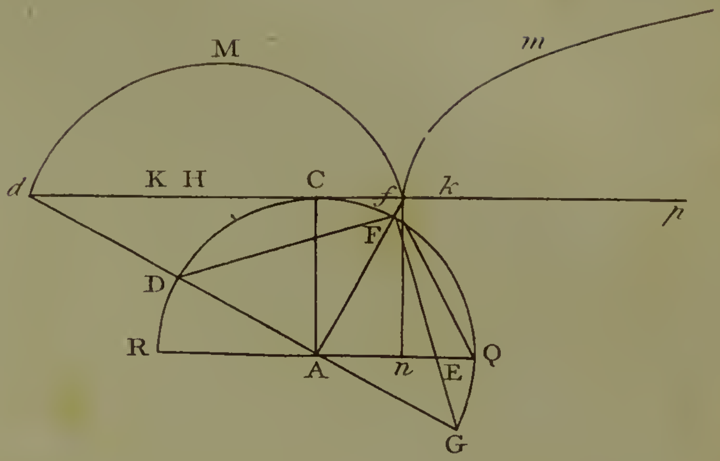

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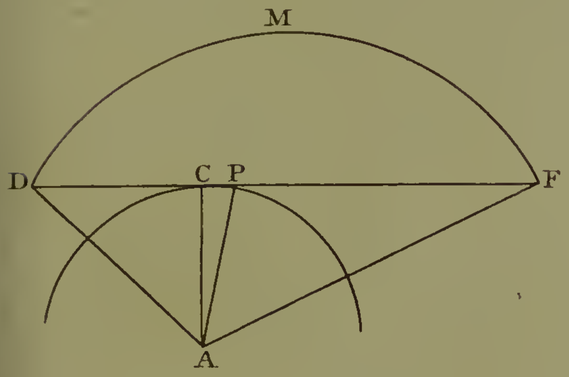


Fig. 51.

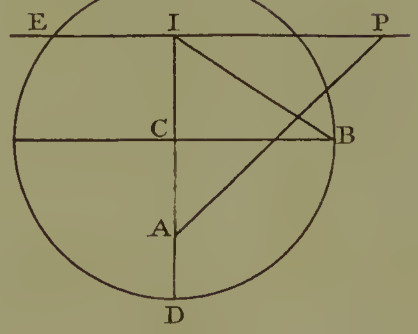


Fig. 52.

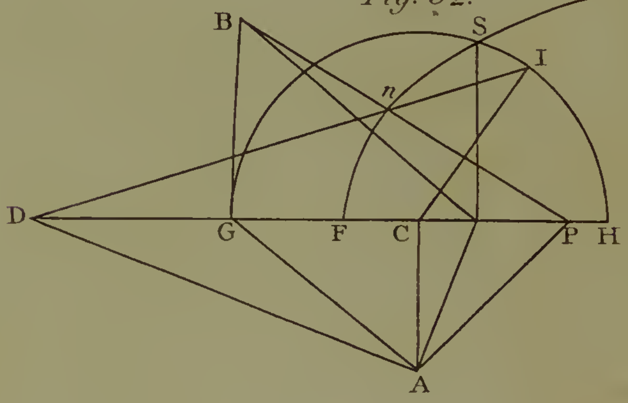


Fig. 53.

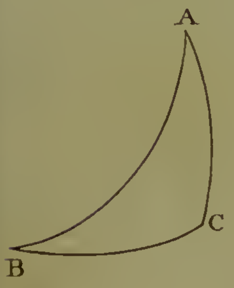


Fig. 54.

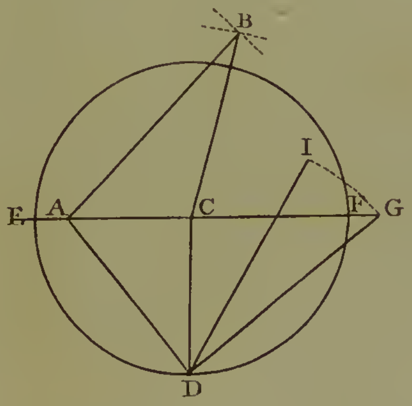


Fig. 56.

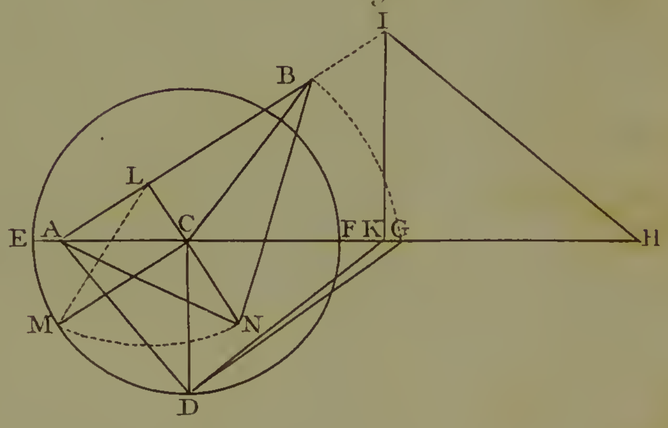


Fig. 55.

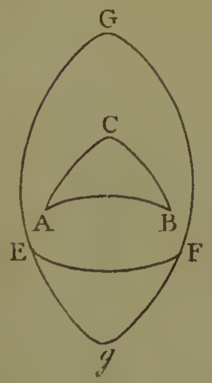
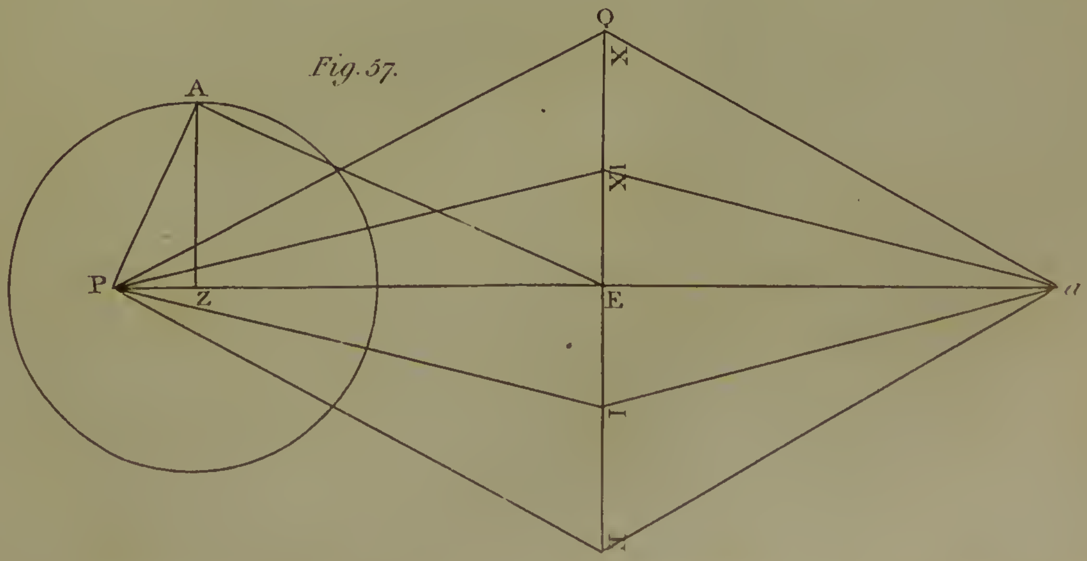


Fig. 57.



Mutlow. sculp.

angle BAC : draw the perpendicular KI, meeting HI in I; join AI; and from the centre C, with the diſtance CG, deſcribe the arch GB, meeting AI in B, join CB, and ABC will be the rectilineal projection of the ſpherical triangle ABC (fig. 53.) and the meaſures of the unknown parts of the triangle may be found as before.

Proposition XXIII. Problem XV.

Given two angles, and a ſide oppoſite to one of them, to deſcribe the gnomonic projection of the triangle, and to find the meaſures of the other parts.

Let the angles A, B, and the ſide BC of the triangle ABC (fig. 55.), be given: let the ſupplemental triangle EFE be formed, in which the angles E, F, G, are the ſupplements of the ſides BC, CA, AB reſpectively, and the ſides EF, FG, GE, the ſupplements of the angles C, A, B. Now, at the centre C (fig. 56.) make the angles CDA, CDK equal to the meaſures of the ſides GE, GF reſpectively, being the ſupplements of the angles B and A; and let the lines DA, DK interſect the diameter of the primitive EF, in the points A and K: draw DG perpendicular to AD, make GH equal to DG, and at the point H make the angle GHI equal to the angle E, or to its ſupplement; and let EI, perpendicular to CH, meet HI in I, and join AI: then from the centre C, with the diſtance CG, deſcribe an arch interſecting AI in B; join CB, and ABC will be the gnomonic projection of the given triangle ABC (fig. 55.): the ſupplement of the angle ACB (fig. 56.) is the meaſure of the ſide AB, (fig. 55.); the meaſures of the other parts are found as before.

It has already been obſerved, that this method of projection has, for the moſt part, been applied to dialling only. However, from the preceding propoſitions, it appears that all the common problems of the ſphere may be more eaſily reſolved by this than by either of the preceding methods of projection; and the facility with which theſe problems are reſolved by this method has given it the preference in dialling. It may not perhaps be amiſs, in this place, to give a brief illuſtration of it in this particular branch of ſcience.

In a horizontal dial, the centre of projection Z (fig. 57.) repreſents the zenith of the the place for which the dial is to be conſtructed; ZA the perpendicular height of the ſtyle: the angle ZPA, equal to the given latitude, determines the diſtance ZP of the zenith from the pole; and AP the edge of the ſtyle, which by its ſhadow gives the hour: the angle ZAP, equal alſo to the latitude, gives the diſtance of the equator EQ from the zenith: let E *a* be equal to EA, and *a* will be the dividing point of the equator. Hence if the angles E *a* I, E *a* II, &c. E *a* XI, E *a* X, &c. be made equal to 15°, 30°, &c. the equator will be divided into hours; and lines drawn from P to theſe points of diviſion will be hour lines.

If the dial be either vertical, or inclined to the horizon, then the point Z will be the zenith of that place whoſe horizon is parallel to the plane of the dial: ZE will be the latitude of that place; and the hours on the former dial will now be changed into others, by a quantity equal to the difference of longitude between the given place and that for which the dial is to be conſtructed. Thus if it be noon when the ſhadow of the ſtyle falls on the line PX, then the difference of meridians is the angle E *a* X, or 30°. Hence, when a dial is to be conſtructed upon a given plane, either perpendicular or inclined to the horizon, the declination and inclination of that plane muſt be previouſly found.

In an erect direct ſouth dial, its zenith Z is the ſouth point of the horizon, ZP is the diſtance of this point from the pole, and ZE its diſtance from the equator. If the dial be directed to the north, Z repreſents the north point of the horizon; PZ the diſtance of Z from the pole under the horizon; and ZE the elevation of the equator above the horizon.

If the dial be an erect eaſt or weſt dial, the zenith Z is the eaſt or weſt points of the horizon accordingly, and the pole P is at an infinite diſtance, for the angle ZAP is a right angle; and therefore the line AP will not meet the meridian PZ. The line ZA produced is the equator, and is divided into hours by lines perpendicular to it.

If the plane of the dial be parallel to the equator, its zenith Z coincides with one of the poles of the equator P; and hence the hour lines of this dial are formed by drawing lines from the point Z, containing angles equal to 15°.

In the preceding methods of projection of the ſphere, equal portions of a great circle on the ſphere are repreſented by unequal portions in the plane of projection, and this inequality increaſes with the diſtance from the centre of projection. Hence, in projections of the earth, thoſe places towards the circumference of the projection are very much diſtorted. In order to avoid this inconveniency, M. de la Hire propoſed, that the eye ſhould be placed in the axis produced at the diſtance of the ſine of 45° beyond the pole: In this caſe arches of the ſphere and and their projections are very nearly proportional to each other. Hence, in the map of the earth, agreeably to this conſtruction, the axis, inſtead of being divided into a line of ſemitangents, is divided equally, in like manner as the circumference. The maps of the world, are frequently conſtructed agreeably to this method of projection.

PROJECTION, in perſpective, denotes the appearance, or repreſention of an object on the perſpective plane. The projection, *e. gr.* of a point, as B (fig. 1. plate 38. vol. 7) is a point *b*, through which the optic ray BE paſſes from the objective point through the plane to the eye; or it is the point wherein the plane cuts the optic ray. And hence is eaſily conceived what is meant by the projection of a line, a plane, or a ſolid.

Projection *in Alchemy* the caſting of a certain imaginary powder, called *powder of projection*, into a crucible, or other veſſel, full of ſome prepared metal, or other matter; which is to be hereby preſently tranſmuted into gold.

Powder of Projection, or of the philoſopher's ſtone, is a powder ſuppoſed to have the virtue of changing any quantity of an imperfect metal, as copper or lead, into a more perfect one, as ſilver or gold, by the admixture of a little quantity thereof. The mark to which alchemiſts direct all their endeavours, is to find the powder of projection; which every one of them as been within an ace of a hundred times. See Philosopher's *Stone*.

PROJECTURE, in architecture, the outjetting and prominency, or emboſſing, which the mouldings and other members have beyond the naked wall, column, &c.

PROLAPSUS, in ſurgery, a prolapſion or falling out of any part of the body from its natural ſituation: thus we ſay, *prolapſus inteſtini*, " a prolapſiun of the inteſtine," &c. See Surgery.

PROLATE, in geometry, an epithet applied to a ſpheroid produced by the revolution of a ſemi-ellipſis about its larger diameter. See Spheroid.

PROLEGOMENA, in philology, certain preparatory obſervations or diſcourſes prefixed to a book, &c. containing ſomething neceſſary for the reader to be appriſed of, to enable him the better to underſtand the book, or to enter deeper into the ſcience, &c.

PROLEPSIS, a figure in rhetoric, by which we anticipate or prevent what might be objected by the adverſary. See ORATORY.

PROLEPTIC, an epithet applied to a periodical diſeaſe which anticipates, or whoſe paroxyſm returns ſooner and ſooner every time; as is frequently the caſe in agues.

PROLIFER FLOS; (*proles*, "an offspring;" and *fero*, "to bear"); a prolific flower, or a flower which from its own ſubſtance produces another; a ſingular degree of luxuriance, to which full flowers are chiefly incident. See BOTANY.

PROLIFIC, ſomething that has the qualities neceſſary for generating. The prolific powers of ſome individuals among mankind are very extraordinary.—Inſtances have been found where children, to the number of ſix, ſeven, eight, nine, and ſometimes ſixteen, have been brought forth after one pregnancy. The wife of Emmanuel Gago, a labourer near Valladolid, was delivered, the 14th of June 1779, of five girls, the two firſt of whom where baptized: the other three were born in an hour after; two of them were baptized; but the laſt, when it came into the world, had every appearance of death. The celebrated Tarſin was brought to bed in the ſeventh month of her pregnancy, at Argenteuil near Paris, 17th July 1779, of three boys, each 14 inches and a half long, and of a girl 13 inches: they were all four baptized, but did not live 24 hours.

The public papers for the month of June 1779 made mention of one Maria Ruiz, of the diſtrict of Lucena in Andaluſia, who was ſucceſſively delivered of 16 boys, without any girls; and ſeven of them were ſtill alive on the 17th of Auguſt thereafter. The following, though a recent fact, is almoſt incredible: In the year 1755, a Muſcovite peaſant, named *James Kyrloff*, and his wife, were preſented to the Empreſs of Ruſſia. This peaſant had been twice married, and was then 70 years of age. His firſt wife was brought to bed 21 times; namely, four times of four children each time; ſeven times of three, and ten times of two; making in all 57 children, who were then alive. His ſecond wife who accompanied him, had already been delivered ſeven times, once of three children, and ſix times of twins, which made 15 children for her ſhare. Thus the Muſcovite patriarch had already had 72 children by two marriages. We are aſſured that the ſultan Muſtapha III. had iſſue by his concubines 580 male children. What number of female children he had, and whether there were twins of both ſexes, we are not informed. Theſe facts ſuppoſe great fecundity; and whatever credit is given to them, we muſt conſider as entirely fabulous what is reported concerning a counteſs of Holland who was delivered of 365 children, of a very ſmall ſize.

PROLIXITY, in diſcourſe, the fault of entering into too minute a detail, or being too long, preciſe, and circumſtantial, even to a degree of tediouſneſs.

PROLOCUTOR of the convocation, the ſpeaker or chairman of that aſſembly. See CONVOCATION.

PROLOGUE, in dramatic poetry, a diſcourſe addreſſed to the audience before the drama or play begins. The original intention was to advertiſe the audience of the ſubject of the piece, and to prepare them to enter more eaſily into the action, and ſometimes to make an apology for the poet.

PROMETHEUS, the ſon of Japetus, ſuppoſed to have been the firſt diſcoverer of the art of ſtriking fire by flint and ſteel; which gave riſe to the fable of his ſtealing fire from heaven: A renowned warrior; but whoſe hiſtory is involved in fable. He flouriſhed about 1687 B. C. The poetical account is, that he formed a man of clay of ſuch exquiſite workmanſhip, that Pallas, charmed with his ingenuity, offered him whatever in heaven could contribute to finiſh his deſign; and for this purpoſe took him up with her to the celeſtial manſions, where he ſtole ſome fire from the chariot of the ſun, which he uſed to animate his image. At this theft Jupiter was ſo enraged, that he ordered Vulcan to chain him down on Mount Caucaſus, and ſent an eagle or vulture to prey on his liver; which every night was renewed, in proportion to the quantity eaten up in the daytime, until at laſt he was delivered by Hercules, who killed the vulture.

PROMETHEUS, in ancient aſtronomy, was the name of a conſtellation of the northern hemiſphere, now called *Hercules, Engonaſin*. See ASTRONOMY.

PROMISE, in ordinary caſes, is a declaration of ſome intention to be put in execution; but in morals is a ſolemn aſſeveration by which one pledges his veracity that he ſhall perform, or cauſe to be performed, the thing which he mentions.

As ſuch a declaration excites expectations in the minds of thoſe to whom it is made; and as to fruſtrate theſe expectations might rouſe indignation, and be followed by conſequences injurious to the perſon, the character, or intereſt, of him who made it—it becomes a matter of prudence in the promiſer to keep his word. And further, as a certain degree of confidence is found neceſſary to the very exiſtence of civil ſociety; and as others may have acted on the faith of his promiſe, it is now not a matter of prudence only to keep his word—it is a duty which he owes to all who have ſpent their time, their money, or their labour, in conſequence of thoſe expectations which he has warranted them to entertain.

It, then, being conſonant to ſound reaſon, neceſſary to the exiſtence of civil ſociety, and in general the intereſt of both the promiſer and promiſee, that the words of the promiſe ſhould be fulfilled, it has become a maxim in morals that a man is obliged to perform his promiſe.

In many inſtances, the great difficulty concerning a promiſe is, how to explain it; for although the grounds of its obligation be thoſe expectations which it has raiſed, a queſtion will occur, Is the promiſer bound to anſwer fully all the expectations to which the different conſtructions of his words may have given birth? Should I, for inſtance, deſire a man to run with a letter to ſuch a place, and engage to ſatiſfy him upon his return; and if on his return I gave him double of the uſual hire in like caſes; but if he be not ſatiſfied with leſs than the triple of ſuch a ſum, am I obliged to grant his demands? This will lead us to conſider the rules by which a promiſe ſhould be interpreted.

If a promiſe were always to be deemed obligatory in the ſenſe in which the promiſee receives it, a man would not know what he had promiſed; the promiſee, from a difference of views, aſſociations, and intereſts, might conceive a ſenſe of which the promiſer had never dreamed; might ſuppoſe engagements which were never intended, which could not be foreſeen, and, although foreſeen, could not be performed. For theſe reaſons it is natural to think that the ſenſe of the promiſer ſhould rather direct the interpretation. He knows preciſely what it is he has undertaken, and is unqueſtionably the beſt judge of what meaning he affixed to his words. His explanation ſhould therefore be admitted, if information alone could give him a title to decide in the affair.

But ſomething more than mere information, or a knowledge of the cauſe, is expected from a judge, as integrity is equally eſſential to his character. Doubts may ariſe when the words will admit of various meanings, whether the promiſer will be ſo candid as impartially to own the preciſe meaning which he had actually annexed to his expreſſions: at any rate, if he wiſhed to deceive, he might purpoſely uſe an ambiguous phraſeology, and perform the promiſe in a ſenſe of his own without ſatiſfying the reaſonable hopes of the promiſee.

When the daughter of Tarpeius bargained with Tatius to betray the citadel for what he and his Sabines wore on their left hands, meaning their rings and their golden bracelets, Tatius probably performed his promiſe in the way which he intended, when he cauſed her to be buried under their ſhields, which they carried alſo on their left hands. But who will ſay that here was not treachery and a diſhonourable abuſe of that confidence which had been repoſed in him?

It muſt therefore be obvious, that the import of a promiſe, where its meaning is diſputed, is not to be determined by the ſenſe of the promiſer nor by the expectations of the promiſee; and if it was ſaid that the obligation of a promiſe aroſe from thoſe expectations which had been raiſed by it, the aſſertion now muſt be limited to thoſe expectations which were intentionally raiſed by the promiſer, or thoſe which to his knowledge the promiſee was induced to entertain in conſequence of that declaration which had been made to him. Should there ſtill be a doubt about what expectations were intentionally raiſed, and what ſhould have been reaſonably entertained, recourſe muſt be had to the judgment of thoſe who are allowed to be perſons of candour, and who are acquainted with the characters of the men, and with thoſe circumſtances in which the promiſe was made.

The following are ſome of the caſes in which a promiſe is not binding. As the obligation to perform the promiſe ariſes from thoſe expectations which are intentionally raiſed by the promiſer; it is plain that no promiſe can be binding before acceptance, before the promiſe has been communicated to the promiſee, and before he has entertained hopes of its performance. The caſe is ſimilar where a promiſe is releaſed, that is, where the performance is diſpenſed with by the promiſee, and where he entertains no expectations on account of any thing that the promiſer has ſaid to him. Should a third perſon entertain hopes on account of the promiſe, he is to cheriſh theſe hopes at his own hazard, having no encouragement from the promiſer to do ſo: yet if this perſon has been warranted to hope by the promiſee, the promiſee has renounced his privilege of releaſing the promiſe, and along with the promiſer becomes bound for its performance.

A promiſe is not binding where the performance is unlawful; and the performance is unlawful where it is contrary to former promiſes, or to any moral and religious precept, which from the beginning to the end of time is of perpetual and unalterable obligation. Thus no man is bound by his promiſe to give to me what he has already promiſed to another; and no man is bound by his promiſe to blaſpheme God, to commit murder, or to criminate the innocent. Such promiſes are unlawfully made, and cannot be otherwiſe than unlawfully performed.

Some have even carried their ſcruples ſo far as to doubt, whether any promiſe, unlawfully made, can be lawfully performed. Should a man, during the lifetime of his wife, happen to promiſe marriage to another, ſuch a man (they ſay) by the Chriſtian religion has already committed adultery in his heart; and ſhould he afterwards become a widower, he is not bound, and he even ought not, to fulfil his engagement, as this would be putting his criminal intention into execution. This ſpecies of reaſoning, we muſt confeſs, is to us unintelligible. As the wife is dead, what now ſhould prevent the man from marrying the object of his affections? Why, ſay the caſuiſts, he already is under a promiſe to marry her, and his promiſe was made at a time when it ſhould not have been made. It is true, the performance, conſidered by itſelf, is oppoſed by no law human or divine; but then it originated in what was wrong; and however much the Supreme Being and the bulk of the creation may be out of the ſecret, we have diſcovered by the ingenious logic of caſuiſtry, that evil can never ſpring out of good, nor good out of evil; but that the means and the end, the motive and the action are always of the ſame complexion in morals.

When a promiſe is made, the particular circumſtances in which it is to be deemed obligatory are ſometimes mentioned. “I promiſe (for inſtance) to lend my friend 200 pounds within three days, provided a certain creditor which I name do not make a demand on me before that time. In other caſes no circumſtance is foreſeen by the promiſer to prevent the fulfilling of his engagement; and hence we have erroneous promiſes, which proceed on the ſuppoſition that things are true, poſſible, and lawful, which are not ſo. An erroneous promiſe, which proceeds on the falſe repreſentation of the promiſee, is not binding.

A London gentleman lately purchaſed an eſtate in the ſouth of England at a public ſale, believing the deſcription which he ſaw in the newſpapers, and which likewiſe was given by the auctioneer, to be true; but finding afterwards that the eſtate nowiſe correſponded to the deſcription, the law freed him from his engagement, becauſe the ſeller had evidently been guilty of a breach of promiſe in not ſatisfying thoſe expectations which he had intentionally and even ſtudiouſly excited in the buyers.

An erroneous promiſe, whoſe performance is impoſſible, is not binding. Before the concluſion of the late war a planter of Tobago promiſed to ſend to his friend in England 12 hogſheads of ſugar from the next year's produce of his eſtate; but before that time Tobago fell into the hands of the French, and the Weſt Indian found it impoſſible to anſwer the expectations of his friend in England.

An erroneous promiſe, whoſe performance is unlawful, or, to ſpeak more preciſely, whoſe performance is contrary to a prior promiſe, or to any moral or religious obligation, is not binding. The great difficulty which many have to encounter in determining when erroneous promiſes ought or ought not to be kept, ariſes from their proceeding on a principle of whoſe conſequences they do not ſeem to be always aware. There is ſeldom, they perceive, a virtuous action that is not attended with ſome happy effects; and it will, perhaps, be generally allowed, that the comparative merit of ſimilar virtues may ſafely be eſtimated by their utility: but to make utility, as ſome do, the criterion of virtue, and pronounce an action vicious or virtuous merely on account of thoſe conſequences which they ſee may flow from it, is a dangerous maxim. Evil has often ſprung out of good, and good out of evil; and good and evil have frequently ſprung from the ſame action.

But ſhould views of utility be laid aſide, and ſhould it be made an invariable rule that truth is on no account to be violated, that deceit is never to be practiſed, and that moral obligations are not to be diſſolved for the proſpect of any phyſical advantage; thoſe doubts which ariſe concerning the validity of erroneous promiſes will ſoon diſappear. Diſagreeable perhaps and ridiculous conſequences may ſometimes ariſe to a few individuals from an honeſt and conſcientious adherence to their promiſe; but will any aſſert that the general good, *that burthen of the ſong*, will ever be endangered by too much veracity?

So numerous inconveniencies ariſe daily from the regular operation of thoſe great phyſical laws, which are under the immediate direction of Providence, that thoſe philoſophers who have adopted the principle of utility, and are much ſurpriſed to ſee the univerſe ſo aukwardly planned for the eaſe and comfort of them and their ſpecies, have been under the neceſſity of imputing many events in nature to the malignity of ſome evil independent being; or of allowing that things have degenerated ſince they firſt came from the hands of the Creator, and that they muſt now be exceedingly altered from what they had been when he choſe to pronounce them all very good. Thus, abſurdity or impiety muſt always be the conſequence of judging of the vice and virtue of an action by its utility, and of eſtimating its utility by our limited views and erroneous conceptions.

As for extorted promiſes, it is curious to obſerve how this queſtion ſhould always be ſtarted, whether or not they ought to be kept? and another queſtion ſhould ſeldom be thought of, whether or not they ought to be made? Fortitude was one of the cardinal virtues among the ancients; and is deemed of ſuch importance in the Chriſtian ſyſtem, that the fearful are claſſed with the unbelievers, and are thought unworthy of the favour of Deity, as being incapable of ſupporting thoſe trials to which heaven expoſes the faithful as the trueſt teſt of Chriſtian virtue. If a perſon ſhould want the neceſſary fortitude to be virtuous, it will be a poor excuſe for his baſeneſs, that he has added deceit to his cowardice: and ſurely it is not the buſineſs of morality, when it has found him guilty of one crime, to grant him a diſpenſation for committing two. The laws of juriſprudence, it will readily be allowed, cannot favour the claims of the promiſee; becauſe they ought never to lend their ſupport to oppreſſion and violence. But their acquittal, ſhould he violate his faith, will by no means vindicate the character of the promiſer. Their acquitting a woman from the charge of adultery, goes a ſhort way in reſtoring the fair reputation of her innocence.

Let juriſprudence decide as it will, the man of honour and the generous patriot can never be brought to reſpect the perſon who, ſtruck with a panic, could betray either himſelf or his friends. The magnanimous ſpirits who could die for the truth will view with contempt his pitiful deceit. Thoſe unfortunate men who may ſuffer from that very diſtruſt which the breach of his faith has begotten, will always deteſt him as a traitor and enemy; and heaven itſelf cannot be ſuppoſed to reward that ſoldier who deſerts her cauſe, and relinquiſhes the poſt which ſhe has aſſigned him, at the ſight of danger.

If we once begin to accommodate morality to the diſpoſitions and humours of mankind, it is hard to ſay where this ſpecies of complaiſance will end. The degrees of timidity are ſo various, and ſome tempers by nature ſo yielding, that repeated importunity or an earneſt requeſt will extort a promiſe.

A young lady was frequently preſſed by her dying huſband to grant him a promiſe that ſhe would not marry after his death. For ſome time ſhe was able to reſiſt with becoming ſpirit his abſurd requeſt; but upon his declaring oftener than once that he could not otherwiſe die in peace, ſhe complied and promiſed. Too young, however, for this effort of continence, ſhe afterwards liſtened to the addreſſes of a ſecond lover, and found her heart inſenſibly engaged before ſhe adverted to the impropriety of a new attachment. But propoſals of marriage could ſcarcely fail to remind her of her promiſe and awaken her ſcruples. Theſe ſhe ſoon communicated to her lover, with her firm reſolution to remain a widow, if the contrary meaſure, which ſhe greatly preferred, and on which her earthly happineſs depended, were not approved by ſome ſpiritual counſellor.

Upon this declaration it was agreed to take the advice of their own miniſter, who was an eminent diſſenting clergyman in the dioceſe of Oxford: but this gentleman, unwilling to decide in a matter of ſuch importance, propoſed to refer it to Dr. Secker, who was then biſhop of that ſee. This prelate too declined to give any judgment in the caſe; but, as was his way, muſtered up a number of arguments on each ſide of the queſtion, and committed them to a letter, which a learned gentleman of our acquaintance had ſome time ago an opportunity of ſeeing in manuſcript.

If the ſentiments to which the biſhop was inclined could have been inferred from his ſtatement of arguments, he ſeemed to think that the promiſe was binding. In our opinion, he ought to have given a poſitive deciſion. It was no matter whether the promiſe was extorted or not: the promiſe was made, and the queſtion was now, whether or not was the performance lawful? That it was lawful appears evident. The lady was under a moral obligation to remain a widow; and no moral obligation, ſo far as we know, required her to marry.

To be fruitful and multiply, indeed, is declared in ſcripture, and is found, to the woeful experience of many, to be one of the general laws of our nature. But of all thoſe laws intended by nature to regulate the conduct of inferior intelligences, the moral, which were meant to be checks and correctors of thoſe abuſes to which the phyſical are apt to be carried, are certainly the moſt ſacred and obligatory. To procreate his ſpecies, a man is not then to be guilty of adultery, nor of fornication, nor to liſten to the lewd calls of incontinency. St. Paul's obſervation, that it is better to marry than burn, cannot be allowed in this inſtance to have much weight. He has not defined what degree of amorous inflammation conſtitutes burning, nor in what caſes this burning would be a ſufficient warrant for marrying. In the preſent inſtance he does not even conſider marriage as a duty; he compares it with burning, and thinks it only the leaſt of the two evils. Not that marriage is evil of itſelf; for he that marrieth doth well; but there are circumſtances in which it would be inconvenient to marry, and in which he that marrieth not is ſaid to do better. But if thoſe inconveniences be reaſons ſufficient to deter from marrying, is that perſon to be held excuſable who, in order to gratify an animal paſſion, ſomewhat refined, ſhould violate an oath, and trample on a ſacred moral obligation?

The young lady might indeed declare that her earthly happineſs was at an end if ſhe were not permitted to marry again: but what circumſtance prevented her from marrying? It was not the opinion of her own paſtor, nor the biſhop of Oxford: the truth is, it was certain ſcruples of her own, which being unable of herſelf to overcome, ſhe had piouſly ſolicited the aſſiſtance of others. It is certainly a misfortune that a devotional and amorous turn ſhould always be ſo cloſely connected in the females. Both, however, cannot always be indulged. Who will ſay, that the motive is rational which inclines one to cheriſh a paſſion which conſcience diſapproves? The virtue of continency might indeed have borne hard on this lady's conſtitution, and in her way to immortal happineſs might have formed a gate ſo ſtraight and narrow as it might be difficult for her to paſs through: but after all, her caſe was not harder than that of nuns, who take the vows of perpetual chaſtity, and endure ſufferings of a ſimilar nature, and in ſome inſtances even perhaps greater than her's; yet doing it cheerfully, from the ſuppoſition that the Omniſcient is well acquainted with the nature of the great ſacrifice which they make, and that after death he will ſtudy to requite them, and beſtow on them ſomething like an equivalent, which in their opinion can ſcarcely be leſs than a happineſs in heaven as ample as their wiſhes and as laſting as their ſouls.

Every promiſe, therefore, which is not releaſed, nor fraudulently obtained by the promiſee, is to be held binding if the performance be lawful and poſſible.

The Chriſtian cannot, and a man of honour will ſcarcely venture to reject this maxim, that a good man ought not to change though he ſwear to his hurt. Yet a ſimple promiſe and a promiſſory oath are not very different in point of obligation. Moſt people know, and, where any moral duty is concerned, they ought particularly to reflect, that this world is governed by an Almighty Being, who knows all things, who lives always, and who is juſt to reward and to puniſh. The perſon who makes a promiſſory oath does it avowedly under an immediate ſenſe of theſe truths; the perſon who makes a ſimple promiſe, though he certainly ought yet may not reflect on the ſeat the time. The former, when he violates his oath, exhibits, only to outward appearance, a greater contempt of the Divine power, knowledge, and juſtice, than he who violates a ſimple promiſe under an impreſſion of the ſame truths. To him who knows the ſecrets of the heart, the breach of the promiſe muſt appear as criminal as the breach of the oath. See ASSUMPSIT and OATH.

PROMONTORY, in geography, a high point of land or rock projecting out into the ſea; the extremity of which towards the ſea is called a *cape* or *headland*.

PROMPTER, in the drama, an officer poſted behind the ſcenes, whoſe buſineſs it is to watch attentively the actors ſpeaking on the ſtage, in order to ſuggeſt and put them forward when at a ſtand, to correct them when amiſs, &c. in their parts.

PROMULGATED, or PROMULGED, ſomething publiſhed or proclaimed, and generally applied to a law to denote the publiſhing or proclaiming it to the people.

PRONAOS, in the ancient architecture, a porch to a church, palace, or other ſpacious building. See the article PORCH.

PRONATION, among anatomiſts. The radius of the arm has two kinds of motions, the one called *pronation*, the other *ſupination*. Pronation is that whereby the palm of the hand is turned downwards; and ſupination, the oppoſite motion thereto, is that whereby the back of the hand is turned downwards. The peculiar muſcles whereby pronation is performed are called *pronatores*, as thoſe by which ſupination is performed are termed *ſupinatores*. See ANATOMY, *Table of the Muſcles*, and *Plates*.

PRONG-HOE, in huſbandry, a term uſed to expreſs an inſtrument uſed to hoe or break the ground near and among the roots of plants. The ordinary contrivance of the hoe is very defective, it being only made for ſcraping on the ſurface; but the great uſe of hoeing being to break and open the ground, beſide the killing of the weeds, which the ancients, and many among us, have thought the only uſe of the hoe, this dull and blunt inſtrument is by no means calculated for the purpoſes it is to ſerve. The prong-hoe conſiſts of two hooked points of ſix or ſeven inches long, and when ſtruck into the ground will ſtir and remove it the ſame depth as the plough does, and thus anſwer both the ends of cutting up the weeds and opening the land. It is uſeful even in the horſe-hoeing huſbandry, becauſe the hoe-plough can only come within three or four inches of the rows of the corn, turnips, and the like; whereas this inſtrument may be uſed afterwards, and with it the land may be raiſed and ſtirred even to the very ſtalk of the plant. See HUSBANDRY and HOE.

PRONOUN, or PRONOMEN, in grammar, a declinable part of ſpeech, which being put inſtead of a noun, points out ſome perſon or thing. See GRAMMAR.

PRONUNCIATION, in grammar, the manner of articulating or ſounding the words of a language. Pronunciation makes the moſt difficult part of written grammar; in regard that a book expreſſing itſelf to the eyes, in a matter that wholly concerns the ears, ſeems next akin to that of teaching the blind to diſtinguiſh colours: hence it is that there is no part ſo defective in grammar as that of pronunciation, as the writer has frequently no term whereby to give the reader an idea of the ſound he would expreſs; for want of a proper term, therefore, he ſubſtitutes a vicious and precarious one. To give a juſt idea of the pronunciation of a language, it ſeems neceſſary to fix as nearly as poſſible all the ſeveral ſounds employed in the pronunciation of that language. Cicero tells us, that the pronunciation underwent ſeveral changes among the Romans: and indeed it is more precarious in the living languages, being, as Du Bos tells us, ſubſervient to faſhion in theſe. The French language is clogged with a difficulty in pronunciation from which moſt others are free; and it conſiſts in this, that moſt of their words have two different pronunciations, the one in common proſe, the other in verſe.

As to the pronunciation of the Engliſh language, the ingenious Mr. Martin, in his Spelling-Book of Arts and Sciences, lays down the following rules: 1. The final (*e*) lengthens the ſound of the foregoing vowel; as in *can*, *cane*; *rob*, *robe*; *tun*, *tune*, &c. 2. The final (*e*), in words ending in *re*, is ſounded before the *r* like *u*; as *maſſacre*, *maſſa-cur*; *lucre*, *lucur*; &c. 3. The Latin diphthongs *æ*, *œ*, are ſounded like *e*; as *Ætna*, *Etna*, *œconomy*, *economy*, &c. but at the end of the words *oe* ſounds like *o*; as in *toe foe*, &c. 4. Alſo the Engliſh improper diphthongs, *ea*, *eo*, *eu*, *ue*, ſound only the *e* and *u*; as *tea* or *te*; *feoffee*, or *feffee*; *due* or *du*; *true* or *tru*, &c. though ſometimes *eo* and *ea* are pronounced like *ee*, as in *people*, *fear*, *near*, &c. 5. Sometimes the diphthong (*ie*) is pronounced like *e* in *cieling*, like *ee* in *field*, and at the end of words always like *y*, as in *lie*, &c. and *ei* is pronounced either like *e* or *ai*, as in *deceit*, *reign*, &c. 6. The triphthong *eau* is pronounced like *o*, in *beau* and *jet d'eau*; and *ieu* ſounds like *u* in *lieu*, *adieu*, &c. 7. The ſound of *c* is hard before the vowels *a*, *o*, *u*, as in *call*, *cold*, *cup*, &c. alſo ſometimes before *h*, as in *chart*, *chord*, &c. and before *l* and *r*, as in *clear*, *creep*, &c. It is otherwiſe generally ſoft, as in *city*, *cell*, *cyder*, *child*, &c. 8. In French words *ch* is ſounded like *ſh*, as in *chagreen*, *machine*; and ſometimes like *qu*, as in *choir*. 9. The ſound of *g* is hard before *a*, *o*, *u*, *l*, *r*, as in *gall*, *go*, *gum*, *glean*, *grope*; alſo before *ui*, as in *guilt*, *guild*, &c. and before *h*, as *ghoſt*; ſometimes before *i*, as in *gibbous*, *gibberiſh*. It is alſo generally hard before *e*, as in *get*, *geld*, &c. but ſoft in many words derived from the Greek and Latin, as in *geometry*, *genealogy*, *genus*, &c. Two *gg* are always hard, as in *dagger*, &c. The ſound of *g*, when ſoft, is like that of *j*. 10. In any part of a word, *ph* ſounds like *f*, as in *philoſophy*, &c. 11. The ſound of *qu*, at the end of French words, is like *k*, as in *riſque*, &c. 12. The ſyllables *ti* and *ci*, if followed by a vowel, ſound like *ſi* or *ſhi*; as in *fiction*, *logician*, &c. 13. When *cc* occurs before *i*, the firſt is hard and the latter is ſoft: as in *flaccid*, &c. 14. The letter *p* is not pronounced at the beginning of ſyllables before *ſ* and *t*; as in *pſalm*, *ptarmics*, &c. As to other peculiarities regarding the pronunciation of ſingle letters, many of them have been taken notice of at the beginning of each, in the courſe of this work.

But it is not enough to know the juſt pronunciation of ſingle letters, but alſo of words: in order to which, the accenting of words ought to be well underſtood; ſince nothing is more harſh and diſagreeable to the ear, than to hear a perſon ſpeak or read with wrong accents. And indeed in Engliſh the ſame word is often both a noun and a verb, diſtinguiſhed only by the accent, which is on the firſt ſyllable of the noun, and on the laſt of the verb; as *fèrment* and *fermènt*; *rècord* and *recòrd*, &c. We are to obſerve alſo, that in order to a juſt expreſſion of words, ſome require only a ſingle accent on the ſyllable, as in *tòrment*, &c. but in others it ſhould be marked double, as in *a''nimal*, becauſe it is pronounced as if the letter were written double, viz. *annimal*.

Mr. Sheridan's Dictionary will be found extremely uſeful as a directory in acquiring the pronunciation of the Engliſh language; but care muſt be taken to avoid his provincial brogue, which has certainly miſled him in ſeveral inſtances. Mr. Walker's Pronouncing Dictionary, will likewiſe well deſerve the ſtudent's particular attention. It is a work of great labour and merit, and is highly uſeful. It has indeed ſome faults and inaccuracies, but it is notwithſtanding, in all probability, the beſt of the kind.

Pronunciation is alſo uſed for the fifth and laſt part of rhetoric, which conſiſts in varying and regulating the voice agreeably to the matter and words, ſo as moſt effectually to perſuade and touch the hearers. See Oratory.

PROOF, in law and logic, is that degree of the evidence which carries conviction to the mind. It differs from demonſtration, which is applicable only to thoſe truths of which the contrary is inconceivable. It differs likewiſe from probability, which produces for the moſt part nothing more than opinion, while proof produces belief. See Probability. The *proof* of crimes was anciently effected among our anceſtors divers ways; viz. by duel or combat, fire, water, &c. See Duel and Ordeal.

Proof *of Artillery and Small Arms*, is a trial whether they ſtand the quantity of powder allotted for that purpoſe. The rule of the board of ordnance is, that all guns, under 24-pounders, be loaded with powder as much as their ſhot weighs; that is, a braſs 24-pounder with 21lb. a braſs 32-pounder with 26lb. 12oz. and a 42-pounder with 31lb. 8oz. the iron 24-pounder with 18lb. the 32-pounder with 21lb. 8oz. and the 42-pounder with 25lb.

The braſs light field-pieces are proved with powder that weighs half as much as their ſhot, except the 24-pounder, which is loaded with 10lb. only.

Government allows 11 bullets of lead in the pound for the proof of muſkets, and 14.5, or 29 in two pounds, for ſervice; 17 in the pound for the proof of carabines, and 20 for ſervice; 28 in the pound for the proof of piſtols, and 34 for ſervice.

When guns of a new metal, or of lighter conſtruction, are proved; then, beſides the common proof, they are fired 200 or 300 times, as quick as they can be, loaded with the common charge given in actual ſervice. Our light ſix-pounders were fired 400 times in 3 hours 27 minutes, loaded with 1lb. 4oz. without receiving any damage.

Proof of *Powder*, is in order to try its goodneſs and ſtrength. See Gunpowder.

Proof *of Cannon*, is made to aſcertain their being well caſt, their having no cavities in their metal, and, in a word, their being fit to reſiſt the effort of their charge of powder. In making this proof, the piece is laid upon the ground, ſupported only by a piece of wood in the middle, of about 5 or 6 inches thick, to raiſe the muzzle a little; and then the piece is fired againſt a ſolid butt of earth.

Tools uſed in the Proof *of Cannon* are as follow:

1. *Searcher*, an iron ſocket with branches, from 4 to 8 in number, bending outwards a little, with ſmall points at their ends: to this ſocket is fixed a wooden handle, from 8 to 12 feet long, and 1½ inch in diameter. This ſearcher is introduced into the gun after each firing, and turned gently round to diſcover the cavities within: if any are found, they are marked on the outſide with chalk; and then the

2. *Searcher with one point* is introduced; about which point a mixture of wax and tallow is put, to take the impreſſion of the holes; and if any are found of one fourth of an inch deep, or of any conſiderable length, the gun is rejected as unſerviceable to the government.

3. *Reliever*, is an iron ring fixed to a handle, by means of a ſocket, ſo as to be at right angles; it ſerves to diſengage the firſt ſearcher, when any of its points are retarded in a hole, and cannot otherwiſe be got out. When guns are rejected by the proof-maſters, they order them to be marked X thus, which the contractors generally alter *IVP* thus; and after ſuch alteration diſpoſe of them to foreign powers for Woolwich proof.

The moſt curious inſtrument for finding the principal defects in pieces of artillery, was invented by lieutenant-general Desaguliers, of the royal regiment of artillery. This inſtrument, grounded on the trueſt mechanical principles, is no ſooner introduced into the hollow cylinder of the gun, than it diſcovers its defects, and more particularly that of the piece not being truly bored; which is a very important one, and to which moſt of the diſaſters happening to pieces of artillery are in a great meaſure to be imputed; for, when a gun is not truly bored, the moſt expert artilleriſt will not be able to make a good ſhot.

Proof *of Mortars and Howitzers*, is made to aſcertain their being well caſt, and of ſtrength to reſiſt the effort of their charge. For this purpoſe the mortar or howitzer is placed upon the ground, with ſome part of their trunnions or breech ſunk below the ſurface, and reſting on wooden billets, at an elevation of about 70 degrees. The *mirror* is generally the only inſtrument to diſcover the defects in mortars and howitzers. In order to uſe it, the ſun muſt ſhine; the breech muſt be placed towards the ſun, and the glaſs over-againſt the mouth of the piece: it illuminates the bore and chamber ſufficiently to diſcover the flaws in it.

Proof *of Foreign Braſs Artillery*. 1ſt, The Pruſſians. Their battering-train and garriſon artillery are proved with a quantity of powder equal to ½ the weight of the ſhot, and fired 75 rounds as faſt as in real ſervice; that is, 2 or 3 rounds in a minute. Their light field-train, from a 12-pounder upwards, are proved with a quantity of powder = 1-3d of the weight of the ſhot, and fired 150 rounds, at 3 or 4 rounds in a minute. From a 12-pounder downwards, are proved with a quantity of powder = 1-5th of the ſhot's weight, and fired 300 rounds, at 5 or 6 rounds each minute, properly ſpunged and loaded. Their mortars are proved with the chambers full of powder, and the ſhells loaded. Three rounds are fired as quick as poſſible. 2d, The Dutch prove all their artillery by firing each piece 5 times: the two firſt rounds with a quantity of powder = 2-3ds of the weight of the ſhot; and the three laſt rounds with a quantity of powder = ½ the weight of the ſhot. 3d, The French the ſame as the Dutch.

Proof, in brandy and other ſpirituous liquors, is a little white lather which appears on the top of the liquor when poured into a glaſs. This lather, as it diminiſhes, forms itſelf into a circle called by the French the *chapelet*, and by the Engliſh the *bead* or *bubble*.

Proofs *of Prints*, were anciently a few impreſſions taken off in the courſe of an engraver's proceſs. He proved a plate in different ſtates, that he might aſcertain how far his labours had been ſucceſsful, and when they were complete. The excellence of ſuch early impreſſions, worked with care, and under the artiſt's eye, occaſioning them to be greedily ſought after, and liberally paid for, it has been cuſtomary among our modern printſellers to take off a number of them, amounting, perhaps to hundreds, from every plate of conſiderable value; and yet their want of rareneſs has by no means abated their price. On retouching a plate, it has been alſo uſual, among the ſame conſcientious fraternity, to cover the inſcription, which was immediately added after the firſt proofs were obtained, with ſlips of paper, that a number of ſecondary proofs might alſo be created.

Proof, in the ſugar trade. See Sugar.

Proofs, in printing. See Printing.

PROPAGATION, the act of multiplying the kind. See Generation.

Propagation *of Plants*. The moſt natural and the moſt univerſal way of propagating plants is by ſeeds. See Plants, and Natural History. But they may alſo be propagated by *ſets*, *pieces*, or *cuttings*, taken from the parent plant. Willows are very eaſily propagated by ſets: ſuch as riſe to be conſiderable timber trees being raiſed from ſets 7 or 8 feet long, ſharpened at their larger ends, which are thruſt into the ground by the ſides of ditches, on the banks of rivers, or in any moiſt ſoil.

The ſallow trees are raiſed from ſets only 3 feet long. The plane tree, mint, &c. may be propagated in the ſame way. In providing the ſlips, ſprigs, or cuttings, however, care muſt be taken to cut off ſuch branches as have knots or joints 2 or 3 inches beneath them; ſmall top ſprigs of 2 or 3 years growth are the beſt for this operation. Plants are alſo propagated by parting their roots, each part of which, properly managed, ſends out freſh roots. Another mode of propagating plants is by layering or laying the tops of the branches in the ground.

The method of layering is this: Dig a ring-trench round the ſtool, of a depth ſuitable to the nature of the plant; and having pitched upon the ſhoots to be layered, bend them to the bottom of the trench (either with or without plaſhing, as may be found moſt convenient), and there *peg* them faſt; or, putting ſome mould upon them, *tread* them hard enough to prevent their ſpringing up again—fill in the mould—place the top of the layer in an upright poſture, treading the mould hard behind it; and cut it carefully off above the firſt, ſecond, or third eye. Plants are alſo propagated by their bulbs.

The number of vegetables that may be propagated from an individual is very remarkable, eſpecially in the moſt minute plants. The annual product of one ſeed even of the common mallow has been found to be no leſs than 200,000; but, it has been ſince proved, by a ſtrict examination into the more minute parts of the vegetable world, that ſo deſpiſed a plant as the common wall moſs produces a much more numerous offspring. In one of the little heads of this plant there have been counted 13824 ſeeds. Now allotting to a root of this plant eight branches, and to each branch ſix heads, which appears to be a very moderate computation, the produce of one ſeed is 6 × 13824 = 82944; and 8 × 82944, gives 663,552 ſeeds as the annual produce of one ſeed, and that ſo ſmall that 13824 of them are contained in a capſule, whoſe length is but one ninth of an inch, its diameter but one 23d of an inch, and its weight but the 13th part of a grain.

For the propagation or culture of particular plants, ſee HUSBANDRY, and the names of the plants in queſtion.

PROPER, ſomething natural and eſſentially belonging to any thing.

PROPERTIUS (SEXTUS AURELIUS), a celebrated Latin poet, born at Mevania, a city of Umbria, now called *Bevagna*, in the duchy of Spoletto. He went to Rome after the death of his father, a Roman knight, who had been put to death by order of Auguſtus, for having followed Antony's party during the triumvirate. Propertius in a ſhort time acquired great reputation by his wit and abilities, and had a conſiderable ſhare in the eſteem of Mæcenas and Cornelius Gallus. He had alſo Ovid, Tibullus, Baſſus, and other ingenious men of his time, for his friends. He died at Rome 19 B. C. He is printed with almoſt all the editions of Tibullus and Catullus: but the beſt edition of him is that which was given ſeparately by Janus Brouckhuſius at Amſterdam, 1702, in 4to, and again in 1714, 4to. *cum curis ſecundis ejuſdem.* We have four books of his Elegies or Amours with a lady called *Hoſtia*, or *Hoſtilia*, to whom he gave the name of *Cynthia*.

PROPERTY, in a general ſenſe, is a particular virtue or quality which nature has beſtowed on ſome things excluſive of all others: thus, colour is a property of light; extenſion, figure, diviſibility, impenetrability, are properties of body.

PROPERTY, in law, is deſcribed to be the higheſt right which a perſon has or can have to any thing.

There is nothing which ſo generally ſtrikes the imagination, and engages the affections of mankind, as the right of property; or that ſole and deſpotic dominion which one man claims and exerciſes over certain external things of the world, in total excluſion of the right of any other individual in the univerſe. And yet there are very few that will give themſelves the trouble to conſider the original and foundation of this right. Pleaſed as we are with the poſſeſſion, we ſeem afraid to look back to the means by which it was acquired, as if fearful of ſome defect in our title; or at beſt we reſt ſatiſfied with the deciſion of the laws in our favour, without examining the reaſon or authority upon which thoſe laws have been built. We think it enough that our title is derived by the grant of the former proprietor, by deſcent from our anceſtors, or by the laſt will and teſtament of the dying owner: not caring to reflect, that (accurately and ſtrictly ſpeaking) there is no foundation in nature or in natural law, why a ſet of words upon parchment ſhould convey the dominion of land; why the ſon ſhould have a right to exclude his fellow-creatures from a determinate ſpot of ground, becauſe his father had done ſo before him; or why the occupier of a particular field or of a jewel, when lying on his death-bed and no longer able to maintain poſſeſſion, ſhould be entitled to tell the reſt of the world which of them ſhould enjoy it after him. Theſe inquiries, it muſt be owned, would be uſeleſs and even troubleſome in common life. It is well if the maſs of mankind will obey the laws when made, without ſcrutinizing too nicely into the reaſons of making them. But when law is to be conſidered not only as a matter of practice, but alſo as a rational ſcience, it cannot be improper or uſeleſs to examine more deeply the rudiments and grounds of theſe poſitive conſtitutions of ſociety.

In the beginning of the world, we are informed by holy writ, that the all-bountiful Creator gave to man "dominion over all "the earth; and over the fiſh of the ſea, and over the fowl of "the air, and over every living thing that moveth upon the "earth." This is the only true and ſolid foundation of man's dominion over external things, whatever airy metaphyſical notions may have been ſtarted by fanciful writers upon this ſubject. The earth, therefore, and all things therein, are the general property of all mankind, excluſive of other beings, from the immediate gift of the Creator. And, while the earth continued thinly inhabited, it is reaſonable to ſuppoſe, that all was in common among them, and that every one took from the public ſtock to his own uſe ſuch things as his immediate neceſſities required.

Theſe general notions of property were then ſufficient to anſwer all the purpoſes of human life; and might perhaps ſtill have anſwered them, had it been poſſible for mankind to have remained in a ſtate of primæval ſimplicity: as may be collected from the manners of many American nations, when firſt diſcovered by the Europeans; and from the ancient method of living among the firſt Europeans themſelves, if we may credit either the memorials of them preſerved in the golden age of the poets, or the uniform accounts given by hiſtorians of thoſe times wherein *erant omnia communia et indiviſa omnibus, veluti unum cunctis patrimonium eſſet.* Not that this communion of goods ſeems ever to have been applicable, even in the earlieſt ages, to aught but the *ſubſtance* of the thing; nor could it be extended to the *uſe* of it. For, by the law of nature and reaſon, he who firſt began to uſe it, acquired therein a kind of tranſient property, that laſted ſo long as he was uſing it, and no longer: or, to ſpeak with greater preciſion, the *right* of poſſeſſion continued for the ſame time only that the *act* of poſſeſſion laſted. Thus the ground was in common, and no part of it was the permanent property of any man in particular; yet whoever was in the occupation of any determinate ſpot of it, for reſt, for ſhade, or the like, acquired for the time a ſort of ownerſhip, from which it would have been unjuſt, and contrary to the law of nature, to have driven him by force; but the inſtant that he quitted the uſe or occupation of it, another might ſeize it without injuſtice. Thus alſo a vine or other tree might be ſaid to be in common, as all were equally entitled to its produce; and yet any private individual might gain the ſole property of the fruit, which he had gathered for his own repaſt. A doctrine well illuſtrated by Cicero, who compares the world to a great theatre, which is common to the public, and yet the place which any man has taken is for the time his own.

But when mankind increaſed in number, craft, and ambition, it became neceſſary to entertain conceptions of more permanent dominion; and to appropriate to individuals, not the immediate *uſe* only, but the very *ſubſtance* of the thing to be uſed: otherwiſe innumerable tumults muſt have ariſen, and the good order of the world been continually broken and diſturbed, while a variety of perſons were ſtriving who ſhould get the firſt occupation of the ſame thing, or diſputing which of them had actually gained it. As human life alſo grew more and more refined, abundance of conveniences were deviſed to render it more eaſy, commodious, and agreeable; as habitations for ſhelter and ſafety, and raiment for warmth and decency. But no man would be at the trouble to provide either, ſo long as he had only an uſufructuary property in them, which was to ceaſe the inſtant that he quitted poſſeſſion;—if, as ſoon as he walked out of his tent, or pulled off his garment, the next ſtranger who came by would have a right to inhabit the one and to wear the other. In caſe of habitations in particular, it was natural to obſerve, that even the brute creation, to whom every thing elſe was in common, maintained a permanent property in their dwellings, eſpecially for the protection of their young; that the birds of the air had neſts, and the beaſts of the fields had caverns, the invaſion of which they eſteemed a very flagrant injuſtice, and would ſacrifice their lives to preſerve them. Hence a property was ſoon eſtabliſhed in every man's houſe and home-ſtall; which ſeem to have been originally mere temporary huts or moveable cabins, ſuited to the deſign of Providence for more ſpeedily peopling the earth, and ſuited to the wandering life of their owners, before any extenſive property in the ſoil or ground was eſtabliſhed. And there can be no doubt, but that moveables of every kind became ſooner appropriated than the permanent ſubſtantial ſoil: partly becauſe they were more ſuſceptible of a long occupancy, which might be continued for months together without any ſenſible interruption, and at length by uſage ripen into an eſtabliſhed right; but principally becauſe few of them could be fit for uſe, till improved and meliorated by the bodily labour of the occupant; which bodily labour, beſtowed upon any ſubject which before lay in common to all men, is univerſally allowed to give the faireſt and moſt reaſonable title to an excluſive property therein.

The article of food was a more immediate call, and therefore a more early conſideration. Such as were not contented with the ſpontaneous product of the earth ſought for a more ſolid refreſhment in the fleſh of beaſts, which they obtained by hunting. But the frequent diſappointments incident to that method of proviſion induced them to gather together ſuch animals as were of a more tame and ſequacious nature; and to eſtabliſh a permanent property in their flocks and herds, in order to ſuſtain themſelves in a leſs precarious manner, partly by the milk of their dams, and partly by the fleſh of the young. The ſupport of theſe their cattle made the article of *water* alſo a very important point. And therefore the book of Geneſis (the moſt venerable monument of antiquity, conſidered merely with a view to hiſtory) will furniſh us with frequent inſtances of violent contentions concerning wells; the excluſive property of which appears to have been eſtabliſhed in the firſt digger or occupant, even in ſuch places where the ground and herbage remained yet in common. Thus we find Abraham, who was but a ſojourner, aſſerting his right to a well in the country of Abimelech, and exacting an oath for his ſecurity, "becauſe he had digged that well." And Iſaac, about 90 years afterwards, reclaimed this his father's property; and, after much contention with the Philiſtines, was ſuffered to enjoy it in peace.

All this while the ſoil and paſture of the earth remained ſtill in common as before, and open to every occupant: except perhaps in the neighbourhood of towns, where the neceſſity of a ſole and excluſive property in lands (for the ſake of agriculture) was earlier felt, and therefore more readily complied with. Otherwiſe, when the multitude of men and cattle had conſumed every convenience on one ſpot of ground, it was deemed a natural right to ſeize upon and occupy ſuch lands as would more eaſily ſupply their neceſſities. This practice is ſtill retained among the wild and uncultivated nations that have never been formed into civil ſtates, like the Tartars and others in the eaſt; where the climate itſelf, and the boundleſs extent of their territory, conſpire to retain them ſtill in the ſame ſavage ſtate of vagrant liberty, which was univerſal in the earlieſt ages, and which Tacitus informs us continued among the Germans till the decline of the Roman empire. We have alſo a ſtriking example of the ſame kind in the hiſtory of Abraham and his nephew Lot. When their joint ſubſtance became ſo great, that paſture and other conveniences grew ſcarce, the natural conſequence was, that a ſtrife aroſe between their ſervants; ſo that it was no longer practicable to dwell together. This contention Abraham endeavoured to compoſe: "Let there be no ſtrife, I pray thee, between thee and me. Is not the whole land before thee? Separate thyſelf, I pray thee, from me: If thou wilt take the left hand, then I will go to the right; or if thou depart to the right hand, then I will go to the left." This plainly implies an acknowledged right, in either, to occupy whatever ground he pleaſed, that was not pre-occupied by other tribes. "And Lot lifted up his eyes, and beheld all the plain of Jordan that it was well watered everywhere, even as the garden of the Lord. Then Lot choſe him all the plain of Jordan, and journeyed eaſt; and Abraham dwelt in the land of Canaan."

Upon the ſame principle was founded the right of migration, or ſending colonies to find out new habitations, when the mother country was overcharged with inhabitants; which was practiſed as well by the Phœnicians and Greeks, as the Germans, Scythians, and other northern people. And, ſo long as it was confined to the ſtocking and cultivation of deſert uninhabited countries, it kept ſtrictly within the limits of the law of nature.

But as the world by degrees grew more populous, it daily became more difficult to find out new ſpots to inhabit, without encroaching upon former occupants; and by conſtantly occupying the ſame individual ſpot, the fruits of the earth were conſumed, and its ſpontaneous produce deſtroyed, without any proviſion for a future ſupply or ſucceſſion. It therefore became neceſſary to purſue ſome regular method of providing a conſtant ſubſiſtence; and this neceſſity produced, or at leaſt promoted and encouraged, the art of agriculture. And the art of agriculture, by a regular connection and conſequence, introduced and eſtabliſhed the idea of a more permanent property in the ſoil than had hitherto been received and adopted. It was clear that the earth would not produce her fruits in ſufficient quantities without the aſſiſtance of tillage; but who would be at the pains of tilling it, if another might watch an opportunity to ſeize upon and enjoy the product of his induſtry, art, and labour? Had not, therefore a ſeparate property in lands, as well as moveables, been veſted in ſome individuals, the world muſt have continued a foreſt, and men have been mere animals of prey; which, according to ſome philoſophers, is the genuine ſtate of nature. Whereas now (ſo graciouſly has Providence interwoven our duty and our happineſs together) the reſult of this very neceſſity has been the ennobling of the human ſpecies, by giving it opportunities of improving in *rational* faculties, as well as of exerting its *natural*. Neceſſity begat property: and in order to inſure that property, recourſe was had to civil ſociety, which brought along with it a long train of inſeparable concomitants; ſtates, governments, laws, puniſhments, and the ublic exerciſe of religious duties. Thus connected together, it was found that a part only of ſociety was ſufficient to provide, by their manual labour, for the neceſſary ſubſiſtence of all; and leiſure was given to others to cultivate the human mind, to invent uſeful arts, and to lay the foundations of ſcience.

The only queſtion remaining is, How this property became actually veſted; or what it is that gave a man an excluſive right to retain in a permanent manner that ſpecific land which before belonged generally to every body, but particularly to nobody? And as we before obſerved, that *occupancy* gave the right to the temporary *uſe* of the ſoil; ſo it is agreed upon all hands, that occupancy gave alſo the original right to the permanent property in the *ſubſtance* of the earth itſelf, which excludes every one elſe but the owner from the uſe of it. There is indeed ſome difference among the writers on natural law, concerning the reaſon why occupancy ſhould convey this right, and inveſt one with this abſolute property: Grotius and Puffendorff inſiſting, that this right of occupancy is founded upon a tacit and implied aſſent of all mankind, that the firſt occupant ſhould become the owner; and Barbeyrac, Titius, Mr. Locke, and others, holding, that there is no ſuch implied aſſent, neither is it neceſſary that there ſhould be; for that the very act of occupancy, alone, being a degree of bodily labour, is from a principle of natural juſtice, without any conſent or compact, ſufficient of itſelf to gain a title. A diſpute that ſavours too much of nice and ſcholaſtic refinement. However, both ſides agree in this, that occupancy is the thing by which the title was in fact originally gained; every man ſeizing to his own continued uſe ſuch ſpots of ground as he found moſt agreeable to his own convenience, provided he found them unoccupied by any one elſe.

Property, both in lands and moveables, being thus originally acquired by the firſt taker, which taking amounts to a declaration, that he intends to appropriate the thing to his own uſe, it remains in him, by the principle of univerſal law, till ſuch time as he does ſome other act which ſhows an intention to abandon it; for then it becomes, naturally ſpeaking, *publici juris* once more, and is liable to be again appropriated by the next occupant. So, if one is poſſeſſed of a jewel, and caſts it into the ſea or a public highway, this is ſuch an expreſs dereliction, that a property will be veſted in the firſt fortunate finder that ſhall ſeize it to his own uſe. But if he hides it privately in the earth, or other ſecret place, and it is diſcovered, the finder acquires no property therein; for the owner hath not by this act declared any intention to abandon it, but rather the contrary: and if he loſes or drops it by accident, it cannot be collected from thence that he deſigned to quit the poſſeſſion; and therefore in ſuch caſe the property ſtill remains in the loſer, who may claim it again of the finder. And this, we may remember, is the doctrine of the Engliſh law with relation to TREASURE-*Trove*.

But this method, of one man's abandoning his property, and another ſeizing the vacant poſſeſſion, however well founded in theory, could not long ſubſiſt in fact. It was calculated merely for the rudiments of civil ſociety, and neceſſarily ceaſed among the complicated intereſts and artificial refinements of polite and eſtabliſhed governments. In theſe it was found, that what became inconvenient or uſeleſs to one man, was highly convenient and uſeful to another; who was ready to give in exchange for it ſome equivalent that was equally deſirable to the former proprietor. This mutual convenience introduced commercial traffic, and the reciprocal transfer of property by ſale, grant, or conveyance: which may be conſidered either as a continuance of the original poſſeſſion which the firſt occupant had; or as an abandoning of the thing by the preſent owner, and an immediate ſucceſſive occupancy of the ſame by the new proprietor. The voluntary dereliction of the owner, and delivering the poſſeſſion to another individual, amount to a transfer of the property; the proprietor declaring his intention of no longer occupying the thing himſelf, but that his own right of occupancy ſhall be veſted in the new acquirer. Or, taken in the other light, if I agree to part with an acre of my land to Titius, the deed of conveyance is an evidence of my intending to abandon the property; and Titius being the only or firſt man acquainted with ſuch my intention, immediately ſteps in and ſeizes the vacant poſſeſſion: thus, the conſent expreſſed by the conveyance gives Titius a good right againſt me; and poſſeſſion or occupancy confirms that right againſt all the world beſides.

The moſt univerſal and effectual way of abandoning property is by the death of the occupant; when, both the actual poſſeſſion and intention of keeping poſſeſſion ceaſing, the property, which is founded upon ſuch poſſeſſion and intention, ought alſo to ceaſe of courſe. For, naturally ſpeaking, the inſtant a man ceaſes to be, he ceaſes to have any dominion: elſe, if he had a right to diſpoſe of his acquiſitions one moment beyond his life, he would alſo have a right to direct their diſpoſal for a million of ages after him; which would be highly abſurd and inconvenient *. All property muſt therefore ceaſe upon death, conſidering men as abſolute individuals, and unconnected with civil ſociety: for then, by the principles before eſtabliſhed, the next immediate occupant would acquire a right in all that the deceaſed poſſeſſed. But as, under civilized governments, which are calculated for the peace of mankind, ſuch a conſtitution would be productive of endleſs diſturbances, the univerſal law of almoſt every nation (which is a kind of ſecondary law of nature) has either given the dying perſon a power of continuing his property, by diſpoſing of his poſſeſſions by will; or, in caſe he neglects to diſpoſe of it, or is not permitted to make any diſpoſition at all, the municipal law of the country then ſteps in, and declares who ſhall be the ſucceſſor, repreſentative, or heir of the deceaſed; that is, who alone ſhall have a right to enter upon this vacant poſſeſſion, in order to avoid that confuſion which its becoming again common would occaſion. And further, in caſe no teſtament be permitted by the law, or none be made, and no heir can be found ſo qualified as the law requires, ſtill, to prevent the robuſt title of *occupancy* from again taking place, the doctrine of eſcheats is adopted in almoſt every country; whereby the ſovereign of the ſtate, and thoſe who claim under his authority, are the ultimate heirs, and ſucceed to thoſe inheritances to which no other title can be formed.

The right of inheritance, or deſcent to the children and relations of the deceaſed, ſeems to have been allowed much earlier than the right of deviſing by teſtament. We are apt to conceive at the firſt view that it has nature on its ſide; yet we often miſtake for nature what we find eſtabliſhed by long and inveterate cuſtom. It is certainly a wiſe and effectual, but clearly a political eſtabliſhment; ſince the permanent right of property, veſted in the anceſtor himſelf, was no *natural*, but merely a *civil* right. It is true, that the tranſmiſſion of one's poſſeſſions to poſterity has an evident tendency to make a man a good citizen and a uſeful member of ſociety: it ſets the paſſions on the ſide of duty, and prompts a man to deſerve well of the public, when he is ſure that the reward of his ſervices will not die with himſelf, but be tranſmitted to thoſe with whom he is connected by the deareſt and moſt tender affections. Yet, reaſonable as this foundation of the right of inheritance may ſeem, it is probable that its immediate original aroſe not from ſpeculations altogether ſo delicate and refined, and, if not from fortuitous circumſtances, at leaſt from a plainer and more ſimple principle. A man's children or neareſt relations are uſually about him on his death-bed, and are the earlieſt witneſſes of his deceaſe. They became therefore generally the next immediate occupants, till at length in proceſs of time this frequent uſage ripened into general law. And therefore alſo in the earlieſt ages, on failure of children, a man's ſervants born under his roof were allowed to be his heirs; being immediately on the ſpot when he died. For we find the old patriarch Abraham expreſsly declaring, that "ſince God had given him no ſeed, his ſteward Eliezer, one born in his houſe, was his heir."

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* This right, inconvenient as it certainly is, the law of Scotland gives to every man over his *real* eſtate, by authoriſing him to entail it on his heirs for ever.

While property continued only for life, teſtaments were uſeleſs and unknown; and when it became inheritable, the inheritance was long indefeaſible, and the children or heirs at law were incapable of excluſion by will. Till at length it was found, that ſo ſtrict a rule of inheritance made heirs diſobedient and head-ſtrong, defrauded creditors of their juſt debts, and prevented many provident fathers from dividing or charging their eſtates as the exigence of their families required. This introduced pretty generally the right of diſpoſing of one's property, or a part of it, by *teſtament*; that is, by written or oral inſtructions properly *witneſſed* and authenticated, according to the *pleaſure* of the deceaſed; which we therefore emphatically ſtyle his *will*. This was eſtabliſhed in ſome countries much later than in others. In England, till modern times, a man could only diſpoſe of one third of his moveables from his wife and children; and, in general, no will was permitted of lands till the reign of Henry VIII. and then only of a certain portion; for it was not till after the Reſtoration that the power of deviſing real property became ſo univerſal as at preſent.

Wills, therefore, and teſtaments, rights of inheritance, and ſucceſſions, are all of them creatures of the civil or municipal laws, and accordingly are in all reſpects regulated by them; every diſtinct country having different ceremonies and requiſites to make a teſtament completely valid; neither does any thing vary more than the right of inheritance under different national eſtabliſhments. In England particularly, this diverſity is carried to ſuch a length, as if it had been meant to point out the power of the laws in regulating the ſucceſſion to property, and how futile every claim muſt be that has not its foundation in the poſitive rules of the ſtate. In perſonal eſtates, the father may ſucceed to his children; in landed property, he never can be their immediate heir by any the remoteſt poſſibility: in general, only the eldeſt ſon, in ſome places only the youngeſt, in others all the ſons together, have a right to ſucceed to the inheritance: In real eſtates, males are preferred to females, and the eldeſt male will uſually exclude the reſt; in the diviſion of perſonal eſtates, the females of equal degree are admitted together with the males, and no right of primogeniture is allowed.

This one conſideration may help to remove the ſcruples of many well-meaning perſons, who ſet up a miſtaken conſcience in oppoſition to the rules of law. If a man diſinherits his ſon, by a will duly executed, and leaves his eſtate to a ſtranger, there are many who conſider this proceeding as contrary to natural juſtice; while others ſo ſcrupulouſly adhere to the ſuppoſed intention of the dead, that if a will of lands be atteſted by only *two* witneſſes inſtead of *three*, which the law requires, they are apt to imagine that the heir is bound in conſcience to relinquiſh his title to the deviſee. But both of them certainly proceed upon very erroneous principles: as if, on the one hand, the ſon had by nature a right to ſucceed to his father's lands; or as if, on the other hand, the owner was by nature entitled to direct the ſucceſſion of his property after his own deceaſe. Whereas the law of nature ſuggeſts, that on the death of the poſſeſſor the eſtate ſhould again become common, and be open to the next occupant, unleſs otherwiſe ordered, for the ſake of civil peace, by the poſitive law of ſociety. The poſitive law of ſociety, which is with us the municipal laws of England and Scotland, directs it to veſt in ſuch perſon as the laſt proprietor ſhall by will, attended with certain requiſites, appoint; and, in defect of ſuch appointment, to go to ſome particular perſon, who, from the reſult of certain local conſtitutions, appears to be the heir at law. Hence it follows, that, where the appointment is regularly made, there cannot be a ſhadow of right in any one but the perſon appointed: and, where the neceſſary requiſites are omitted, the right of the heir is equally ſtrong, and built upon as ſolid a foundation, as the right of the deviſee would have been, ſuppoſing ſuch requiſites were obſerved.

But, after all, there are ſome few things, which, notwithſtanding the general introduction and continuance of property, muſt ſtill unavoidably remain in common; being ſuch wherein nothing but an uſufructuary property is capable of being had: and therefore they ſtill belong to the firſt occupant during the time he holds poſſeſſion of them, and no longer. Such (among others) are the elements of light, air, and water; which a man may occupy by means of his windows, his gardens, his mills, and other conveniences: ſuch alſo are the generality of thoſe animals which are ſaid to be *feræ naturæ*, or of a wild and untameable diſpoſition; which any man may ſeize upon and keep for his own uſe or pleaſure. All theſe things, ſo long as they remain in poſſeſſion, every man has a right to enjoy without diſturbance; but if once they eſcape from his cuſtody, or he voluntarily abandons the uſe of them, they return to the common ſtock, and any other man has an equal right to ſeize and enjoy them afterwards.

Again, there are other things in which a permanent property may ſubſiſt, not only as to the temporary uſe, but alſo the ſolid ſubſtance; and which yet would be frequently found without a proprietor, had not the wiſdom of the law provided a remedy to obviate this inconvenience. Such are foreſts and other waſte grounds, which were omitted to be appropriated in the general diſtribution of lands: ſuch alſo are wrecks, eſtrays, and that ſpecies of wild animals which the arbitrary conſtitutions of poſitive law have diſtinguiſhed from the reſt by the well-known appellation of *game*. With regard to theſe and ſome others, as diſturbances and quarrels would frequently ariſe among individuals contending about the acquiſition of this ſpecies of property by firſt occupancy, the law has therefore wiſely cut up the root of diſſenſion, by veſting the things themſelves in the ſovereign of the ſtate; or elſe in his repreſentatives appointed and authoriſed by him, being uſually the lords of manors. And thus our legiſlature has univerſally promoted the grand ends of civil ſociety, the peace and ſecurity of individuals, by ſteadily purſuing that wiſe and orderly maxim, of aſſigning to every thing capable of ownerſhip a legal and determinate owner.

In this age of paradox and innovation, much has been ſaid of *liberty* and *equality*; and ſome few have contended for an equalization of property. One of the wildeſt declaimers on this ſubject, who is for aboliſhing property altogether has (inadvertently we ſuppoſe) given a complete confutation, not only of his own arguments, but alſo of the arguments of all who have written, or, we think, can write, on the ſame ſide of the queſtion. After labouring to prove that it is groſs injuſtice in any man to retain more than is abſolutely neceſſary to ſupply him with food, clothes, and ſhelter, this zealous reformer ſtates an objection to his theory, ariſing from the well-known allurements of ſloth, which, if the accumulation of property were not permitted, would baniſh induſtry from the whole world. The objection he urges fairly, and anſwers it thus: "It may be obſerved, that the equality for which we are pleading is an equality that would ſucceed to a ſtate of great intellectual improvement. So bold a revolution cannot take place in human affairs, till the general mind has been highly cultivated. The preſent age of mankind is greatly enlightened; but, it is to be feared, is not yet enlightened enough. Haſty and undigeſted tumults may take place, under the idea of an equalization of property; but it is only a calm and clear conviction of juſtice, of juſtice mutually to be rendered and received, of happineſs to be produced by the *deſertion of our moſt rooted habits*, that can introduce an invariable ſyſtem of this ſort. Attempts without this preparation will be productive only of confuſion. Their effect will be momentary, and a new and more barbarous inequality will ſucceed. Each man with unaltered appetite will watch his opportunity to gratify his love of power, or his love of diſtinction, by uſurping on his inattentive neighbours."

Theſe are juſt obſervations, and ſuch as we have often made to ourſelves on the various propoſed reformations of government. The illumination which the author requires before he would introduce his abolition of property, would conſtitute men more than angels; for, to be under the influence of no paſſion or appetite, and to be guided in every action by unmixed benevolence and pure intellect, is a degree of perfection which we can attribute to no being inferior to God. But it is the object of the greater part of this writer's book to prove that all men muſt arrive at ſuch perfection before his ideal republic can contribute to their happineſs; and therefore every one who is conſcious of being at any time ſwayed by paſſion, and who feels that he is more attached to his wife or children than to ſtrangers, will look without envy to the preſent inequalities of property and power, if he be an intelligent diſciple of Mr. Godwin.

Literary PROPERTY. See COPY-*Right*.

PROPHECY is a word derived from προφητεια, and in its original import ſignifies the prediction of future events.

As God alone can perceive with certainty the future actions of free agents, and the remote conſequences of thoſe laws of nature which he himſelf eſtabliſhed, prophecy, when clearly fulfilled, affords the moſt convincing evidence of an intimate and ſupernatural communion between God and the perſon who uttered the prediction. Together with the power of working miracles, it is indeed the only evidence which can be given of ſuch a communion. Hence, among the profeſſors of every religious ſyſtem except that which is called the religion of nature, there have been numberleſs pretenders to the gift of prophecy. The Pagan nations of antiquity had their oracles, augurs, and ſoothſayers. Modern idolaters have their necromancers and diviners; and the Jews, Chriſtians and Mahometans have their ſeers and prophets.

The ill-founded pretenſions of paganiſm, ancient and modern, have been expoſed under various articles of this work. (See DIVINATION, MAGIC, NECROMANCY, and MYTHOLOGY.) And the claims of the Arabian impoſtor are examined under the articles ALCORAN and MAHOMETANISM; ſo that at preſent we have only to conſider the uſe, intent, and truth of the Jewiſh and Chriſtian prophecies.

Previous to our entering on this inveſtigation, it may be proper to obſerve, that, in the Scriptures of the Old and New Teſtaments, the ſignification of the word prophecy is not always confined to the foretelling of future events. In ſeveral inſtances it is of the ſame import with preaching, and denotes the faculty of illuſtrating, and applying to preſent practical purpoſes, the doctrines of prior revelation. Thus, in Nehemiah it is ſaid, "Thou haſt appointed prophets to preach;" and whoever ſpeaketh unto men to edification, and exhortation, and comfort, is by St. Paul called a *prophet*. Hence it was that there were ſchools of prophets in Iſrael, where young men were inſtructed in the truths of religion, and fitted to exhort and comfort the people.

In this article, however, it is chiefly of importance to confine ourſelves to that kind of prophecy which, in declaring truths either paſt, preſent, or future, required the immediate inſpiration of God.

Every one who looks into the hiſtory of the world muſt obſerve, that the minds of men have from the beginning been gradually opened by a train of events ſtill improving upon, and adding light to each other; as that of each individual is, by proceeding from the firſt elements and ſeeds of ſcience, to more enlarged views and a ſtill higher growth. Mankind neither are nor ever have been capable of entering into the depths of knowledge at once; of receiving a whole ſyſtem of natural or moral truths together; but muſt be let into them by degrees, and have them communicated by little and little, as they are able to bear it. That this is the caſe with reſpect to human ſcience is a fact which cannot be queſtioned; and there is as little room to queſtion it with reſpect to the progreſs of religious knowledge among men, either taken collectively or in each individual. Why the caſe is thus in both, why all are not adult at once in body and mind, is a queſtion which the religion of nature is equally called upon with revelation to anſwer. The fact may not be eaſily accounted for, but the reality of it is incontrovertible.

Accordingly, the great object of the ſeveral revelations recorded in the Old Teſtament was evidently to keep alive a ſenſe of religion in the minds of men, and to train them by degrees for the reception of thoſe ſimple but ſublime truths by which they were to be ſaved. The notions which the early deſcendants of Adam entertained of the Supreme Being, and of the relation in which they ſtood to him, were probably very groſs; and we ſee them gradually refined by a ſeries of revelations or prophecies, each in ſucceſſion more explicit than that by which it was preceded, till the advent of Him who was the way, the truth, and the life, and who brought to light life and immortality.

When a revelation was made of any important truth, the grounds of which the mind of man has not faculties to comprehend, that revelation, though undoubtedly a prophecy, muſt have been ſo far from confirming the truth of revealed religion in general, that it could not gain credit itſelf but by ſome extrinſic evidence that it came indeed from God. Hence we find Moſes, after it was revealed to him from the burning buſh that he ſhould deliver his countrymen from Egyptian bondage, replying, "Behold, they will not believe me, nor hearken to my voice; for they will ſay, The Lord hath not appeared unto thee." This revelation certainly conſtituted him a prophet to Iſrael; and there cannot be a doubt but that he perfectly knew the divine ſource from which he received it: but he very naturally and reaſonably concluded, that the children of Iſrael would not believe that the Lord had appeared to him, unleſs he could give them ſome other proof of this preternatural appearance than his own ſimple affirmation of its reality. This proof he was immediately enabled to give, by having conferred upon him the power of working miracles in confirmation of his prophecy. Again, when Gideon was called to the deliverance of Iſrael, the angel of the Lord came and ſaid unto him, "The Lord is with thee, thou mighty man of valour: go in this thy might, and thou ſhalt ſave Iſrael from the hand of the Midianites. Have not I ſent thee?" Here was a prophecy delivered by the angel of the Lord, to encourage Gideon's undertaking: but he, being probably afraid of ſome illuſion of ſenſe or imagination, demanded a ſign that he was really an angel who talked with him. A ſign is accordingly given him, a miraculous ſign, with which he is ſatisfied, and undertakes the work appointed him.

From theſe and many ſimilar tranſactions recorded in the Old Teſtament, it appears that prophecy was never intended as evidence of an original revelation. It is indeed, by its very nature, totally unfit for ſuch a purpoſe; becauſe it is impoſſible, without ſome extrinſic proof of its divine origin, to know whether any prophecy be true or falſe, till the æra arrive at which it ought to be fulfilled. When it is fulfilled, it affords complete evidence that he who uttered it ſpake by the ſpirit of God, and that the doctrines which he taught of a religious nature were all either dictated by the ſame ſpirit, or at leaſt are true, and calculated to direct mankind in the way of their duty.

The prophecies vouchſafed to the patriarchs in the moſt early periods of the world, were all intended to keep alive in their minds a ſenſe of religion, and to direct their views to the future completion of that firſt and greateſt prophecy which was made to Adam immediately on his fall: but in order to ſecure credit to thoſe prophecies themſelves, they were always accompanied by ſome miraculous ſign that they were indeed given by the God of truth, and were not the deluſions of fanaticiſm or hypocriſy. Prophecy, in the proper ſenſe of the word, commenced with the fall; and the firſt inſtance of it is implied in the ſentence denounced upon the original deceiver of mankind: "I will put enmity between thee and the woman, and between thy ſeed and her ſeed: It ſhall bruiſe thy head, and thou ſhalt bruiſe his heel."

This prophecy, though one of the moſt important that ever was delivered, when conſidered by itſelf is exceedingly obſcure. That Adam ſhould have underſtood it, as ſome of his degenerate ſons have pretended to do, in a literal ſenſe, is abſolutely impoſſible. He knew well that it was the great God of heaven and earth who was ſpeaking, and that ſuch a Being was incapable of trifling with the wretchedneſs of his fallen creature. The ſentence denounced upon himſelf and his wife was awful and ſevere. The woman was doomed to ſorrow in conception; the man, to ſorrow and travail all the days of his life. The ground was curſed for his ſake; and the end of the judgment was, "Duſt thou art, and to duſt thou ſhalt return." Had our firſt parents been thus left, they muſt have looked upon themſelves as rejected by their Maker, delivered up to trouble and ſorrow in the world, and as having no hope in any other. With ſuch impreſſions on their minds they could have retained no ſenſe of religion; for religion, when unaccompanied by hope, is a ſtate of phrenſy and diſtraction: yet it is certain that they could have no hope from any thing expreſsly recorded by Moſes, except what they might draw from this ſentence paſſed on their deceiver. Let us then endeavour to aſcertain what conſolation it could afford them.

At that awful juncture, they muſt have been ſenſible that their fall was the victory of the ſerpent, whom by experience they had found to be an enemy to God and to man. It could not therefore but be ſome comfort to them to hear this enemy firſt condemned, and to ſee that, however he had prevailed againſt them, he had gained no victory over their Maker. By his condemnation they were ſecured from thinking that there was any malignant being equal to the Creator in power and dominion; an opinion which, through the prevalency of evil, gained ground in after times, and was deſtructive of all true religion. The belief of God's ſupreme dominion being thus preſerved, it was ſtill neceſſary to give them ſuch hopes as might induce them to love as well as to fear him: and theſe they could not but conceive, when they heard from the mouth of their Creator and Judge, that the ſerpent's victory was not complete even over themſelves; that they and their poſterity ſhould be enabled to conteſt his empire; and that, though they were to ſuffer much in the ſtruggle, they ſhould yet finally prevail, bruiſe the ſerpent's head, and deliver themſelves from his power and dominion.

This prophecy therefore was to our firſt parents a light ſhining in a dark place. All that they could certainly conclude from it was, that their caſe was not deſperate; that ſome remedy, ſome deliverance from the evil they were under, would in time appear; but *when*, or *where*, or by *what means* they were to be delivered, they could not poſſibly underſtand, unleſs the matter was further revealed to them, as probably it was at the inſtitution of ſacrifice. (See Sacrifice.) Obſcure, however, as this promiſe or prophecy was, it ſerved after the fall as a foundation for religion, and truſt and confidence towards God in hopes of deliverance in time from the evils of diſobedience: and this appears to have been the ſole purpoſe for which it was given—and not, as ſome well-meaning though weak advocates for Chriſtianity have imagined, as a prediction pointing *directly* to the croſs of Chriſt.

As this prophecy was the firſt, ſo is it the only conſiderable one in which we have any concern from the creation to the days of Noah. It was proportioned to the then wants and neceſſities of the world, and was the grand charter of God's mercy after the fall. Nature had no certain help for ſinners; her rights were loſt with her innocence. It was therefore neceſſary either to deſtroy the offenders, or to raiſe them to a capacity of ſalvation, by giving them ſuch hopes as might enable them to exerciſe a reaſonable religion. So far the light of this prophecy extended. By what *means* God intended to work their ſalvation, he did not expreſsly declare: and who has a right to complain that he did not, or to preſcribe to him rules in diſpenſing his mercy to the children of men?

Upon the hopes of mercy, which this prophecy gives in very general terms, mankind reſted till the birth of Noah. At that period a new prophecy was delivered by Lamech, who foretells that his ſon ſhould comfort them concerning the work and toil of their hands, "becauſe of the *earth which the Lord had curſed.*" We are to remember, that the curſe pronounced upon the earth was part of the ſentence paſſed upon our firſt parents; and when that part was remitted, if it ever was remitted, mankind would acquire new and more lively hopes that in God's good time they ſhould be freed from the whole. But it has been ſhown by biſhop Sherlock, in his "Uſe and Intent of Prophecy," that this declaration of Lamech's was a prediction, that during the life of his ſon the curſe ſhould be taken off from the earth: and the ſame prelate has proved with great perſpicuity, and in the moſt ſatisfactory manner, that this happy revolution actually took place after the flood. The limits preſcribed to an article of this kind will not permit us even to abridge his arguments. We ſhall only obſerve, that the truth of his concluſion is manifeſt from the very words of ſcripture; for, when God informs Noah of his deſign to deſtroy the world, he adds, "But with thee will I eſtabliſh my covenant:" and as ſoon as the deluge was over, he declared that he "would not again curſe the ground any more for man's ſake; but that, while the earth ſhould remain, ſeed-time and harveſt, and cold and heat, and ſummer and winter, and day and night, ſhould not ceaſe." From this laſt declaration it is apparent that a curſe *had* been on the earth, and that ſeed-time and harveſt had often failed; that the curſe was now taken off; and that in conſequence of this covenant, as it is called, with Noah and his ſeed and with every living creature, mankind ſhould not henceforth be ſubjected to toil ſo ſevere and ſo generally fruitleſs.

It may ſeem ſurpriſing perhaps to ſome, that, after ſo great a revolution in the world as the deluge made, God ſhould ſay nothing to the remnant of mankind of the puniſhments and rewards of another life, but ſhould make a new covenant with them relating merely to fruitful ſeaſons and the bleſſings of the earth. But, in the ſcriptures, we ſee plainly a gradual working of Providence towards the redemption of the world from the curſe of the fall; that the temporal bleſſings were firſt reſtored, as an earneſt and pledge of better things to follow; and that the covenant given to Noah had, ſtrictly ſpeaking, nothing to do with the hopes of futurity, which were reſerved to be the matter of another covenant, in another age, and to be revealed by him, whoſe province it was to "bring life and immortality to light through the goſpel." But if Noah and his forefathers expected deliverance from the whole curſe of the fall, the actual deliverance from one part of it was a very good pledge of a further deliverance to be expected in time. Man himſelf was curſed as well as the ground; he was doomed to duſt: and fruitful ſeaſons are but a ſmall relief, compared to the greatneſs of his loſs. But when fruitful ſeaſons came, and one part of the curſe was evidently abated, it gave great aſſurance that the other ſhould not laſt for ever; but that by ſome means, ſtill unknown to them, they ſhould be freed from the whole, and finally bruiſe the ſerpent's head, who, at the deluge, had ſo ſeverely bruiſed man's heel.

Upon this aſſurance mankind reſted for ſome generations, and practiſed, as we have every reaſon to believe, a rational worſhip to the one God of the univerſe. At laſt, however, idolatry was by ſome means or other introduced (ſee Polytheism), and ſpread ſo univerſally through the world, that true religion would in all probability have entirely failed, had not God viſibly interpoſed to preſerve ſuch a ſenſe of it as was neceſſary for the accompliſhment of his great deſign to reſtore mankind. This he did by calling Abraham from amidſt his idolatrous kindred, and renewing to him the word of prophecy: "Get thee out of thy country (ſaid he), and from thy kindred, and from thy father's houſe, unto a land that I will ſhow thee. And I will make of thee a great nation, and I will bleſs thee, and make thy name great; and thou ſhalt be a bleſſing. And I will bleſs them that bleſs thee, and curſe him that curſeth thee; and in thee ſhall all the families of the earth be bleſſed." Theſe magnificent promiſes are ſeveral times repeated to the father of the faithful, with additional circumſtances of great importance—ſuch as, "that he ſhould be multiplied exceedingly; that he ſhould be a father of many nations; that kings ſhould come out of him;" and, above all, that God would eſtabliſh an *everlaſting covenant* with him and his ſeed, to give him and them all the land of Canaan for an *everlaſting poſſeſſion*, and to be *their God*."

Upon ſuch of theſe promiſes as relate to temporal bleſſings we need not dwell. They are much of the ſame nature with thoſe which had been given before to Lamech, Noah, Shem, and Japheth; and all the world knows how amply and literally they have been fulfilled. There was however ſo little probability in nature of their accompliſhment at the time when they were made, that we find the patriarch aſking, "whereby he ſhould *know* that he ſhould inherit ſuch an extent of country?" And as the promiſes that he ſhould inherit it were meant to be a foundation for religion, and confidence in God, a miraculous ſign was given him that they came indeed from the ſpirit of truth. This removed from his mind every doubt, and made him give the fulleſt credit, not only to them, but alſo to that other promiſe, "that in his ſeed ſhould all the nations of the earth be bleſſed."

What diſtinct notion he had of this bleſſing, or in what manner he hoped it ſhould be effected, we cannot pretend to ſay. "But (ſays biſhop Sherlock) that he underſtood it to be a promiſe of reſtoring mankind, and delivering them from the remaining curſe of the fall, there can be no doubt. He knew that death had entered by ſin; he knew that God had promiſed victory and redemption to the ſeed of the woman. Upon the hopes of this reſtoration the religion of his anceſtors was founded; and when God, from whom this bleſſing on all men was expected, did expreſsly promiſe a bleſſing on all men, and in this promiſe founded his everlaſting covenant—what could Abraham elſe expect but the completion in his ſeed of that ancient promiſe and prophecy concerning the victory to be obtained by the woman's ſeed? The curſe of the ground was expiated in the flood, and the earth reſtored with a bleſſing, which was the foundation of the temporal covenant with Noah; a large ſhare of which God expreſsly grants to Abraham and his poſterity particularly, together with a promiſe to bring, by their means, a new and further bleſſing upon the whole race of men. If we lay theſe things to heart, we cannot ſuppoſe that leſs could be expected from the new promiſe or prophecy given to Abraham, than a deliverance from that part of the curſe ſtill remaining on men: *Duſt thou art, and unto duſt thou ſhalt return.* In virtue of this covenant, Abraham and his poſterity had reaſon to expect that the time would come when man ſhould be called from his duſt again. For this expectation they had his aſſurance who gave the covenant, that he would be their God for ever. Well might our Saviour then tell the ſons of Abraham, that even Moſes at the buſh ſhowed the reſurrection of the dead, when he called the Lord the God of Abraham, and the God of Iſaac, and the God of Jacob."

Theſe promiſes made to Abraham were renewed to Iſaac and Jacob; to the laſt of whom it was revealed, not only that all the nations of the earth ſhould be bleſſed in his ſeed, but that the bleſſing ſhould ſpring from his ſon Judah. It is, however, by no means evident that any one of thoſe patriarchs knew preciſely by what *means** the curſe of the fall was to be entirely removed, and all men called from their duſt again. It was enough that they were convinced of the fact in general terms, ſince ſuch conviction was a ſufficient foundation of a rational religion; and the deſcendants of Abraham had no other foundation upon which to reſt their hopes, and pay a cheerful worſhip to the God of their fathers, till the giving of the law to Moſes. Then indeed they were incorporated into a ſociety, with municipal laws of their own, and placed under a theocratic government; the temporal promiſes made to their fathers were amply fulfilled; religion was maintained among them by rewards and puniſhments equally diſtributed in this world (ſee Theology): and a ſeries of prophets ſucceeding one another pointed out with greater and greater clearneſs, as the fulneſs of time approached, the perſon who was to redeem mankind from the power of death; by what means he was to work that great redemption, and at what preciſe period he was to make his appearance in the world. By theſe ſupernatural interpoſitions of divine providence, the principles of pure theiſm and the practice of true religion were preſerved among the children of Iſrael, when all other nations were ſunk in the groſſeſt idolatry, and wallowed in the moſt abominable vices; when the far-famed Egyptians, Greeks and Romans fell down with adoration to ſtocks and ſtones and the vileſt reptiles; and when they had no well grounded hope of another life, and were in fact without God in the world.

From this ſhort deduction we think ourſelves entitled to conclude, that the *primary* uſe and intent of prophecy, under the various diſpenſations of the Old Teſtament, was not, as is too often ſuppoſed, to eſtabliſh the divine miſſion of Jeſus Chriſt, but to keep alive in the minds of thoſe to whom it was given, a ſenſe of religion, and a hope of future deliverance from the curſe of the fall. It was, in the expreſſive language of St. Peter, "a light that ſhone in a dark place, unto which men did well to take heed until the day dawned and the day-ſtar aroſe in their hearts." But though this was certainly the original intent of prophecy (for Chriſt, had he never been foretold, would have proved himſelf to be the Son of God with power by his aſtoniſhing miracles, and his reſurrection from the dead), yet it cannot be denied, that a long ſeries of prophecies, given in different and far diſtant ages, and having all their completion in the life, death, and reſurrection of Jeſus, concur very forcibly with the evidence of miracles to prove that he was the ſeed of the woman ordained to bruiſe the head of the ſerpent, and reſtore man to his forfeited inheritance. To the Jews the force of this evidence muſt have been equal, if not ſuperior, to that of miracles themſelves; and therefore we find the apoſtles and firſt preachers of the goſpel, in their addreſſes to them, conſtantly appealing to the law and the prophets, whilſt they urged upon the Gentiles the evidence of miracles.

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* This they certainly could not know from the promiſes expreſſed in the very general terms in which they are recorded in the book of Geneſis. It is, however, not improbable that thoſe promiſes, as they immediately received them, were conceived in terms more preciſe and particular; and, at all events, Dr. Warburton has proved, to the full conviction of every man who is not a determined unbeliever, that Abraham was commanded to ſacrifice his ſon Iſaac, not only as a trial of his obedience, but alſo that God might give him, what he earneſtly deſired, a ſcenical repreſentation of the means by which mankind were to be redeemed from death. The learned writer thinks, and his reaſoning compels us to think with him, that to this tranſaction our Saviour alludes when he ſays, "Your father Abraham rejoiced to ſee my *day*, and he ſaw it and was glad."

In order to form a right judgment of the argument for the truth of Chriſtianity drawn from the ſure word of prophecy, we muſt not conſider the prophecies given in the Old Teſtament as ſo many *predictions* only independent of each other; for, if we do, we ſhall totally loſe ſight of the purpoſe for which they were originally given, and ſhall never be able to ſatisfy ourſelves when confronted by the objections of unbelievers. It is eaſy for men of leiſure and tolerable parts to find difficulties in particular predictions, and in the application of them made by writers who lived many hundred years ago, and who had many ancient books and records of the Jewiſh church, from which they drew many paſſages, and perhaps ſome prophecies; which books and records we have not, to enable us to underſtand and to juſtify their applications. But it is not ſo eaſy a matter to ſhow, or to perſuade the world to believe, that a chain of prophecies reaching through ſeveral thouſand years, delivered at different times, yet manifeſtly ſubſervient to one and the ſame adminiſtration of providence from beginning to end, is the effect of art and contrivance and religious fraud. In examining the ſeveral prophecies recorded in the Old Teſtament, we are not to ſuppoſe that each of them *expreſsly* pointed out and *clearly* characteriſed Jeſus Chriſt. Had they done ſo, inſtead of being a ſupport to religion in general, the purpoſe for which they were originally intended, they would have had a very different effect, by making thoſe to whom they were given repine at being placed under diſpenſations ſo very inferior to that of the goſpel. We are therefore to inquire only whether all the notices, which, in general and often metaphorical terms, God gave to the fathers of his intended ſalvation, are perfectly anſwered by the coming of Chriſt; and we ſhall find, that nothing has been promiſed with reſpect to that ſubject which has not been performed in the ampleſt manner. If we examine the prophecies in this manner, we ſhall find that there is not one of them, which the Apoſtles have applied to the Meſſiah, that is not applicable in a rational and important ſenſe to ſomething in the birth, life, preaching, death, reſurrection and aſcenſion of Jeſus of Nazareth; that, as applied to him, they are all conſiſtent with each other; and that, though ſome few of them may be applied without abſurdity to perſons and events under the Jewiſh diſpenſation, Chriſt is the only perſon that ever exiſted in whom they all meet as in a centre. In the limits preſcribed us, it is impoſſible that we ſhould enter upon a particular proof of this poſition. It has been proved by numberleſs writers, and, with reſpect to the moſt important prophecies, by none with greater ſucceſs than biſhop Sherlock in his "Uſe and Intent of Prophecy in the ſeveral Ages of the World;" a work which we recommend to our readers, as one of the moſt valuable on the ſubject in our own or any other language.

But, admitting that it would have been improper, for the reaſons already hinted at, to have given a clear and preciſe deſcription of Chriſt, and the Chriſtian diſpenſation, to men who were ordained to live under diſpenſations leſs perfect—how, it may be aſked, comes it to paſs, that many of the prophecies applied by the writers of the goſpel to our Saviour and his actions are ſtill dark and obſcure, and ſo far from belonging evidently to him and to him only, that it requires much learning and ſagacity to ſhow even now the connection between ſome prophecies and the events?

In anſwer to theſe queſtions, the learned prelate juſt referred to obſerves, "That the obſcurity of prophecy does not ariſe from hence, that it is a relation or deſcription of ſomething *future*; for it is as eaſy to ſpeak of things future plainly, and intelligibly, as it is of things paſt or preſent. It is not, therefore, of the nature of prophecy to be obſcure; for it may eaſily be made, when he who gives it thinks fit, as plain as hiſtory. On the other ſide, a figurative and dark deſcription of a future event will be figurative and dark ſtill when the event happens; and conſequently will have all the obſcurity of a figurative and dark deſcription as well after as before the event. The prophet Iſaiah deſcribes the peace of Chriſt's kingdom in the following manner: 'The wolf ſhall dwell with the lamb, and the leopard ſhall lie down with the kid, and the calf and the young lion, and the fatling, together, and a little child ſhall lead them.' Nobody, ſome modern Jews excepted, ever underſtood this literally; nor can it now be *literally* applied to the ſtate of the goſpel. It was and is capable of different interpretations: it may mean temporal peace, or that internal and ſpiritual peace—that tranquillity of mind, which ſets a man at peace with God, himſelf, and the world. But, whatever the true meaning is, this prophecy does no more obtrude one determinate ſenſe upon the mind ſince the coming of Chriſt than it did before. But then we ſay, the ſtate of the goſpel was very properly prefigured in this deſcription, and is as properly prefigured in a hundred more of the like kind; and ſince they all agree in a fair application to the ſtate of the goſpel, we ſtrongly conclude, that this ſtate was the thing foretold under ſuch expreſſions. So that the argument from prophecy for the truth of Chriſtianity does not reſt on this, that the event has neceſſarily limited and aſcertained the particular ſenſe and meaning of every prophecy; but in this, that every prophecy has in a proper ſenſe been completed by the coming of Chriſt. It is abſurd, therefore, to expect clear and evident conviction from every ſingle prophecy applied to Chriſt: the evidence muſt ariſe from a view and compariſon of all together." It is doubtleſs a great miſtake to ſuppoſe that prophecy was intended ſolely or chiefly for their ſakes in whoſe time the events predicted are to happen. What great occaſion is there to lay in ſo long beforehand the evidence of prophecy to convince men of things that are to happen in their own times; the truth of which they may, if they pleaſe, learn from their own ſenſes? Yet ſome people are apt to talk as if they thought the truth of the events predicted depended very much on the evidence of prophecy: they ſpeak, for inſtance, as if they imagined the certainty and reality of our Saviour's reſurrection were much concerned in the clearneſs of the prophecies relating to that great and wonderful event, and ſeem to think that they are confuting the truth of his reſurrection when they are pointing out the abſurdity of the prophecies relating to it. But can any thing be more abſurd? For, what ground or pretence is there to inquire, whether the prophecies foretelling that the Meſſiah ſhould die, and riſe again, do truly belong to Chriſt, unleſs we are firſt ſatisfied that Chriſt died, and roſe again?

The part which unbelievers ought to take in this queſtion, if they would make any uſe of prophecy, ſhould be, to ſhow from the prophets that Chriſt was neceſſarily to riſe from the dead; and then to prove that in fact Jeſus never did riſe. Here would be a plain conſequence. But, if they like not this method, they ought to let the prophecies alone; for, if Chriſt did not riſe, there is no harm done though the prophets have not foretold it. And if they allow the reſurrection of Chriſt, what do they gain by diſcrediting the prophets? The event will be what it is, let the prophecies be what they will.

Theſe conſiderations ſhow how far the goſpel is *neceſſarily* concerned in prophetical evidence, and how clear the prophecies ſhould be. Chriſt claims to be the perſon foretold in the law and the prophets; and, as truth muſt ever be conſiſtent with itſelf, this claim muſt be true as well as all others. This is the part then to be tried on the evidence of prophecy: Is Chriſt that perſon deſcribed and foretold under the Old Teſtament, or not? Whether all the prophecies relating to him be plain or not plain, it matters little; the ſingle queſtion is, Are there enough plain, to ſhow us that Chriſt is the perſon foretold under the Old Teſtament? If there be, we are at an end of our inquiry, and want no further help from prophecy; eſpecially ſince we have ſeen the day dawn, and enjoyed the marvellous light of the goſpel of God.

But ſo unreaſonable are unbelievers, that, whilſt ſome of them object to the obſcurity of the prophecies, others have rejected them altogether on account of their clearneſs, pretending that they are hiſtories, and not predictions. The prophecies againſt which this objection has been chiefly urged are thoſe of Daniel, which were firſt called in queſtion by the famous Porphyry. He affirmed that they were not compoſed by Daniel, whoſe name they bear, but by ſome author who lived in Judea about the time of Antiochus Epiphanes; becauſe all to that time contained true hiſtory, but that all the facts beyond that were manifeſtly falſe.

This method of oppoſing the prophecies, as a father of the church rightly obſerves, is the ſtrongeſt teſtimony of their truth; for they are ſo exactly fulfilled, that to infidels the prophet ſeemed not to have foretold things future, but to have related things paſt. To an infidel of this age, if he has the ſame ability and knowledge of hiſtory that Porphyry had, all the ſubſequent prophecies of Daniel, except thoſe which are ſtill fulfilling, would appear to be hiſtory, and not prophecy: for it entirely overthrows the notion of their being written in the days of *Antiochus Epiphanes*, or of the *Maccabees*, and eſtabliſhes the credit of Daniel as a prophet beyond contradiction, that there are ſeveral of thoſe prophecies which have been fulfilled ſince that period as well as before; nay, that there are prophecies of Daniel which are fulfilling at this very time in the world.

Our limits will not permit us to enter into the objections which have been made to this prophet by the author of "The Literal Scheme of Prophecy conſidered;" nor is there occaſion that we ſhould enter into them. They have been all examined and completely anſwered by biſhop Chandler in his "Vindication of his Defence of Chriſtianity," by Mr. Samuel Chandler in his "Vindication of the Antiquity and Authority of Daniel's Prophecies," and by biſhop Newton in his excellent "Diſſertations on the Prophecies." To theſe authors we refer the reader; and ſhall conclude the preſent article with a view of ſome prophecies given in very remote ages, which are in this age receiving their accompliſhment.

Of theſe, the firſt is that of Noah concerning the ſervitude of the poſterity of Canaan. In the greater part of original manuſcripts, and in our verſion of the holy ſcriptures, this prophecy is thus expreſſed: "Curſed be Canaan; a ſervant of ſervants ſhall he be to his brethren:" but in the Arabic verſion, and in ſome copies of the Septuagint, it is, "Curſed be *Ham* the father of Canaan; a ſervant of ſervants ſhall he be to his brethren." Whether the curſe was really pronounced upon Ham, which we think moſt probable, or only upon his ſon Canaan, we ſhall find the prediction remarkably fulfilled, not barely ages after the book of Geneſis was very generally known, but alſo at this very day. It is needleſs to inform any man who has but looked into the Old Teſtament, that when the ancient patriarchs pronounced either a curſe or a bleſſing upon any of their ſons, they meant to declare the future fortunes, not of that ſon individually, but of his deſcendants as a tribe or nation. Let us keep this in mind, and proceed to compare with Noah's prophecy, firſt, the fortunes of the deſcendants of Canaan, the fourth ſon of Ham, and then the fortunes of the poſterity of Ham by his other ſons.

With the fate of the Canaanites every reader is acquainted. They were conquered by Joſhua ſeveral centuries after the delivery of this prophecy; and ſuch of them as were not exterminated were by him and Solomon reduced to a ſtate of the loweſt ſervitude to the Iſraelites, the poſterity of Shem the brother of Ham. The Greeks and Romans too, who were the deſcendants of Japheth, not only ſubdued Syria and Paleſtine, but alſo purſued and conquered ſuch of the Canaanites as were anywhere remaining; as for inſtance the Tyrians and Carthaginians, of whom the former were ruined by Alexander and the Grecians, and the latter by Scipio and the Romans. Nor did the effects of the curſe ſtop there. The miſerable remainder of that devoted people have been ever ſince ſlaves to a foreign yoke; firſt, to the Saracens, who are deſcended from Shem; and afterwards to the Turks, who are deſcended from Japheth; and under the Turkiſh dominion they groan at this day.

If we take the prophecy as it ſtands in the Arabic verſion, its accompliſhment is ſtill more remarkable. The whole continent of Africa was peopled principally by the poſterity of Ham. And for how many ages have the better parts of that country lain under the dominion, firſt of the Romans, then of the Saracens, and now of the Turks! In what wickedneſs, ignorance, barbarity, ſlavery, and miſery, live moſt of its inhabitants! and of the poor negroes how many thouſands are every year ſold and bought like beaſts in the market, and conveyed from one quarter of the world to do the work of beaſts in another; to the full accompliſhment indeed of the prophecy, but to the laſting diſgrace of thoſe who are from the love of gain the inſtruments of fulfilling it. Nothing can be more complete than the execution of the ſentence as well upon Ham as upon Canaan; and the hardieſt infidel will not dare to ſay that it was pronounced after the event.

The next prophecy which we ſhall notice is that of Abraham concerning the multitude of his deſcendants; which every one knows is ſtill fulfilled in the Jews even in their diſperſed ſtate, and therefore cannot have been given after the event of which it ſpeaks.

Of the ſame kind are the ſeveral prophecies concerning Iſhmael; of which ſome have been fulfilled, and others are at preſent fulfilling in the moſt aſtoniſhing manner. Of this ſon of Abraham it was foretold, that "he ſhould be a wild man; that his hand ſhould be againſt every man, and every man's hand againſt him; that he ſhould dwell in the preſence of all his brethren; that he ſhould be multiplied exceedingly, beget twelve princes, and become a great nation." The ſacred hiſtorian who records theſe prophecies adds, that "God was with the lad, and he grew, and dwelt in the wilderneſs, and became an archer."

To ſhow how fully and literally all theſe prophecies have been accompliſhed, would require more room than we have to beſtow; and to the reader of hiſtory the labour would be ſuperfluous. We ſhall therefore only requeſt the unbeliever to attend to the hiſtory of the Arabs, the undoubted deſcendants of Iſhmael; and to ſay how it comes to paſs, that, though they have been robbers by land and pirates by ſea for time immemorial; though their hands have been againſt every man, and every man's hand againſt them; they always have dwelt, and at this day dwell, in the preſence of their brethren, a free and independent people. It cannot be pretended that no attempt has ever been made to conquer them; for the greateſt conquerors in the world have all in their turns attempted it:

but though ſome of them made great progreſs, not one was ever crowned with ſucceſs. It cannot be pretended that the inacceſſibleneſs of their country has been their protection; for their country has been often penetrated, though it never was entirely ſubdued. When in all human probability they have been on the brink of ruin, they were ſignally and providentially delivered. Alexander was preparing an expedition againſt them, when he was cut off in the flower of his age. Pompey was in the career of his conqueſts, when urgent affairs called him elſewhere. Ælius Gallius had penetrated far into their country, when a fatal diſeaſe deſtroyed great numbers of his men, and obliged him to return. Trajan beſieged their capital city, but was defeated by thunder and lightning and whirlwinds. Severus beſieged the ſame city twice, and was twice repelled from before it. The Turks, though they were able to wreſt from them their foreign conqueſts, have been ſo little able to ſubdue the Arabs themſelves, or even to reſtrain their depredations, that they are obliged to pay them a ſort of annual tribute for the ſafe paſſage of the pilgrims who go to Mecca to pay their devotions. On theſe facts we ſhall not exclaim. He who is not ſtruck upon comparing the ſimple hiſtory of this ſingular people with the prophecies ſo long ago delivered of them and their great anceſtor, whoſe love of liberty is compared to that of the wild aſs, would riſe wholly unmoved from our exclamations.

A fourth prophecy of this kind, which cannot be alleged to have been uttered after the event, is the denunciation of Moſes againſt the children of Iſrael in caſe of their diſobedience; which is ſo literally fulfilled, that even at this moment it appears rather a hiſtory of the preſent ſtate of the Jews, than a remote prediction of their apoſtacy and puniſhment. "And the Lord ſhall ſcatter thee among all people from the one end of the earth even unto the other. And among theſe nations ſhalt thou find no eaſe, neither ſhall the ſole of thy foot have reſt; but the Lord ſhall give thee there a trembling heart, and failing of eyes, and ſorrow of mind. And thy life ſhall hang in doubt before thee; and thou ſhalt fear day and night, and ſhalt have none aſſurance of thy life." (Deut. xxviii. 64, 65, 66.) "And thou ſhalt become an aſtoniſhment, a proverb, and a by-word, among all nations, whither the Lord ſhall lead you." (Deut. xxviii. 37.)

Similar to this denunciation, but attended with ſome circumſtances ſtill more wonderful, is the following prediction of the prophet Hoſea: "The children of Iſrael ſhall abide many days without a king, and without a prince, and without a ſacrifice, and without an image, and without an ephod, and without teraphim. Afterwards ſhall the children of Iſrael return, and ſeek the Lord their God, and David their king; and ſhall fear the Lord and his goodneſs in the latter days*." In this paſſage we find the ſtate of the Jews for the laſt 1700 years clearly and diſtinctly deſcribed with all its circumſtances. From the time that they rejected their Meſſiah, all things began to work towards the deſtruction of their polities both civil and religious; and within a few years from his death, their city, temple, and government were utterly ruined; and they themſelves not carried into a gentle captivity, to enjoy their laws, and live under governors of their own, as they did in Babylon, but they were ſold like beaſts in a market, and became ſlaves in the ſtricteſt ſenſe; and from that day to this have had neither prince nor chief among them. Nor will any one of them ever be able, after all their pretences, to prove his deſcent from Aaron, or to ſay with certainty whether he is of the tribe of Judah or of the tribe of Levi, till he ſhall diſcover that unknown country where never mankind dwelt, and where the apocryphal Eſdras has placed their brethren of the ten tribes. This being the caſe, it is impoſſible they can have either an altar, or a ſacrifice, or a prieſthood, according to the inſtitution of Moſes, but are evidently an outcaſt people living under laws which cannot be fulfilled.

The cauſe of this deplorable condition is likewiſe aſſigned with the ſame perſpicuity: they are ſcattered over the face of the earth, becauſe they do not acknowledge Chriſt for the Meſſiah; becauſe they do not ſubmit to their own king, the true David. In the prophetic writings the name of David is frequently given to the Meſſiah, who was to deſcend from that prince. Thus Ezekiel, ſpeaking of the kingdom of Chriſt, ſays, "I will ſet up one Shepherd over them, and he ſhall feed them, even my ſervant David: he ſhall feed them, and he ſhall be their ſhepherd." And Jeremiah ſays, "They ſhall ſerve the Lord their God, and David their king, whom I will raiſe up unto them."

That in theſe places, as well as in the paſſage under conſideration, the Meſſiah is meant, is undeniable; for David the ſon of Jeſſe was dead long before any of the three prophets was born; and by none of them it is ſaid, "afterwards David their king ſhall come again;" but, "afterwards the children of Iſrael ſhall *return* to David their king," they ſhall recover from their blind infatuation, and ſeek him whom they have not yet known. By their not receiving Jeſus for the Chriſt, they have forfeited all claim to the divine favour, and are, of conſequence, "without a king, and without a chief, and without a ſacrifice, and without an altar, and without a prieſthood."

The time, however, will come, when they ſhall return and ſeek "the Lord their God and David their king;" when they ſhall tremble before him whom their fathers crucified, and honour the ſon even as they honour the father. That this part of the prophecy will in time be as completely fulfilled as the other has been, may be confidently expected from the wonderful preſervation of the Jews for ſo many ages. Scattered as they are over the whole earth, and hated as they are by all nations, it might naturally be thought, that in proceſs of time they would have coaleſced with their conquerors, and have been ultimately abſorbed and annihilated by the union, ſo that not a trace of them ſhould now have remained: yet the fact is, that, diſperſed as they have ever ſince been over the whole face of the globe, they have never, in a ſingle inſtance in any country, loſt their religious or national diſtinctions; and they are now generally ſuppoſed to be as numerous as they were under the reigns of David and Solomon. This is contrary to all hiſtory, and all experience of the courſe of human affairs in ſimilar caſes; it has been boldly and juſtly ſtyled a ſtanding miracle. Within 1000 or 1200 years back, a great variety of extraordinary and important revolutions have taken place among the nations of Europe. In the ſouthern part of this iſland the Britons were conquered by the Saxons, the Saxons by the Danes, and the Danes and Saxons by the Normans; but in a few centuries theſe oppoſite and hoſtile nations were conſolidated into one indiſtinguiſhable maſs. Italy, about the ſame time that Britain was ſubdued by the Saxons, was conquered by the Goths and Vandals: and it is not eaſy to conceive a more ſtriking contraſt than that which ſubſiſted between the poliſhed inhabitants of that delightful country and their ſavage invaders; and yet how ſoon did all diſtinction ceaſe between them! In France, the Roman colonies gradually aſſimilated with the ancient Gauls; and in Spain, though the Moors continued for ſeveral ages, and till their final expulſion, a diſtinct people, yet, after they were once reduced to a ſtate of ſubjection, their numbers very ſenſibly diminiſhed; and ſuch of them as were ſuffered to remain after their laſt overthrow have been long ſince ſo blended with the Spaniards that they cannot now be diſtinguiſhed. But, with regard to the Jews, the wonder is, that, though they do not in any country where they are ſettled bear any proportion to the natural inhabitants; though they are univerſally reduced to a ſtate of the loweſt ſubjection, and even expoſed to hatred, contempt, and perſecution; yet in no inſtance does there ſeem to be the leaſt appearance or probability of their numbers being diminiſhed, in no inſtance do they diſcover any decay of attachment to their religious principles. Whence then comes it that this people alone, who, having no form of government or a republic anywhere ſubſiſting, are without the means by which other people are kept united and diſtinct, ſhould ſtill be preſerved amongſt ſo many different nations? How comes it, when they have been thus ſcattered into ſo many diſtant corners, like duſt which cannot be perceived, that they ſhould ſtill ſo long ſurvive the diſſolution of their own ſtate, as well as that of ſo many others? To theſe queſtions the anſwer is obvious: They are preſerved, that, as a nation, "they may return and ſeek the Lord their God and David their king, and fear the Lord and his goodneſs in the latter days."

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* Such is our tranſlation of this remarkable prophecy; but the Greek verſion of the Seventy has it, perhaps more properly, thus: "The children of Iſrael ſhall abide many days without a king, and without a chief, and without ſacrifice, and without an altar, and without a prieſthood, and without prophecies. Afterwards," &c.

We might here ſubjoin many prophecies both from the Old and the New Teſtament, and eſpecially from the writings of St. Paul and St. John, which ſo clearly deſcribe the various fortunes of the Chriſtian church, her progreſs to that ſtate of general corruption under which ſhe was ſunk three centuries ago, and her gradual reſtoration to her primitive purity, that they cannot be ſuppoſed to proceed from the cunning craftineſs of men, or to have been written after the events of which they ſpeak. To do juſtice to theſe, however, would require a volume, and many excellent volumes have been written upon them. The reader who wiſhes for ſatisfaction on ſo intereſting a ſubject will do well to conſult the writings of Mr. Mede and Sir Iſaac Newton, together with Biſhop Newton's Diſſertations, and the Sermons of Hurd, Halifax, and Bagot, preached at Warburton's lecture. We ſhall only obſerve, that one of the ableſt reaſoners that Great Britain ever produced, after having paid the cloſeſt attention to the predictions of the New Teſtament, hath been bold enough to put the truth of revealed religion itſelf upon the reality of that prophetic ſpirit which foretold the deſolation of Chriſt's church and kingdom by antichriſt. "If (ſays he), IN THE DAYS OF ST. PAUL AND ST. JOHN, there was any footſtep of ſuch a ſort of power as this in the world; or if there HAD BEEN any ſuch power in the world; or if there WAS THEN any appearance or probability that could make it enter into the heart of man to imagine that there EVER COULD BE any ſuch kind of power in the world, much leſs in the *temple* or *church of God*; and if there be not NOW ſuch a power actually and conſpicuouſly exerciſed in the world; and if any picture of this power, DRAWN AFTER THE EVENT, can now deſcribe it more plainly and exactly than it was originally deſcribed in the words of the prophecy—then may it with ſome degree of plauſibility be ſuggeſted, that the prophecies are nothing more than enthuſiaſtic imaginations."

Upon the whole, we conclude with biſhop Sherlock, that the various prophecies recorded in the Holy Scriptures were given, not to enable man to foreſee with clearneſs future events, but to ſupport the ſeveral diſpenſations of religion under which they were reſpectively promulgated. The principal prophecies recorded in the Old Teſtament led mankind to hope for a complete deliverance from the curſe of the fall; and therefore tended to fill their minds with gratitude, and to enforce a cheerful obedience to that God who in the midſt of judgment remembereth mercy. The prophecies, whether in the Old or New Teſtament, that pourtray the preſent ſtate of the Jews, and the various fortunes of the Chriſtian church, as they are daily fulfilling in the preſence of all men, are the ſtrongeſt poſſible proof of the divinity of our holy religion, and ſupply to us in the latter days the place of miracles, by which it was at firſt eſtabliſhed.

PROPHET, in general, a perſon who foretels future events; but is particularly applied to ſuch inſpired perſons among the Jews as were commiſſioned by God to declare his will and purpoſes to that people. Among the canonical books of the Old Teſtament we have the writings of 16 prophets, four of whom are denominated the *greater prophets*, viz. Iſaiah, Jeremiah, Ezekiel, and Daniel; ſo called from the length or extent of their writings, which exceed thoſe of the others, viz. Hoſea, Joel, Amos, Obadiah, Jonah, Micah, Nahum, Habakkuk, Haggai, Zechariah, and Malachi, who are called the *leſſer prophets*, from the ſhortneſs of their writings. The Jews do not place Daniel among the prophets, becauſe, they ſay, he lived the life of a courtier rather than that of a prophet. An account of the ſeveral writings of the prophets may be ſeen each under its particular head. See the article ISAIAH, &c.

Sons of the PROPHETS, in ſcripture-hiſtory, an appellation given to young men who were educated in the ſchools or colleges under a proper maſter, who was commonly, if not always, an inſpired prophet, in the knowledge of religion and in ſacred muſic, and thus were qualified to be public preachers; which ſeems to have been part of the buſineſs of the prophets on the ſabbath-days and feſtivals. It is probable that God generally choſe the prophets, whom he inſpired, out of theſe ſchools. See PROPHECY.

PROPITIATION, in theology, a ſacrifice offered to God to aſſuage his wrath, and render him propitious. Among the Jews there were both ordinary and public ſacrifices, as holocauſts, &c. offered by way of thankſgiving; and extraordinary ones, offered by particular perſons guilty of any crime, by way of propitiation. The Romiſh church believe the maſs to be a ſacrifice of propitiation for the living and the dead. The reformed churches allow of no propitiation but that one offered by Jeſus Chriſt on the croſs. See SACRIFICE.

PROPITIATORY, any thing rendering God propitious; as we ſay *propitiatory* ſacrifices, in contradiſtinction to ſacrifices which were *euchariſtical*. Among the Jews, the propitiatory was the cover or lid of the ark of the covenant; which was lined both within and withoutſide with plates of gold, inſomuch that there was no wood to be ſeen. This propitiatory was a type or figure of Chriſt, whom St. Paul calls the propitiatory ordained from all ages. See ARK *of the Covenant*.

PROPOLIS, the name of a certain ſubſtance more tenacious than wax, with which the bees ſtop up all the holes or cracks in the ſides of their hives. See BEE.

PROPONTIS, or SEA OF MARMORA, a part of the Mediterranean, dividing Europe from Aſia; it has the Helleſpont or canal of the Dardanelles to the ſouth-weſt, whereby it communicates with the Archipelago, and the ancient Boſphorus of Thrace, or Strait of Conſtantinople, to the north-eaſt, communicating with the Black or Euxine Sea. It has two caſtles: that on the Aſia ſide is on a cape, where formerly ſtood a temple of Jupiter. The caſtle of Europe is on an oppoſite cape, and had anciently a temple of Serapis. It is 120 miles long, and in ſome places upwards of 40 miles broad.

PROPORTION, the identity or ſimilitude of two ratios. Hence quantities that have the ſame ratio between them are ſaid to be proportional; *e. gr.* if A be to B as C to D, or 8 be to 4 as 30 to 15; A, B, C, D, and 8, 4, 30, and 15, are ſaid to be in proportion, or are ſimply called proportionals. Proportion is frequently confounded with ratio; yet have the two in reality very different ideas, which ought by all means to be diſtinguiſhed. Ratio is properly that relation or habitude of two things, which determines the quantity of one from the quantity of another, without the intervention of any third: thus we ſay the ratio of 5 and 10 is 2, the ratio of 12 and 24 is 2. Proportion is the ſameneſs or likeneſs of two ſuch relations: thus the relations between 5 and 10 and 12 and 24 being the ſame, or equal, the four terms are ſaid to be in proportion. Hence ratio exiſts between two numbers, but proportion requires at leaſt three. Proportion, in fine, is the habitude or relation of two ratios when compared together; as ratio is of two quantities. See ALGEBRA, ARITHMETIC, and GEOMETRY.

Arithmetical and Geometrical PROPORTION. See PROGRESSION.

Harmonical or Muſical PROPORTION, is a kind of numeral proportion formed thus: of three numbers, if the firſt be to the third as the difference of the firſt and ſecond to the difference of the ſecond and third; the three numbers are in harmonical proportion.

Thus 2, 3, 6, are harmonical, becauſe 2 : 6 :: 1 : 3. So alſo four numbers are harmonical, when the firſt is to the fourth as the difference of the firſt and ſecond to the difference of the third and fourth.

Thus 24, 16, 12, 9, are harmonical, becauſe 24 : 9 :: 8 : 3. By continuing the proportional terms in the firſt caſe, there ariſes a harmonical progreſſion or ſeries.

1. If three or four numbers in harmonical proportion be multiplied or divided by the ſame number; the products or quotients will alſo be in harmonical proportion: thus, if 6, 8, 12, which are harmonical, be divided by 2, the quotients 3, 4, 6, are alſo harmonical; and reciprocally their products by 2, viz. 6, 8, 12.

2. To find a harmonical mean between two numbers given: divide double the product of the two numbers by their ſum, the quotient is the mean required: thus, ſuppoſe 3 and 6 the extremes, the product of theſe is 18, which doubled gives 36; this divided by 9 (the ſum of 3 and 6) gives the quotient 4. Whence 3, 4, 6, are harmonical.

3. To find a third harmonical proportional to two numbers given.

Call one of them the firſt term, and the other the ſecond: multiply them together, and divide the product by the number remaining after the ſecond is ſubtracted from double the firſt; the quotient is a third harmonical proportional: thus, ſuppoſe the given terms 3, 4, their product 12 divided by 2 (the remainder after 4 is taken from 6, the double of the firſt), the quotient is 6, the harmonical third ſought.

4. To find a fourth harmonical proportion to three terms given: multiply the firſt into the third, and divide the product by the number remaining after the middle or ſecond is ſubtracted from double the firſt; the quotient is a third harmonical proportion: thus, ſuppoſing the numbers 9, 12, 16, a fourth will be found by the rule to be 24.

5. If there be four numbers diſpoſed in order, whereof one extreme and the two middle terms are in arithmetical proportion; and the ſame middle terms with the other extreme are in harmonical proportion, the four are in geometrical proportion; as here 2 : 3 :: 4 : 6, which are geometrical; whereof 2, 3, 4, are arithmetical, and 3, 4, 6, harmonical.

6. If betwixt any two numbers you put an arithmetical mean, and alſo a harmonical one, the four will be in geometrical proportion: thus, betwixt 2 and 6 an arithmetical mean is 4, and a harmonical one 3; and the four 2 : 3 :: 4 : 6, are geometrical.

We have this notable difference between the three kinds of proportion, arithmetical, harmonical, and geometrical; that from any given number we can raiſe a continued arithmetical ſeries increaſing *in infinitum*, but not decreaſing: the harmonical is decreaſable *in infinitum*, but not increaſable; the geometrical is both.

PROPORTION, or *Rule of Three*. See ARITHMETIC.

Reciprocal PROPORTION. See RECIPROCAL.

PROPORTION is alſo uſed for the relation between unequal things of the ſame kind, whereby their ſeveral parts correſpond to each other with an equal augmentation or diminution. Thus, in reducing a figure into little, or in enlarging it, care is taken to obſerve an equal diminution or enlargement, through all its parts; ſo that if one line, *e. gr.* be contracted by one-third of its length, all the reſt ſhall be contracted in the ſame proportion.

PROPORTION, in architecture, denotes the juſt magnitude of the members of each part of a building, and the relation of the ſeveral parts to the whole; *e. gr.* of the dimenſions of a column, &c. with regard to the ordonnance of a whole building. One of the greateſt differences among architects, M. Perrault obſerves, is in the proportions of the heights of entablatures with reſpect to the thickneſs of the columns, to which they are always to be accommodated. In effect, there is ſcarce any work, either of the ancients or moderns, wherein this proportion is not different; ſome entablatures are even near twice as high as others:—yet it is certain this proportion ought of all others to be moſt regulated; none being of greater importance, as there is none wherein a defect is ſooner ſpied, nor any wherein it is more ſhocking.

Compaſs of PROPORTION, a name by which the French, and after them ſome Engliſh, authors call the SECTOR.

PROPORTIONAL, relating to proportion. Thus we ſay, proportional compaſſes, parts, ſcales, ſpirals, &c.

PROPORTIONALS, in geometry, are quantities, either linear or numeral, which bear the ſame ratio or relation to each other.

PROPOSITION, in logic, part of an argument wherein ſome quality, either negative or poſitive, is attributed to a ſubject.

PROPOSITION, in mathematics, is either ſome truth advanced and ſhown to be ſuch by demonſtration, or ſome operation propoſed and its ſolution ſhown. If the propoſition be deduced from ſeveral theoretical definitions compared together, it is called a *theorem*; if from a praxis, or ſeries of operations, it is called a *problem*. See the articles THEOREM and PROBLEM.

PROPOSITION, in oratory. See ORATORY.

PROPOSITION, in poetry, the firſt part of a poem, wherein the author propoſes briefly, and in general, what he is to ſay in the body of his work. It ſhould comprehend only the matter of the poem, that is, the action and perſons that act. Horace preſcribes modeſty and ſimplicity in the propoſition, and would not have the poet promiſe too much, nor raiſe in the reader too great ideas of what he is going to relate.

PROPREFECT, among the Romans, the prefect's lieutenant, or an officer whom the prefect of the pretorium commiſſioned to do part of his duty in his place.

PROPRETOR, a Roman magiſtrate, who, having diſcharged the office of pretor at home, was ſent into a province to command there with his former pretorial authority. It was alſo an appellation given to thoſe who, without having been pretors at Rome, were ſent extraordinarily into the provinces to adminiſter juſtice with the authority of pretors.

PROPRIETOR, or PROPRIETARY, is he who poſſeſſes any thing as his own in the utmoſt degree. Such monks were called *proprietary* as had reſerved goods and effects to themſelves, notwithſtanding their formal renunciation of all at the time of their profeſſion. They are frequently mentioned in the *Monaſt. Anglic.* &c. and were to be very ſeverely dealt with; to be excommunicated, deprived of burial, &c. *Monachi proprie-*

tarii excommunicentur ab abbatibus: et, ſi in morte proprietarius inventus fuerit, eccleſiaſtica careat ſepultura, &c. Addit. ad Matt. Par.

PRO RATA, in commerce, a term ſometimes uſed by merchants for *in proportion;* as each perſon muſt reap the profit or ſuſtain the loſs, *pro rata* to his intereſt, that is, in proportion to his ſtock.

PROROGATION, the act of prolonging, adjourning, or putting off, to another time. The difference between a prorogation and an adjournment of parliament is, that by prorogation the ſeſſion is ended, and ſuch bills as paſſed in either houſe, or both houſes, and had not the royal aſſent, muſt at the next aſſembly begin again.

PROSCRIPTION, a publication made in the name of the chief or leader of a party, whereby he promiſes a reward to any one who ſhall bring him the head of one of his enemies. Sylla and Marius by turns proſcribed each other's adherents.—Under the triumvirate a great part of the beſt and braveſt of the Romans fell by proſcription. The term took its riſe from the practice of writing down a liſt of the perſons' names, and poſting it in public; from *pro*, and *ſcribo* "I write."

PROSE, the natural language of mankind, looſe and unconfined by poetical meaſures, rhymes, &c. In which ſenſe it ſtands oppoſed to verſe. There is, however, a ſpecies of proſe which is meaſured, ſuch as that in which epitaphs and other inſcriptions are generally written; and indeed every man who has formed for himſelf a ſtyle writes in uniform periods regularly recurring. It has been much diſputed whether a poem can be written in proſe. We enter not into that diſpute, as we have ſaid enough on the ſubject elſewhere. See Novel. The word *proſe* comes from the Latin *proſa*, which ſome will have derived from the Hebrew *poras*, which ſignifies *expendit:* others deduce it from the Latin *prorſa*, of *prorſus*, "going forwards;" by way of oppoſition to *verſa*, or "turning backwards," as is neceſſary in writing.

PROSECUTION, in the criminal law. The next ſtep towards the puniſhment of offenders after Commitment, is their proſecution, or the manner of their formal accuſation. And this, in the Engliſh law, is either upon a previous finding of the fact by an inqueſt or grand jury; or without ſuch previous finding. The former way is either by Presentment or Indictment. See thoſe articles. The remaining methods of proſecution are without any previous finding by a jury, to fix the authoritative ſtamp of veriſimilitude upon the accuſation. One of theſe, by the common law, was when a thief was taken *with the mainour*, that is, with the thing ſtolen upon him *in manu*. For he might, when ſo detected, *flagrante delicto*, be brought into court, arraigned, and tried, without indictment: as by the Daniſh law he might be taken and hanged upon the ſpot without accuſation or trial. But this proceeding was taken away by ſeveral ſtatutes in the reign of Edward III. though in Scotland a ſimilar proceſs remains to this day. So that the only ſpecies of proceeding at the ſuit of the king, without a previous indictment or preſentment by a grand jury, now ſeems to be that of Information; which ſee. Theſe are all the methods of proſecution at the ſuit of the king. There yet remains another, which is merely at the ſuit of the ſubject, and is called an Appeal. But of all methods of proſecution, that by indictment is the moſt general. See Indictment.

PROSECUTOR, in law, he that purſues a cauſe in another's name.

PROSELYTE, a new convert to ſome religion or religious ſect.

PROSERPINACA, in botany: A genus of the trigynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 15th order, *Inundatæ*. The calyx is tripartite ſuperior; there is no corolla; there is one trilocular ſeed.

PROSERPINE, in fabulous hiſtory, the daughter of Jupiter and Ceres, was carried off by Pluto as ſhe was gathering flowers with her companions. Ceres, diſconſolate for the loſs of her daughter, after having long ſought her, heard where ſhe was, and entreated Jupiter to let her return from hell. This requeſt Jupiter granted, on condition ſhe had taſted nothing in Pluto's dominions. Ceres therefore went to fetch her; but when her daughter was preparing to return, Aſcalaphus gave information that he had ſeen Proſerpine eat ſome grains of a pomegranate ſhe had gathered in Pluto's garden; on which ſhe was ſentenced to continue in Tartarus in quality of Pluto's ſpouſe, and the queen of thoſe gloomy regions: but to mitigate the grief of Ceres for her diſappointment, Jupiter granted that her daughter ſhould only ſpend ſix months together in hell with her huſband, and the other ſix on earth with her mother. Some mythologiſts imagine that the latter part of the fable alludes to the corn, which muſt remain all the winter hid in the earth, in order to ſprout forth in the ſpring and produce the harveſt.

PROSEUCHE, in antiquity, properly ſignifies *prayer;* but it is taken for the places of prayer of the Jews, and was pretty near the ſame as their ſynagogues. But the ſynagogues were originally in the cities, and were covered places: whereas, for the moſt part, the proſeuches were out of the cities, and on the banks of rivers; having no covering, except perhaps the ſhade of ſome trees or covered galleries. The word is Greek, *ϖροσευχη, prayer*.

PROSLAMBANOMENE, the name of a muſical note in the Greek ſyſtem. As the two tetrachords of the Greeks were conjunctive, or, in other words, as the higheſt note of the firſt ſerved likewiſe for the loweſt note of the ſecond, it is plain that a complete octave could not be formed. To remedy this deficiency, therefore, one note beneath the loweſt tetrachord was added, as an octave to the higheſt of the laſt tetrachord. Thus, if we ſuppoſe the firſt to have begun on B, the laſt muſt have ended on A, to which one note ſubjoined immediately beneath the loweſt B in the diatonic order muſt have formed an octave. This note was called *proſlambanomene*. But it appears from authors who have ſcrutinized antiquity with ſome diligence, and perhaps with as much ſucceſs as the data upon which they proceeded could produce, that the names of the notes in the Greek ſyſtem, which originally ſignified their natural ſtation in the ſcale of aſcending or deſcending ſounds, were afterwards applied to their poſitions in the lyre. *Higher* or *lower*, then, according to this application, did not ſignify their degrees of acuteneſs or gravity, but their higher or lower ſituation upon this inſtrument.

PROSODY, that part of grammar which treats of the quantities and accents of ſyllables, and the manner of making verſes. The Engliſh proſody turns chiefly on two things, numbers and rhyme. See Poetry.

PROSOPIS, in botany: A genus of the monogynia order, belonging to the decandria claſs of plants. The calyx is hemiſpherical and quadridentate; the ſtigma is ſimple, the legumen inflated and monoſpermous.

PROSOPOPŒIA, a figure in oratory, whereby we raiſe qualities of things inanimate into perſons. See Oratory.

PROSTATÆ, in anatomy, a gland, generally ſuppoſed to be two ſeparate bodies, though in reality but one, ſituated juſt before the neck of the bladder, and ſurrounding the beginning of the urethra. See Anatomy.

PROSTYLE, in architecture, a range of columns in the front of a temple.

PROTAGORAS, a famous Greek philoſopher, was born at Abdera. In his youth, his poverty obliged him to ſubmit to the ſervile office of frequently carrying logs of wood from the neighbouring fields to Abdera. It happened, that as he was going on briſkly towards the city under one of theſe loads, he was met by Democritus, who was particularly ſtruck with the neatneſs and regularity of the bundle. Deſiring him to ſtop and reſt himſelf, Democritus examined more cloſely the ſtructure of the load, and found that it was put together with mathematical exactneſs; upon which he aſked the youth whether he himſelf had made it up. Protagoras aſſured him that he had; and immediately taking it to pieces, with great eaſe replaced every log in the ſame exact order as before. Democritus expreſſed much admiration of his ingenuity; and ſaid to him, "Young man, follow me, and your talents ſhall be employed upon greater and better things." The youth conſented, and Democritus took him home, maintained him at his own expenſe, and taught him philoſophy; which qualified him for the office of legiſlator of the Thurians. He was more ſubtile than ſolid in his reaſonings: however, he taught at Athens with great reputation, but was at length baniſhed from thence for the impiety of his doctrines. He then travelled, and viſited the iſlands in the Mediterranean, where it is ſaid he was the firſt philoſopher who taught for money. He died in a voyage to Sicily, in a very advanced age. He commonly reaſoned by dilemmas, and left the mind in ſuſpenſe with reſpect to all the queſtions he propoſed. His moral principles were adopted by Hobbes. (See Moral Philosophy). Plato wrote a dialogue againſt him. He flouriſhed 400 years B. C.

PROTASIS, in the ancient drama, the firſt part of a comic or tragic piece, wherein the ſeveral perſons are ſhown, their characters intimated, and the ſubject of the piece propoſed and entered upon. It might reach as far as our firſt two acts; and where it ended the epitaſis commenced. See the article Epitasis.

PROTEA, the Silver-tree: A genus of the monogynia order, belonging to the tetrandria claſs of plants; and in the natural method ranking under the 47th order, *Stellatæ*. There is one quadrifid petal ſurrounding the germ; there is no proper calyx; the receptacle is paleaceous. There are 36 ſpecies, all natives of the Cape of Good Hope; of which the moſt remarkable are, 1. The *conifera*, with linear, ſpear-ſhaped, entire leaves, grows to the height of 10 or 12 feet, with a ſtraight regular ſtem. The branches naturally form a large regular head. The leaves are long and narrow, of a ſhining ſilver colour, and, as they remain the whole year, make a fine appearance in the greenhouſe. 2. The *argentea*, commonly called *ſilver-tree*, has a ſtrong upright ſtem covered with purpliſh bark, dividing into ſeveral branches which grow erect, garniſhed with broad, ſhining, ſilvery leaves, which make a fine appearance when intermixed with other exotics. Through the whole year it exhibits its gloſſy white or ſilvery leaves. It has at firſt a very uncommon and beautiful appearance, and ſometimes in the courſe of 12 or 15 years reaches the height of 20 feet, which it never exceeds. In a rich ſoil it grows twice as quick, and is by far the largeſt of the protea kind. They are generally planted near ſome farms, and very ſeldom grow wild; Mr. Sparrman thinks it was probably brought to the Cape of Good Hope from *Anamaqua*; for he had travelled over the whole north-eaſt ſide of Hottentot's Holland, without finding it either in its wild ſtate or planted. 3. The *nitida*, or wageboom, greatly reſembles the ſecond ſort: the leaves are very ſilky and white, with erect purple branches.

All theſe plants being tender exotics, require to be continually kept in the green-houſe during winter. The firſt may be propagated by cuttings, which ſhould be cut off in April, juſt before the plants begin to ſhoot; the ſecond and third ſorts may be propagated by ſeeds.

PROTECTOR, a perſon who undertakes to ſhelter and defend the weak, helpleſs, and diſtreſſed. Every Catholic nation, and every religious order, has a protector reſiding at the court of Rome, who is a cardinal, and is called the *cardinal protector*. Protector is alſo ſometimes uſed for a *regent* of a kingdom, made choice of to govern it during the minority of a prince. Cromwell aſſumed the title and quality of *lord protector of the commonwealth of England*, &c.

PROTESILAI Turris, the ſepulchre of Proteſilaus, with a temple, at which Alexander ſacrificed, (Arrian;) ſituated at the ſouth extremtiy of the Helleſpont, next the Cherſoneſus Thracia. Proteſilaus was the firſt Greek who landed on the coaſt of Troy, and the firſt Greek ſlain by the Trojans, (Homer, Ovid.) His wife Laodamia, to aſſuage her grief, begged the gods for a ſight of his ſhade; and obtaining her requeſt, ſhe expired in his embraces, (Hyginus.) Proteſilaus was alſo called *Phylacides*, from Phylace, a town of Theſſaly.

PROTEST, in law, is a call of witneſs, or an open affirmation that a perſon does, either not at all, or but conditionally, yield his conſent to any act, or to the proceeding of any judge in a court in which his juriſdiction is doubtful, or to anſwer upon his oath further than he is bound by law. Any of the lords in parliament have a right to proteſt their diſſent to any bill paſſed by a majority; which proteſt is entered in form. This is ſaid to be a very ancient privilege. The commons have no right to proteſt. See Parliament.

Protest, in commerce, a ſummons written by a notary-public to a merchant, banker, or the like, to accept or diſcharge a bill of exchange drawn on him, after his having refuſed either to except or pay it. See Bill *of Exchange*.

PROTESTANT, a name firſt given in Germany to thoſe who adhered to the doctrine of Luther; becauſe in 1529 they proteſted againſt a decree of the Emperor Charles V. and the diet of Spires; declaring that they appealed to a general council. The ſame name has alſo been given to thoſe of the ſentiments of Calvin; and is now become a common denomination for all thoſe of the reformed churches.

PROTEUS, in heathen mythology. See Egypt.

PROTHONOTARY, a term which properly ſignifies *firſt notary*, and which was anciently the title of the principal notaries of the emperors of Conſtantinople.

Prothonotary, with us, is uſed for an officer in the court of king's bench and common pleas; the former of which courts has one, and the latter three. The prothonotary of the king's bench records all civil actions ſued in that court, as the clerk of the crown-office does all criminal cauſes. The prothonotaries of the common pleas enter and enrol all declarations, pleadings, aſſizes, judgments, and actions: they alſo make out all judicial writs, except writs of *habeas corpus*, and *diſtringas jurator*, for which there is a particular office, called the *habeas corpora office*: they likewiſe enter recognizances acknowledged, and all common recoveries; make exemplifications of records, &c.

In the court of Rome there is a college of 12 prelates, called *apoſtolical prothonotaries*, empowered to receive the laſt wills of cardinals, to make all informations and proceedings neceſſary for the canonization of ſaints, and all ſuch acts as are of great conſequence to the Papacy: for which purpoſe they have the right of admiſſion into all conſiſtories, whether public or half public. They alſo attend on the pope, whenever he performs any extraordinary ceremony out of Rome.

PROTO, a Greek term, frequently uſed in compoſition of priority: thus, proto-collum, in the ancient juriſprudence, ſignifies the firſt leaf of a book; proto-martyr, the firſt martyr; proto-plaſt, the firſt man formed, &c.

PROTOGENES, a celebrated ancient painter, was born at Caunas, a city of Caria, ſubject to the Rhodians, and flouriſhed 300 years before the birth of our Saviour. He was at firſt obliged to paint ſhips for his livelihood; but afterwards acquired the higheſt reputation for hiſtory painting; though Apelles blamed him for finiſhing his pieces too highly, and not knowing when to have done. The fineſt of his pictures was that of Jaliſus, which is mentioned by ſeveral ancient authors, though none of them give any deſcription of it. He worked ſeven years on this picture; during which time he lived entirely upon lupines and water, being of opinion that this light and ſimple nouriſhment left him greater freedom of fancy. Apelles, on ſeeing this picture, was ſtruck with ſuch admiration, that he was unable to ſpeak, or to find words ſufficient to expreſs his idea of its beauty. It was this picture that ſaved the city of Rhodes when beſieged by Demetrius king of Macedon; for, being able to attack it only on that ſide where Protogenes worked, which he intended to burn, he choſe rather to abandon his deſign than to deſtroy ſo fine a piece. Pliny ſays, that Apelles aſking him what price he had for his pictures, and Protogenes naming an inconſiderable ſum, Apelles, concerned at the injuſtice done to the beauty of his productions, gave him 50 talents, about 10,000l. for one picture only, declaring publicly that he would ſell it for his own. This generoſity made the Rhodians ſenſible of the merit of Protogenes; and they were ſo eager to purchaſe the picture Apelles had bought, that they paid him a much greater price for it than he had given.

PROTOTYPE, is the original or model after which a thing was formed; but chiefly uſed for the patterns of things to be engraved, caſt, &c.

PROTRACTOR, an inſtrument for laying down and meaſuring angles upon paper with accuracy and diſpatch; and by which the uſe of the line of chords is ſuperſeded. This inſtrument is variouſly formed, as ſemicircular, rectangular, or circular; and conſtructed of different materials, as braſs, ivory, &c. It is neceſſary in laying down thoſe ſurveys or other plans where angles are concerned. For the ſemicircular protractor and its uſe in laying down and meaſuring angles, ſee Geometry.

The rectangular protractor is conſtructed in form of a right-angled parallelogram, which, when applied to a caſe of mathematical inſtruments, is ſubſtituted in place of the ſemicircular protractor and ſcale of equal parts. Fig. 1. pl. 32. is a repreſentation of it: the manner of uſing it is exactly ſimilar to that of the ſemicircular one.

The circular protractor, as its name implies, is a complete circle, and is ſuperior by far to either of the former, both in point of accuracy and diſpatch, eſpecially when ſeveral angles are to be formed at the ſame point. The limb of this inſtrument is divided into 360 degrees, and each degree in ſome protractors is halved: it has a ſubdividing ſcale or vernier, by which an angle may be laid down or meaſured to a ſingle minute. In the centre of the protractor is a fine mark, which, when an angle is to be protracted or meaſured, is to be laid upon the angular point, and 0, or zero on the limb, upon the given line forming one ſide of the angle.

Fig. 2. repreſents a circular protractor whoſe limb is divided as above deſcribed; and the dividing ſcale on the index, which moves round the limb of the protractor on a conical centre, gives every minute of a degree. That part of the index beyond the limb has a ſteel point fixed at the end, in a direct line with the centre of the protractor, and whoſe uſe is to prick off the propoſed angles.

Fig. 3. is another circular protractor, a little differently conſtructed from the former. The central point is formed by the interſection of two lines croſſing each other at right angles, which are cut on a piece of glaſs. The limb is divided into degrees and half degrees, having an index with a vernier graduated to count to a ſingle minute, and is furniſhed with a tooth and pinion, by means of which the index is moved round by turning a ſmall nut. It has two pointers, one at each end of the index, furniſhed with ſprings for keeping them ſuſpended while they were bringing to any angle; and being brought, applying a finger to the top of the pointer, and preſſing it down, pricks off the angle. There is this advantage in having two pointers, that all the bearings round a circuit may be laid or pricked off, although the index traverſes but one half of the protractor.

Another circular protractor, different from either of the former, is repreſented at fig. 4. The centre is alſo formed by the interſection of two lines at right angles to each other, which are cut on glaſs, that all parallax may thereby be avoided. The index is moved round by a tooth and pinion. The limb is divided into degrees and half degrees, and ſubdivided to every minute by the vernier. The pointer may be ſet at any convenient diſtance from the centre, as the ſocket which carries it moves upon the bar BC, and is fixed thereto by the nut D, at right angles to the bar BC, and moveable with it. There is another bar EF: On this bar different ſcales of equal parts are placed; ſo that by moving a ſquare againſt the inner edge thereof, angles may be transferred to any diſtance within the limits, from the centre containing the ſame number of degrees marked out by the index.

It would indeed be ſuperfluous to deſcribe any more of theſe circular protractors, eſpecially as the little alterations in them depend very much upon the fancy of the artiſt. Suffice it however to ſay that we have ſeen others ſtill differently conſtructed, one of which we ſhall briefly deſcribe. The diviſions upon the limb of this inſtrument are ſimilar to thoſe already deſcribed; but the index is a ſtraight bar continued to ſome conſiderable diſtance each way beyond the limb of the inſtrument, and has a vernier to ſhow minutes as uſual; a mark upon one of the edges of the index always coincides with the centre of the inſtrument. Inſtead, therefore, of pricking down the angle as in the former, part of the line containing the angle may be drawn, which, although perhaps not ſo accurate as a point, is more conſpicuous, and the line is eaſily completed upon removal of the protractor. The common dimenſions of the circular part of theſe inſtruments is from ſix to ten inches diameter; and they are made of braſs.

PROTUBERANCE, in anatomy, is any eminence whether natural or preternatural, that projects or advances out beyond the reſt.

PROVEDITOR, an officer in ſeveral parts of Italy, particularly at Venice, who has the direction of matters relating to policy.

PROVENCE, a province or government of France, bounded by Dauphine on the north, by Piedmont on the eaſt, by the Mediterranean on the ſouth, and by the river Rhone, which ſeparates it from Languedoc, on the weſt: it is about 100 miles long, and near as many broad.

PROVEND, or Provender, originally ſignified a kind of veſſel containing the meaſure of corn daily given to a horſe, or other beaſt of labour, for his ſubſiſtence; but is now generally uſed to ſignify the food for cattle, whatever it is.

PROVERB, according to Camden, is a conciſe, witty, and wiſe ſpeech, grounded upon experience, and for the moſt part containing ſome uſeful inſtruction.

Book of Proverbs, a canonical book of the old Teſtament, containing a part of the proverbs of Solomon the ſon of David king of Iſrael. The firſt 24 chapters are acknowledged to be the genuine work of that prince; the next five chapters are a collection of ſeveral of his proverbs made by order of king Hezekiah; and the two laſt ſeem to have been added, though belonging to different and unknown authors, Agur the ſon of Jakeh, and king Lemuel. In this excellent book are contained rules for the conduct of all conditions of life; for kings, courtiers, maſters, ſervants, fathers, mothers, children, &c.

PROVIDENCE, the ſuperintendence and care which God exerciſes over creation.

That there exiſts a divine providence which attends to the affairs of this world, and directs their courſe, has been a received opinion among the human race in every country and in every period of hiſtory. Every altar that is erected, every prayer and every ſacrifice that is offered up, affords a proof of this belief. So fully have men been convinced of the ſincerity of each other's faith upon this ſubject, that in one form, that of an appeal to the Divine Ruler of the world by the ſolemnity of an oath, they have introduced it both into the moſt ordinary and the moſt important buſineſs of life.

This univerſal conviction of men of all degrees of knowledge, from the moſt profound philoſopher to the rudeſt barbarian, is probably to be traced to ſome primæval tradition, never totally effaced from any nation under heaven. The truth itſelf, however, is ſuſceptible of the moſt complete proof from principles of ſcience. If the world had a beginning, it may obviouſly have an end, and can be continued in exiſtence only by the conſtant energy of that power by which it was at firſt created. He therefore who acknowledges a creation and denies a providence, involves himſelf in this palpable contradiction—"that a ſyſtem, which of itſelf had not an original and momentary exiſtence, may yet of itſelf have a perpetual exiſtence; or that a being which cannot of itſelf exiſt for a ſecond of time, may yet, of itſelf, exiſt for thouſands of years!" Or ſhould we be ſo complaiſant, as for a moment to ſuppoſe, with certain theiſts, ancient and modern, that the *matter* of the univerſe is ſelf-exiſtent and eternal, and that the power of God was exerted, not in creating ſubſtances, but in reducing the original matter from a ſtate of chaos into that beautiful order in which we ſee it arranged; the conſtant energy of providence muſt ſtill be admitted as neceſſary to preſerve the forms and to continue the motions which were originally impreſſed upon the chaotic maſs. From late experiments it appears extremely doubtful whether any two atoms of the moſt ſolid body be in actual contact; and that they are not *all* in contact is certain. (See METAPHYSICS, and OPTICS). Yet it requires a very conſiderable degree of force to carry to a greater diſtance from one another the parts of a ſtone or of a bar of iron. By what power then are theſe parts kept contiguous? It cannot be by their own; becauſe nothing can act where it is not preſent, and becauſe our beſt philoſophy has long taught us that the atoms of matter are eſſentially inactive. Again, it requires a very great degree of force to bring two bodies, however ſmall, into *apparent* contact (ſee OPTICS); and therefore it follows that they muſt be kept aſunder by ſome foreign power. Every attempt to ſolve theſe phenomena by the intervention of a ſubtile fluid is vain; for the queſtion recurs, what keeps the parts of the fluid itſelf contiguous, and yet ſeparated from each other?

The coheſion therefore of the parts of matter, and that which is called their repulſive power, demonſtrate, through the whole ſyſtem, the immediate energy of ſomething which is not matter, and by which every body ſmall and great is preſerved in its proper form. It has been elſewhere ſhown (ſee METAPHYSICS, and MOTION), that the various motions which are regularly carried on through the univerſe, by which animals and vegetables grow and decay, and by which we have day and night, ſummer and winter, cannot be accounted for by any laws of mere mechaniſm, but neceſſarily imply the conſtant agency of ſomething which is itſelf diſtinct from matter. But the forms of bodies are preſerved, and their natural motions carried on, for purpoſes obviouſly planned by Wiſdom. The power therefore which effects theſe things muſt be combined with intelligence: but power and intelligence preſerving the order of the univerſe conſtitute all that is meant by a general providence; which is therefore as certainly adminiſtered as the ſun daily riſes and ſets, or as bodies are kept ſolid by what is termed coheſion and repulſion.

Abſtracted and metaphyſical as this reaſoning may appear, it is by no means peculiar to the philoſophers of Europe. Its force has been felt from time immemorial by the Bramins of Hindoſtan, who, as ſir William Jones informs us, "being unable to form a diſtinct idea of brute matter independent of mind, or to conceive that the work of ſupreme goodneſs was left a moment to itſelf, imagine that the Deity is ever preſent to his work, not in ſubſtance but in ſpirit and in energy." On this rational and ſublime conception they have indeed built numberleſs abſurd ſuperſtitions; but their holding the opinion itſelf, ſhows that they believe in the reality of providence upon philoſophical principles: and what truth is there on which the mind of man has not ingrafted marks of its own weakneſs?

Few nations, however, except the ancient Greeks, have had philoſophers equally ſubtile with the Bramins of India; and therefore though all mankind have in general agreed in the belief of a ſuperintending Providence, they have in different ages and countries admitted that truth upon different kinds of evidence, and formed very different notions concerning the mode in which the Divine ſuperintendence is exerted.

While ſocieties are ſtill in a rude and unpoliſhed ſtate, while individuals poſſeſs little ſecurity and little leiſure for the exertion of their rational powers, every important or ſingular appearance in nature becomes an object of wonder or of terror. In this ſtate of ignorance, men ſee not the univerſe as it is, a great collection of connected parts, all contributing to form one grand and beautiful ſyſtem. Every appearance ſeems to ſtand alone; they know that it muſt have a cauſe, but what that cauſe is they are ignorant. The phenomena exhibited by nature are ſo complicated and ſo various, that it never occurs to them that it is poſſible for one Being to govern the whole. Hence aroſe the different ſyſtems of polytheiſm that have appeared in the world. Nature was divided into different regions, and a particular inviſible power was aſſigned to each department: one conducted the flaming chariot of the ſun, another wielded the terrible thunderbolt, and others were employed in diffuſing plenty, and introducing the uſeful arts among men. Thus, although the various ſyſtems of polytheiſm in general acknowledged one Supreme Ruler, the father of gods and men, yet they at the ſame time peopled not only the regions above, the air and the heavens, but they alſo filled the ocean and the land, every grove, and every mountain, with active but inviſible natures. Having ariſen from the ſame cauſes, theſe ſyſtems of polytheiſm, which are ſo many hypotheſes concerning Divine providence, are all extremely ſimilar; and we have a very favourable ſpecimen of them in the elegant mythology of Greece and Rome, which gave to every region of nature a guardian genius, and taught men in the deep receſſes of the foreſt, or the windings of the majeſtic flood, to expect the preſence of protecting and friendly powers. See POLYTHEISM.

Notwithſtanding this univerſal reception, in ſome form or other, of the doctrine of a divine providence, it has in every age met with ſome opponents. The moſt ancient of theſe were Democritus and Leucippus. They denied the exiſtence of a Deity—aſſerted that all things were mechanically neceſſary, and that thought and ſenſe were only modifications of matter. This is atheiſm in the ſtricteſt ſenſe, and the only form of it that has ever been conſiſtently ſupported. Epicurus followed upon the ſame principles; but he rendered the ſyſtem altogether abſurd, by confeſſing the freedom of the human will. To avoid the imputation of atheiſm, he aſſerted the exiſtence of God; but declared that he reſided above the heavens, and interfered not in human affairs. One of his maxims was, that "the bleſſed and immortal Being neither hath any employment himſelf, nor troubles himſelf with others." Maximus Tyrius juſtly obſerves, that this is rather a deſcription of a Sardanapalus than of a Deity. And ſome of the moraliſts of antiquity remarked, that they knew many men among themſelves poſſeſſed of active and generous minds, whoſe characters they valued more highly than that of Epicurus's god. Some of the ancients alſo appear to have entertained the following ſtrange notion: They acknowledged the exiſtence of a Supreme and of many inferior deities; but at the ſame time, they ſuppoſed that there is a certain fate which rules over all, and is ſuperior to the gods themſelves. See Necessity in Mythology.

The providence exerted by the Author of nature over his works is uſually divided into two branches: a *general*, referring to the management of the univerſe at large; and a *particular* providence, chiefly regarding particular men,

Upon the firſt of theſe, in *The Religion of Nature delineated*, the queſtion is ſtated ſomewhat in the following manner: The world may be ſaid to be governed, or at leaſt cannot be ſaid to fluctuate fortuitouſly, if there are laws or rules by which natural cauſes act; if the ſeveral phenomena in it ſucceed regularly, and in general the conſtitution of things is preſerved; if there are rules obſerved in the production of herbs, trees, and the like; if the ſeveral kinds of animals are furniſhed with faculties proper to determine their actions in the different ſtations which they hold in the general economy of the world; and, laſtly, if rational beings are taken care of in ſuch a manner as will at laſt agree beſt with reaſon. By the providence of God we ought to underſtand his governing the world by *ſuch* laws as theſe now mentioned: ſo that if there are ſuch, there muſt be a Divine providence.

With regard to *inanimate objects*, the caſe agrees preciſely with the above ſuppoſition. The whole of that univerſe which we ſee around us is one magnificent and well regulated machine. The world that we inhabit is a large globe, which, conducted by an inviſible power, flies with a rapidity of which we have no conception, through an extent of ſpace which ſets at defiance every power of fancy to embody it into any diſtinct image. A large flaming orb ſtands immoveable in the heavens; around which this, and other worlds of different magnitudes, perform their perpetual revolutions. Hence ariſe the expected returns of day and night, and the regular diverſity of ſeaſons. Upon theſe great operations a thouſand other circumſtances depend. Hence, for example, the vapours aſcend from the ocean, meet above in clouds, and after being condenſed, deſcend in ſhowers to cover the earth with fertility and beauty. And theſe appearances are permanent and regular. During every age ſince men have been placed upon the earth, this aſtoniſhing machine continued ſteadily to perform its complicated operations. Nothing is left to chance. The ſmalleſt bodies are not leſs regular than the largeſt, and obſerve continually the ſame rules of attraction, repulſion, &c. The apparent variations of nature proceed only from different circumſtances and combinations of things, acting all the while under their ancient laws. We ourſelves can calculate the effects of the laws of gravitation and of motion. We can render them ſubſervient to our own purpoſes, with entire certainty of ſucceſs if we only adhere to the rules eſtabliſhed by nature, that is to ſay, by providence.

Vegetables alſo live and flouriſh according to preſcribed methods. Each ſort is produced from its proper ſeed; has the ſame texture of fibres, is at all times nouriſhed by the *ſame* kind of juices, digeſted and prepared by the *ſame* veſſels. Trees and ſhrubs receive annually their peculiar liveries, and bear their proper fruits: ſo regular are they in this laſt reſpect, that every ſpecies may be ſaid to have its profeſſion or trade appointed to it, by which it furniſhes a certain portion of manufacture, or of food, to ſupply the wants of animals: being created for the purpoſe of conſumption, all vegetables produce great quantities of ſeed to ſupply the neceſſary waſte. Here too, then, there is evidently a *regulation* by which the ſeveral orders are preſerved, and the ends of them anſwered according to their firſt eſtabliſhment.

With regard to *animals*, they too, in ſtructure of their form, are ſubject to laws ſimilar to thoſe which govern the vegetable world. In the ſentient part of their conſtitution they are no leſs ſubject to rule. The lion is always fierce, the fox is crafty, and the hare is timid. Every ſpecies retains from age to age its appointed place and character in the great family of nature. The various tribes are made and placed in ſuch a manner as to find proper means of ſupport and defence. Beaſts, birds, fiſhes, and inſects, are all poſſeſſed of organs and faculties adapted to their reſpective circumſtances, and opportunities of finding their proper food and prey.

Man is ſubject to the ordinary laws which other material and animal ſubſtances obey; but he is left more at large in the determination of his actions. Yet even here things do not fluctuate at random. Individuals do indeed riſe and periſh according to fixed rules, and nations themſelves have only a temporary endurance. But the ſpecies advances with a ſteady progreſs to intellectual improvement. This progreſs is often interrupted; but it appears not to be leſs ſure at the long-run than even the mechanical laws which govern the material part of our conſtitution. Amidſt the convulſion of ſtates and the ruin of empires, the uſeful arts, when once invented, are never loſt. Theſe, in better times, render ſubſiſtence eaſy, and give leiſure for reflection and ſtudy to a greater number of individuals. Tyre and Sidon have paſſed away, Athens itſelf has become the prey of barbarians, and the proſperity of ancient Egypt is departed, perhaps for ever; but the ſhip, the plough, and the loom, remain, and have been perpetually improving. Thus every new convulſion of ſociety does leſs miſchief than the laſt; and it is hoped that by the aſſiſtance of printing the moſt poliſhed arts and the moſt refined ſpeculations have now become immortal.

The world is not then left in a ſtate of confuſion: it is reduced into order, and methodiſed for ages to come; the ſeveral ſpecies of beings having their offices and provinces aſſigned them. Plants, animals, men, and nations, are in a ſtate of continual change but ſucceſſors are appointed to relieve them, and to carry on the *ſcheme of Providence.*

But the great difficulty is, how to account for that providence which is called *particular:* For rational beings, and free agents, are capable of doing and deſerving well or ill; and the ſafety or danger, the happineſs or unhappineſs, of a man here, muſt depend upon many things that ſeem ſcarcely *capable* of being determined by Providence. Beſides *himſelf* and his own conduct, he depends upon the conduct of *other men*; whoſe actions, as we naturally ſuppoſe, cannot, conſiſtently with their free will, be controuled for the advantage of another individual. The actions of numbers of men proceeding upon their private freedom, with different degrees of ability, as they croſs and impede, or directly oppoſe each other, muſt produce very different effects upon men of different characters, and thus in a ſtrange manner embarraſs and entangle the general plan. And as to the *courſe of nature*, it may juſtly be aſked, is the force of gravitation to be ſuſpended till a good man paſs by an infirm building? (See Prayer). Add to this, that ſome circumſtances appear abſolutely irreconcileable. The wind which carries one into port drives another back to ſea; and the rains that are juſt ſufficient upon the hills may drown the inhabitants of the valleys. In ſhort, may we expect *miracles?* or can there be a particular Providence that foreſees and prepares for the ſeveral caſes of individuals, without force frequently committed upon the laws of nature and the freedom of intelligent agents?

In whatever way it is brought about, there is little doubt that ſomething of this kind *muſt* take place. For as the Deity *does* direct, as already mentioned, the great and general progreſs of things in this world, he muſt alſo manage thoſe of leſs importance. Nations are compoſed of individuals. The progreſs of individuals is the progreſs of the nation, and the greateſt events uſually depend upon the hiſtory and the moſt trifling actions of private perſons. The difficulty is to conceive how the ſuperintendence and management of all this can be brought about. But as the ways and the thoughts of the Omnipotent Spirit, whoſe influence pervades, and rules, and animates nature, reſemble not the limited operations of men, we can only form conjectures concerning the means by which his government is conducted.

1. In the firſt place, then, it is not impoſſible that the Deity ſhould foreſee the future actions of intelligent beings. Many of theſe actions depend upon the mechaniſm of the material world, which was formed by himſelf, and muſt be entirely known to him. Many men among ourſelves poſſeſs much ſagacity in diſcerning the future actions of others, from attending to their known characters, and the circumſtances in which they are placed. If ſuperior natures do exiſt, and minds more perfect than the human, they muſt poſſeſs this penetration in a more eminent degree in proportion to the excellence of their intellectual powers. But if this diſcernment be in God proportionable to his nature, as in lower beings it is proportionable to theirs, it then becomes altogether unlimited, and the future actions of free agents are at once unlocked and expoſed to his view. Add to this, that the Author of nature is well acquainted with the creatures that he has made; he knows the mechaniſm of our bodies, the nature and extent of our underſtandings, and all the circumſtances by which we are ſurrounded. With all theſe advantages, it is making no great ſtretch to ſuppoſe him capable of diſcerning the line of conduct which we ſhall purſue; and this even ſetting aſide the infinity of his nature, to which a thouſand years are as one day, and ſuppoſing him to reaſon from probabilities in the imperfect manner that we do.

2. There is no impoſſibility at leaſt, that men, whoſe characters and actions are thus foreknown, may be introduced into the world in ſuch times and places as that their acts and behaviour may not only coincide with the general plan of things, but may alſo anſwer many private caſes. The celeſtial bodies are ſo placed that their jarring attractions make out a ſplendid ſyſtem. Why then may there not be in the Divine mind ſomething like a projection of the future hiſtory of mankind, as well as of the motions of the heavenly bodies? And why ſhould it not be thought poſſible for men, as well as for them, by ſome ſecret law, or rather by the management of an unſeen power, to be brought into their places in ſuch a manner as that, by the free uſe of their faculties, the conjunctions and oppoſitions of their intereſts and inclinations, the natural influence of their different degrees of talents, power, and wealth, they may conſpire to make out the great ſcheme of human affairs? There is no abſurdity in this ſuppoſition: it is not beyond the power of an almighty and perfect Being; and it is worthy of him. Let us take from the Jewiſh hiſtory, as moſt generally known, an example of what may be ſuppoſed to happen daily. It was the intention of providence to place David the ſon of Jeſſe upon the throne of the Hebrews. The country is invaded by a foreign enemy: the hoſtile armies meet, and lie encamped upon oppoſite mountains. A man comes forth from the army of the invaders, as was extremely common in thoſe times, and defies the Hebrew hoſt to ſend forth a champion to meet him in ſingle combat. Terrified by the gigantic bulk and mighty force of Goliah, no man would riſk the unequal conflict. David, who was too young to carry arms, had been ſent to the camp with proviſions for his brothers, and heard the challenge. In defence of his flock he had killed ſome beaſts of prey in the wilderneſs, and he was an excellent markſman with the ſling. He thought it might probably be as eaſy to kill a man as a wild beaſt; at all events, he knew that a ſtone well directed would prove no leſs fatal to a giant than to a dwarf: he therefore reſolved to try his ſkill; and he tried it with ſucceſs. Here no man's free will was interrupted, and no miracle was accompliſhed: Yet by this *train* of circumſtances thus *brought* together, a foundation was laid for the future fortunes of the ſon of Jeſſe, for the greatneſs of his country, and for accompliſhing the purpoſes of Providence. According to Seneca, "Hoc dico, fulmina non mitti a Jove, ſed ſic omnia diſpoſita, ut ea etiam quæ ab illo non fiunt, tamen ſine ratione non fiunt; quæ illius eſt.—Nam etſi Jupiter illa nunc non facit, fecit ut fierent."—*I ſay, that the lightning comes not directly from the hand of Jove, but things are properly diſpoſed for the indirect execution of his will: for he acts not immediately, but by the intervention of means.*

3. Laſtly, it is *not impoſſible* that many things may be accompliſhed by ſecret influence, upon the human mind, either by the Deity himſelf, or by the intervention of agents poſſeſſed of powers ſuperior to thoſe which belong to us. "For inſtance, if the caſe ſhould require that a particular man be delivered from ſome threatening *ruin*, or from ſome *misfortune*, which would certainly befal him if he ſhould go ſuch a way at ſuch a time, as he intended: upon this occaſion ſome *new* reaſons may be preſented to his mind why he ſhould not go *at all*, or not *then*, or not *by that road*; or he may forget to go. Or, if he is to be delivered from ſome dangerous *enemy*, either ſome new turn given to his thoughts may divert him from going where the *enemy* will be, or the enemy may be after the ſame manner diverted from coming where *he* ſhall be, or his reſentment may be *qualified*; or ſome proper method of *defence* may be ſuggeſted to the perſon in danger. After the ſame manner advantages and ſucceſſes may be conferred on the deſerving; as, on the other ſide, men, by way of puniſhment for their crimes, may incur miſchiefs and calamities. Theſe things, and ſuch as theſe (ſays Mr. Wollaſton), *may be*. For, ſince the motions and actions of men, which depend upon their wills, do alſo depend upon their judgments, as theſe again do upon the *preſent appearances* of things in their minds; if a new proſpect of things can be any way produced, the lights by which they are ſeen *altered*, new forces and directions impreſſed upon the ſpirits, paſſions *exalted* or *abated*, the power of judging *enlivened* or *debilitated*, or the attention taken off without any ſuſpenſion or alteration of the ſtanding laws of nature,—then, without that, *new* volitions, deſigns, meaſures, or a ceſſation of thinking, may alſo be produced; and thus many things prevented that otherwiſe would *be*, and many brought about that would *not*. That there may poſſibly be ſuch inſpirations of new thoughts and counſels (continues our author), may perhaps appear further from this, that we frequently find thoughts ariſing in our heads, into which we are led by no diſcourſe, nothing we read, no clue of reaſoning, but they ſurpriſe and come upon us from we know not what quarter. If they proceeded from the mobility of ſpirits ſtraggling out of order, and fortuitous affections of the brain, or were they of the nature of *dreams*, why are they not as wild, incoherent, and extravagant as they are?" Is it not much more reaſonable to imagine that they come by the order and direction of an all-ſeeing and all-gracious God, who continually watches over us, and diſpoſes every thing in and about us for the good of ourſelves or others? not to ſpeak of the agreeableneſs of this notion to the opinions of the beſt and wiſeſt men in all ages *. "If this, then, be the caſe, as it ſeems to be, that men's minds are ſuſceptible of ſuch *inſinuations* and *impreſſions*, as frequently, by ways unknown, do affect them, and give them

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* That ſuch was the general belief of the Greeks in the days of Homer, is plain from that poet's conſtantly introducing his deities into the narrative of his poems, and telling us that Minerva, or ſome other god, altered the minds of his heroes. "By

an inclination towards this or that; how many things (ſays our author) may be brought to paſs by theſe means without *fixing* and *refixing* the laws of nature, any more than they are unfixed when one man alters the opinion of another by throwing in his way a book proper for that purpoſe!"

All this may be effected either by the immediate interpoſition of God himſelf, or by that of beings *inviſible*, and in nature ſuperior to us, who act as the miniſters of his providence. That there are ſuch beings we can hardly doubt, as it is in the higheſt degree improbable that ſuch imperfect beings as men are at the top of the ſcale of created exiſtence. And ſince we ourſelves, by the uſe of our limited powers, do often alter the courſe of things within our ſphere from what they would be if left to the ordinary laws of motion and gravitation, without being ſaid to alter thoſe laws; why may not ſuperior beings do the ſame as inſtruments of divine providence? This idea of the intervention of ſuperior natures is beautifully illuſtrated by Thomſon in the following paſſage:

> Theſe are the haunts of meditation, theſe
> The ſcenes where ancient bards th' inſpiring breath,
> Ecſtatic, felt; and, from this world retir'd,
> Converſ'd with angels and immortal forms
> On gracious errands bent: to ſave the fall
> Of virtue ſtruggling on the brink of vice;
> In waking whiſpers, and repeated dreams,
> To hint pure thought, and warn the favour'd ſoul
> For future trials fated to prepare.

We agree, however, with Mr. Wollaſton, in thinking the power of theſe beings not ſo large as to alter or ſuſpend the general laws of nature (ſee MIRACLE); for the world is not like a bungling piece of clock-work, which requires to be often ſet backwards or forwards. We are likewiſe perfectly ſatiſfied, that they cannot change their condition, to ape us or inferior beings; and conſequently we are not apt haſtily to credit ſtories of *portents*, &c. ſuch as cannot be true, unleſs the nature of things and their manner of exiſtence were occaſionally reverſed. Yet, as men may be ſo placed as to become, even by the free exerciſe of their own powers, *inſtruments* of God's particular providence to other men; ſo may we well ſuppoſe that theſe higher beings may be ſo *diſtributed* through the univerſe, and ſubject to ſuch an economy, unknown to us, as may render *them alſo* inſtruments of the ſame providence; and that they may, in proportion to their greater abilities, be capable, *conſiſtently with the laws of nature*, of influencing human affairs in proper places.

We ſhall next proceed to ſtate ſome of the chief objections which in ancient or modern times have been brought againſt the opinion, that the world is governed by a Divine Providence.

1. The firſt of theſe is this, that the ſyſtem of nature contains many imperfections which it ought not to do if it be the work of a perfectly wiſe and good Being. To avoid the force of this objection, ſome modern writers have deſerted the ground of ſupreme and abſolute goodneſs, which the ancient theiſts always occupied, and have aſſerted that the divine perfection conſiſts in unlimited power and uncontrouled ſupremacy of will; that conſequently the Deity does not always that which is beſt, but merely what he himſelf pleaſes; and that for no other reaſon but becauſe he *wills* to do ſo. But this is no better than atheiſm itſelf. For it is of no importance to us whether the univerſe is governed by blind fate or chance, that is to ſay, by nothing at all; or whether it is governed by an arbitrary ſovereign will that is directed by chance, or at leaſt by no principle of beneficence.

The true anſwer to this objection is, that no created ſyſtem can have every perfection, becauſe it muſt neceſſarily be deſtitute of ſelf-exiſtence and independence; and therefore if beings deſtitute of ſome perfections be better than nothing, it was worthy of infinite power and perfect goodneſs to create ſuch beings. In our preſent ſtate, we mortals ſtand upon too low ground to take a commanding view of the whole frame of things. We can only reaſon concerning what is unknown from the little that is within our reach. In that little, we can ſee that wiſdom and goodneſs reign; that nature always aims to produce perfection; that many ſalutary effects reſult even from the thunder and the ſtorm: and we doubt not that a view of the whole ſtructure of the univerſe would afford an additional triumph to the goodneſs and ſkill of its great Architect.

We ſee a regular aſcent in the ſcale of beings from mere lifeleſs matter up to man; and the probability is, that the ſcale continues to aſcend as far above man in perfection as created beings can poſſibly be raiſed. The ſole purpoſe of God in creating the world muſt have been to produce happineſs: but this would be moſt effectually done by creating, in the firſt place, as many of the moſt perfect claſs of beings as the ſyſtem could contain; and afterwards other claſſes leſs and leſs perfect, till the whole univerſe ſhould be completely full. We do not poſitively aſſert ſuch a ſcheme of creation,

> Where all muſt full, or not coherent be;
> And all that riſes, riſe in due degree,

was actually in the divine Architect's intention; but that it is poſſible, is ſufficiently obvious. No man will pretend to ſay, that this earth could afford a comfortable ſubſiſtence to a greater number of the human race, were all the inferior animals annihilated, than it could at preſent, ſwarming as every element is with life. Suppoſe then, that as many men had been placed at firſt upon the earth as it could poſſibly ſupport, and that matters had been ſo conſtituted, as that the number ſhould never have been either increaſed or diminiſhed; we beg leave to aſk, whether, ſince there would have been evidently room for inferior animals, it would have been moſt worthy of infinite goodneſs to leave the whole globe to men, or to introduce into it different orders of leſs perfect beings, which, while they could not incommode this principal inhabitant, would each find pleaſure in its own exiſtence? To this queſtion different anſwers cannot ſurely be given. Let the reader then extend his view, and conſider the univerſe, which, however vaſt, cannot be poſitively infinite, as one ſyſtem as much united as the ſeveral parts of this globe; let him ſuppoſe that there were at firſt created as many of the higheſt order of beings as it could have contained had creation there ſtopped; let him remember that happineſs in many different degrees is valuable; and he will not ſurely think it any imputation on the goodneſs of God that there are in the univerſe many beings far from perfection. The moſt imperfect of theſe are by themſelves better than nothing; and they all contribute to make up a ſyſtem which, conſidered as a whole, we have every reaſon to believe to be as perfect as any thing not ſelf-exiſtent can poſſibly be.

2. If the world is conducted by a benevolent providence, how came evil to be introduced into it? This queſtion has perplexed mankind in all ages. The ancient Perſians reſolved it, by aſſerting the exiſtence of two gods, Oromaſdes the author of good, and Arimanius the author of evil. From them the Chriſ-

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this," ſays Plutarch, "the poet does not mean to make God *deſtroy* the will of man, but only move him to will: nor does he miraculouſly produce the appetites themſelves in men, but only cauſes ſuch imaginations as are capable of exciting them."

tian heretics called *Manichees* borrowed their doctrine of two oppoſite coeternal principles. Both the Platoniſts and Stoics aſcribed the origin of evil to the perverſeneſs or imperfection of matter, which they thought the Deity could not alter; and Pythagoras imagined a ſtate of pre-exiſtence, in which the ſouls of men had committed offences, for which they are here ſuffering the puniſhment. But theſe hypotheſes are, ſome of them impious, and all unſatisfactory.

Taking the expreſſion in its moſt extenſive ſenſe, the evils to which the human race are expoſed may be reduced to *pain, uneaſineſs, diſappointment of appetites*, and *death*; of which not one could have been wholly prevented, without occaſioning greater evils, inconſiſtent with the perfect goodneſs of the Creator. As long as we have ſolid bodies capable of motion, ſupported by food, ſubject to the influence of the atmoſphere, and diviſible, they muſt neceſſarily be liable to diſſolution or death: but if a man could ſuffer death, or have his limbs broken, without feeling pain, the human race had been long ago extinct. A fever is a ſtate of the body in which the fluids are in great diſorder. Felt we no uneaſineſs from that diſorder, we ſhould have no inducement to pay the proper attention to our ſtate, and ſhould certainly die unawares, without ſuſpecting ourſelves to be in danger; whereas, under the preſent adminiſtration of divine providence, the pain and ſickneſs of the diſeaſe compel us to have recourſe to the remedies proper for reſtoring us to ſoundneſs and to health. Of the uneaſineſſes to which we are liable, and which are not the effect of immediate pain, the greateſt has been ſometimes ſaid to ariſe from the apprehenſion of death, which conſtantly ſtares us in the face, and frequently embitters all our pleaſures even in the hour of perfect health. But this dread of death is implanted in our breaſts for the very beſt of purpoſes. Had we no horror at the apprehenſion of death, we ſhould be apt, whenever any misfortune befel us, to quit this world raſhly, and ruſh unprepared into the preſence of our Judge: but the horror which attends our reflections on our own diſſolution, ariſing not from any apprehenſions of the pain of dying, but from our anxiety concerning our future ſtate of exiſtence, tends ſtrongly to make us act, while we are here, in ſuch a manner as to enſure our happineſs hereafter. Add to this, that the fear of death is the greateſt ſupport of human laws. We every day ſee perſons breaking through all the regulations of ſociety and good life, notwithſtanding they know death to be the certain conſequence, and feel all the horrors of it that are natural to man: and therefore were death diveſted of theſe horrors, how inſignificant would capital puniſhments be as guardians of the law, and how inſecure would individuals be in civil ſociety?

With regard to the unavoidable misfortunes and anxieties of our preſent ſtate, ſo far from being truly hurtful in themſelves, they are proofs of divine beneficence. When we ſee men diſpleaſed with their ſituation, when we hear them complain of the difficulties, the miſeries, and the cares of life, of the hardſhips which they have undergone, and the labours which ſtill lie before them; inſtead of accounting them unfortunate, we ought to regard them as active beings, placed in the only ſituation that is fit for the improvement of their nature. That diſcontent, theſe reſtleſs wiſhes to improve their condition, are ſo many ſure indications that their faculties will not languiſh. They who are in the leaſt degree accuſtomed to obſerve the human character, know well the influence which pleaſure and repoſe have in enfeebling every manly principle, and how capable they are of attaching us even to a ſordid and diſhonourable exiſtence.

Happy indeed it is for the human race, that the number of thoſe men is ſmall whom providence has placed in ſituations in which perſonal activity is unneceſſary. By far the greater number are compelled to exert themſelves, to mix and to contend with their equals, in the race of fortune and of honour. It is thus that our powers are called forth, and that our nature reaches its higheſt perfection. It is even perhaps a general truth, that they who have ſtruggled with the greateſt variety of hardſhips, as they always acquire the higheſt energy of character, ſo if they have retained their integrity, and have not ſunk entirely in the conteſt, ſeldom fail to ſpend their remaining days reſpectable and happy, ſuperior to paſſion, and ſecured from folly by the poſſeſſion of a wiſdom dearly earned.

But the benefits of phyſical evils have been ſet in a ſtill ſtronger light by a great maſter of moral wiſdom, who was himſelf ſubject to many of thoſe evils. That man is a moral agent, ſent into this world to acquire habits of virtue and piety to fit him for a better ſtate, is a truth to which no conſiſtent theiſt will for a moment refuſe his aſſent. But almoſt all the moral good which is left among us, is the apparent effect of phyſical evil.

"Goodneſs is divided by divines into ſoberneſs, righteouſneſs, and godlineſs. Let it be examined how each of theſe duties would be practiſed if there were no phyſical evil to enforce it.

"Sobriety or temperance is nothing but the forbearance of pleaſure; and if pleaſure was not followed by pain, who would forbear it? We ſee every hour thoſe in whom the deſire of preſent indulgence overpowers all ſenſe of paſt, and all foreſight of future miſery. In a remiſſion of the gout, the drunkard returns to his wine, and the glutton to his feaſt; and if neither diſeaſe nor poverty were felt or dreaded, every one would ſink down in idle ſenſuality, without any care of others, or of himſelf. To eat and drink, and lie down to ſleep, would be the whole buſineſs of mankind.

"Righteouſneſs, or the ſyſtem of ſocial duty, may be ſubdivided into juſtice and charity. Of juſtice, one of the heathen ſages has ſhown, with great acuteneſs, that it was impreſſed upon mankind only by the inconveniences which injuſtice had produced. 'In the firſt ages (ſays he) men acted without any rule but the impulſe of deſire; they practiſed injuſtice upon others, and ſuffered it from others in their turn: but in time it was diſcovered, that the pain of ſuffering wrong was greater than the pleaſure of doing it; and mankind, by a general compact, ſubmitted to the reſtraint of laws, and reſigned the pleaſure to eſcape the pain.'

"Of charity, it is ſuperfluous to obſerve, that it could have no place if there were no want; for of a virtue which could not be practiſed, the omiſſion could not be culpable. Evil is not only the occaſional but the efficient cauſe of charity; we are incited to the relief of miſery by the conſciouſneſs that we have the ſame nature with the ſufferer; that we are in danger of the ſame diſtreſſes, and may ſome time implore the ſame aſſiſtance.

"Godlineſs or piety is elevation of the mind towards the Supreme Being, and extenſion of the thoughts of another life. The other life is future, and the Supreme Being is inviſible. None would have recourſe to an inviſible power, but that all other ſubjects had eluded their hopes. None would fix their attention upon the future, but that they are diſcontented with the preſent. If the ſenſes were feaſted with perpetual pleaſure, they would always keep the mind in ſubjection. Reaſon has no authority over us but by its power to warn us againſt evil.

"In childhood, while our minds are yet unoccupied, religion is impreſſed upon them; and the firſt years of almoſt all who have been well educated are paſſed in a regular diſcharge of the duties of piety: but as we advance forward into the crowds of life, innumerable delights ſolicit our inclinations, and innumerable cares diſtract our attention. The time of youth is paſſed in noiſy frolics; manhood is led on from hope to hope, and from project to project; the diſſoluteneſs of pleaſure, the inebriation of ſucceſs, the ardour of expectation, and the vehemence of competition, chain down the mind alike to the preſent ſcene: nor is it remembered how ſoon this miſt of trifles muſt be ſcattered, and the bubbles that float upon the rivulet of life be loſt for ever in the gulph of eternity. To this conſideration ſcarce any man is awakened but by ſome preſſing and reſiſtleſs evil; the death of thoſe from whom he derived his pleaſures, or to whom he deſtined his poſſeſſions, ſome diſeaſe which ſhows him the vanity of all external acquiſitions, or the gloom of age which intercepts his proſpects of long enjoyment, forces him to fix his hopes upon another ſtate; and when he has contended with the tempeſts of life till his ſtrength fails him, he flies at laſt to the ſhelter of religion.

"That miſery does not make all virtuous, experience too certainly informs us; but it is no leſs certain, that of what virtue there is, miſery produces far the greater part. Phyſical evil may be therefore endured with patience, ſince it is the cauſe of moral good; and patience itſelf is one virtue by which we are prepared for that ſtate in which evil ſhall be no more." *Johnſon's Idler*, No. 89.

The calamities and the hardſhips of our preſent ſtate, then, are ſo far from being real evils, of which providence ought to be accuſed, that in every point of view in which we can conſider them, they afford the ſureſt proofs of the wiſdom of its adminiſtration, and of its goodneſs to man.

The moſt ſerious difficulty lies in accounting for the permiſſion of moral evil or guilt, in a ſyſtem governed by infinite benevolence and wiſdom. Thoſe who in a conſiſtent manner hold the doctrine of the abſolute neceſſity of human actions in its full extent, and acknowledge all its conſequences, find it eaſy to elude this difficulty. They very fairly deny the exiſtence of any ſuch thing as moral evil in the abſtract; and aſſert, that what we call a *crime*, is nothing more than an action which we always regard with a painful ſenſation: that theſe apparent evils endure only for a time; and that all will at laſt terminate in the perfection and happineſs of every intelligent being.

Upon the ſyſtem of liberty, the ſhorteſt anſwer ſeems to be this: that ſome things are abſolutely impoſſible, not from any weakneſs in the Deity, but becauſe they infer abſurdity or contradiction. Thus it is impoſſible for twice two to be any thing elſe than four; and thus it is impoſſible for Omnipotence itſelf to confer ſelf-approbation upon an intelligent being who has never deſerved it; that is to ſay, it is impoſſible for a man of ſenſe to be pleaſed with himſelf for having done a certain action, while he himſelf is conſcious that he never did that action. But ſelf-approbation conſtitutes the higheſt, the moſt unmingled, and permanent felicity of which our nature is capable. It is not in the power of Omnipotence itſelf, then, to beſtow the higheſt and moſt permanent felicity of our nature; it muſt be *earned* and deſerved before it can be obtained. In the ſame manner good deſert, virtue, or merit, cannot be *conferred*; they muſt be *acquired*. To enable us to acquire theſe, we muſt be expoſed to difficulties, and muſt ſuffer in a certain degree. If theſe difficulties had no influence upon our conduct and feelings, if they expoſed us to no real danger, no fabric of merit and of ſelf-approbation could be reared upon them. All that the Supreme Being could do for us, was to confer ſuch an original conſtitution and character as would enable us to do well if we ſhould exert our utmoſt powers. The univerſe is not ruled by favour, but by juſtice. Complete felicity muſt be purchaſed. Guilt is an abuſe of our freedom, a doing ill where we could have done well, and is entirely the work of man. Heaven could not avoid permitting its exiſtence, and expoſin us to danger; for temptation is neceſſary to virtue, and virtue is the perfection of our nature, our glory, and our happineſs.

The permiſſion of moral evil has been ſo ably accounted for by Simplicius, a Pagan writer, and therefore not biaſſed by any partiality to the Jewiſh or Chriſtian Scriptures, that we cannot deny ourſelves the pleaſure of laying his reaſoning before our readers. He aſks, "Whether God may be called the author of ſin, becauſe he permits the ſoul to uſe her liberty? and anſwers the queſtion thus:

"He who ſays that God ſhould not permit the exerciſe of its freedom to the ſoul, muſt affirm one of theſe two things; either that the ſoul, though by nature capable of indifferently chooſing *good* or *evil*, ſhould yet be conſtantly prevented from chooſing evil; or elſe that it ſhould have been made of ſuch a nature as to have no *power* of chooſing *evil*.

"The former aſſertion (continues he) is irrational and abſurd; for what kind of liberty would that be in which there ſhould be no freedom of choice? and what choice could there be, if the mind were conſtantly reſtrained to one ſide of every alternative? With reſpect to the ſecond aſſertion, it is to be obſerved (ſays he), that no evil is in itſelf deſirable, or can be choſen *as evil*. But if this power of determining itſelf either way in any given caſe muſt be taken from the ſoul, it muſt either be as ſomething not good, or as ſome great evil. But whoever ſaith ſo, does not conſider how many things there are which, though accounted good and deſirable, are yet never put in competition with this freedom of will: for without it we ſhould be on a level with the brutes; and there is no perſon who would rather be a brute than a man. If God then ſhows his goodneſs in giving to inferior beings ſuch perfections as are far below this, is it incongruous to the divine nature and goodneſs to give man a ſelf-determining power over his actions, and to permit him the free exerciſe of that power? Had God, to prevent man's ſin, taken away the liberty of his will, he would likewiſe have deſtroyed the foundation of all virtue, and the very nature of man; for there could be no virtue were there not a poſſibility of vice; and man's nature, had it continued rational, would have been divine, becauſe impeccable. Therefore (continues he), though we attribute to God, as its author, this ſelf-determining power, which is ſo neceſſary in the order of the univerſe; we have no reaſon to attribute to him that evil which comes by the abuſe of liberty: for God doth not cauſe that averſion from good which is in the ſoul when it ſins; he only gave to the ſoul ſuch a power as might turn itſelf to evil, out of which he produces much good, which, without ſuch a power, could not have been produced by Omnipotence itſelf." So conſonant to the doctrine of our ſcriptures is the reaſoning of this opponent of the writings of Moſes? *Fas eſt et ab hoſte doceri.*

The laſt objection to the belief of a divine providence ariſes from the apparent confuſion of human affairs, that all things happen alike to all, that bad men are proſperous, and that a total want of juſtice appears to attend the divine adminiſtrations. Even the beſt men have at times been ſhaken by this conſideration. But there are many reaſons for rendering this world a mixed ſcene: it would become unfit for a ſtate of trial and of education to virtue were it otherwiſe.

It has been ſhown already, that phyſical evil is the parent of moral good; and therefore it would be abſurd to expect that the virtuous ſhould be entirely exempted from that evil For the occaſional proſperity of the wicked, many reaſons have been aſſigned even by thoſe who, in their diſquiſitions, were not guided by that revelation which has brought to light life and immortality. "God ſays Plutarch) ſpares the wicked, that he may ſet to mankind an example of forbearance, and teach them not to revenge their injuries too haſtily on each other.

He ſpares ſome wicked men from early puniſhment, in order to make them inſtruments of his juſtice in puniſhing others. And he ſpares all for a time, that they may have leiſure for repentance; for men (ſays the ſame excellent moraliſt) look at nothing further, in the puniſhments which they inflict, than to ſatisfy their revenge and malice, and therefore they purſue thoſe who have offended them with the utmoſt rage and eagerneſs; whereas God, aiming at the cure of thoſe who are not utterly incurable, gives them *μεταϐαλλεσθαι χρονον*, "time to be converted."

But this objection receives the beſt ſolution from the doctrine of the immortality of the human ſoul.

——— And ſee
'Tis come, the glorious morn! the ſecond birth
Of heaven and earth! awakening nature hears
The *new creating word*, and ſtarts to life,
In every height'ned form, from pain and death
For ever free. *The great eternal ſcheme*,
Involving all, and in a *perfect whole*
Uniting, as the proſpect wider ſpreads,
To reaſon's eye cleared up a-pace.
Ye vainly wiſe! Ye blind preſumptuous! now,
Confounded in the duſt, adore that Pow'r
And Wiſdom oft arraign'd: ſee now the cauſe
Why unaſſuming worth in ſecret liv'd
And died neglected: why the good man's ſhare
In life was gall and bitterneſs of ſoul:
Why the lone widow and her orphans pin'd
In ſtarving ſolitude; while luxury,
In palaces, lay ſtraining her low thought,
To form unreal wants: why heav'n-born truth,
And moderation fair, wore the red marks
Of ſuperſtition's ſcourge: why licens'd pain,
That cruel ſpoiler, that emboſom'd foe,
Imbitter'd all our bliſs. Ye good diſtreſt!
Ye noble few! who here unbending ſtand
Beneath life's preſſure, yet bear up a while,
And what your bounded view, which only ſaw
A little part, deem'd evil, is no more:
The ſtorms of wintry time will quickly paſs,
And one unbounded ſpring encircle all.
Thomſon's Winter.

Providence-*Plantation*; a colony of New-England, which with Rhode-iſland, formerly conſtituted a charter government. Its chief town is Newport.

Providence, one of the beſt of the Bahama iſlands in the American ocean, but the beſt of thoſe planted and fortified by the Engliſh. It is ſeated on the eaſt ſide of the gulph of Florida. W. lon 77. 35. N. lat. 25. 0.

PROVINCE, in Roman antiquity, a country of conſiderable extent, which, upon being entirely reduced under the Roman dominion, was new-modelled according to the pleaſure of the conquerors, and ſubjected to the command of annual governors, ſent from Rome; being commonly obliged to pay ſuch taxes and contributions as the ſenate thought fit to demand. Of theſe countries, that part of France next the Alps was one, and ſtill retains the name of *Provence*. Nicod derives the word *a procul vivendo*, "living afar off;" but it is better deduced from *pro* and *vinco*, "I overcome."

Province, in geography, a diviſion of a kingdom or ſtate, compriſing ſeveral cities, towns, &c. all under the ſame government, and uſually diſtinguiſhed by the extent either of the civil or eccleſiaſtical juriſdiction. The church diſtinguiſhes its provinces by archbiſhoprics; in which ſenſe, England is divided into two provinces, Canterbury and York. The United Provinces are ſeven provinces of the Netherlands, who, revolting from the Spaniſh dominion, made a perpetual alliance, offenſive and defenſive, at Utrecht, anno 1579. See United *Provinces*.

PROVINCIAL, ſomething relating to a province. It alſo denotes, in Romiſh countries, a perſon who has the direction of the ſeveral convents of a province.

PROVISIONS, in a military ſenſe, implies all manner of eatables, food or provender, uſed in an army, both for man and beaſt.

PROVOST of a city or town, is the chief municipal magiſtrate in ſeveral trading cities, particularly Edinburgh, Paris, &c. being much the ſame with mayor in other places. He preſides in city-courts, and, together with the bailies, who are his deputies, determines in all differences that ariſe among citizens.

The provoſt of Edinburgh is called *lord*, and the ſame title is alſo claimed by the provoſt of Glaſgow. The former calls yearly conventions of the royal boroughs to Edinburgh by his miſſives, and is, *ex officio*, preſident to the convention when met.

Provost, *or Provot-Royal*, a ſort of inferior judge formerly eſtabliſhed throughout France, to take cognizance of all civil, perſonal, real and mixed cauſes, among the people only.

Grand Provost *of France*, or *of the Houſehold*. Before the revolution this officer had juriſdiction in the king's houſe, and over the officers therein; looked to its policy, the regulation of proviſions, &c.

Grand Provost *of the Conſtable*, a judge, who manages proceſſes againſt the ſoldiers in the army who have committed any crime. He has four lieutenants diſtributed throughout the army, called *provoſts of the army*, and particularly provoſts in the ſeveral regiments.

Provost *Marſhal of an Army*, is an officer appointed to ſeize and ſecure deſerters, and all other criminals. He is to hinder ſoldiers from pillaging, to indict offenders, and ſee the ſentence paſſed on them executed. He alſo regulates the weights and meaſures, and the price of proviſions, &c. in the army. For the diſcharge of his office, he has a lieutenant, a clerk, and a troop of marſhal-men on horſeback, as alſo an executioner. There is alſo a provoſt-marſhal in the navy, who hath charge over the priſoners, &c. The French alſo had a provoſt-general of the marines, whoſe duty it was to proſecute the marines when guilty of any crime, and to make report thereof to the council of war; beſides a marine provoſt in every veſſel, who was a kind of gaoler, and took the priſoners into his care, and kept the veſſel clean.

Provosts *of the Marſhals*, were a kind of lieutenants of the marſhals of France; of theſe there were 180 ſeats in France; their chief juriſdiction regarded highwaymen, footpads, houſe-breakers, &c.

Provost *of the Mint*, a particular judge inſtituted for the apprehending and proſecuting of falſe coiners.

Provost, or *Prevot*, in the king's ſtables; his office is to attend at court, and hold the king's ſtirrup when he mounts his horſe. There are four provoſts of this kind, each of whom attends in turn, monthly.

PROW, denotes the head or forepart of a ſhip, particularly in a galley; being that which is oppoſite to the poop or ſtern.

PROXIMITY, denotes the relation of nearneſs, either in reſpect of place, blood or alliance.

PRUDENCE, in ethics, may be defined an ability of judging what is beſt, in the choice both of ends and means. According to the definition of the Roman moraliſt, *De Officiis*, lib. i. cap. 43. prudence is the knowledge of what is to be deſired or avoided. Accordingly, he makes *prudentia* (*De Legibus*, lib. i.) to be a contraction of *providentia*, or foreſight. Plato (*De Legibus*, lib. iii.) calls this the leading virtue; and Juvenal, Sat. x. obſerves, "*Nullum numen abeſt ſi ſit* prudentia."

The idea of prudence includes ευβελια, or due conſultation; that is, concerning ſuch things as demand conſultation in a right manner, and for a competent time, that the reſolution taken up may be neither too precipitate nor too ſlow; and συνησις, or a faculty of diſcerning proper means when they occur; and to the perfection of prudence, theſe three things are further required, viz. δεινοτης, or a natural ſagacity; αγχινοια, preſence of mind, or a ready turn of thought; and εμπειρια, or experience. The extremes of prudence are craft or cunning on the one hand, which is the purſuit of an ill end by direct and proper though not honeſt means; and folly on the other, which is either a miſtake, both as to the end and means, or proſecuting a good end by foreign and improper means. Grove's *Moral Philoſophy*, vol. ii. chap. ii.

PRUDENTIUS, or Aurelius Prudentius Clemens, a famous Chriſtian poet, under the reign of Theodoſius the Great, who was born in Spain in the year 348. He firſt followed the profeſſion of an advocate, was afterwards a judge, then a ſoldier, and at length had an honourable employment at court. We have a great number of his poems, which, from the choice of his ſubjects, may be termed *Chriſtian poems*; but the ſtyle is barbarous, and very different from the purity of the Auguſtan age. The moſt eſteemed editions of Prudentius's works are that of Amſterdam, in 1667, with Heinſius's Notes, and that of Paris in 1687, *in uſum Delphini*.

PRUNELLA, in botany: A genus of the gymnoſpermia order, belonging to the didynamia claſs of plants; and in the natural method ranking under the 12th order, *Verticillatæ*. The filaments are bifurcated, with an anthera only on one point; the ſtigma is bifid.

PRUNES, are plums dried in the ſunſhine, or in an oven.

PRUNING, in gardening and agriculture, is the lopping off the ſuperfluous branches of trees, in order to make them bear better fruit, grow higher, or appear more regular.

Pruning, though an operation of very general uſe, is nevertheleſs rightly underſtood by few; nor is it to be learned by rote, but requires a ſtrict obſervation of the different manners of growth of the ſeveral ſorts of fruit-trees; the proper method of doing which cannot be known without carefully obſerving how each kind is naturally diſpoſed to produce its fruit: for ſome do this on the ſame year's wood, as vines; others, for the moſt part, upon the former year's wood, as peaches, nectarines, &c. and others upon ſpurs which are produced upon wood of three, four, &c. to fifteen or twenty years old, as pears, plums, cherries, &c. Therefore, in order to the right management of fruit-trees, proviſion ſhould always be made to have a ſufficient quantity of bearing wood in every part of the trees; and at the ſame time there ſhould not be a ſuperfluity of uſeleſs branches, which would exhauſt the ſtrength of the trees, and cauſe them to decay in a few years.

The reaſons for pruning of fruit-trees, are, 1. To preſerve them longer in a vigorous bearing-ſtate; 2. To render them more beautiful; and, 3. To cauſe the fruit to be larger and better taſted.

The general inſtructions for pruning are as follow: The greateſt care ought to be taken of fruit-trees in the ſpring, when they are in vigorous growth; which is the only proper ſeaſon for procuring a quantity of good wood in the different parts of the tree, and for diſplacing all uſeleſs branches as ſoon as they are produced, in order that the vigour of the tree may be entirely diſtributed to ſuch branches only as are deſigned to remain. For this reaſon trees ought not to be neglected in April and May, when their ſhoots are produced: however, thoſe branches which are intended for bearing the ſucceeding year ſhould not be ſhortened during the time of their growth, becauſe this would cauſe them to produce two lateral ſhoots, from the eyes below the place where they were ſtopped, which would draw much of the ſtrength from the buds of the firſt ſhoot: and if the two lateral ſhoots are not entirely cut away at the winter-pruning, they will prove injurious to the tree. This is to be chiefly underſtood of ſtone-fruit and grapes; but pears and apples, being much harder, ſuffer not ſo much though it is a great diſadvantage to thoſe alſo to be thus managed. It muſt likewiſe be remarked, that peaches, nectarines, apricots, cherries, and plums, are always in the greateſt vigour when they are leaſt maimed by the knife; for where large branches are taken off, they are ſubject to gum and decay. It is therefore the moſt prudent method to rub off all uſeleſs buds when they are firſt produced, and to pinch others, where new ſhoots are wanted to ſupply the vacancies of the wall; by which management they may be ſo ordered as to want but little of the knife in winter-pruning. The management of pears and apples is much the ſame with theſe trees in ſummer; but in winter they muſt be very differently pruned: for as peaches and nectarines, for the moſt part, produce their fruit upon the former year's wood, and muſt therefore have their branches ſhortened according to their ſtrength, in order to produce new ſhoots for the ſucceeding year; ſo, on the contrary, pears, apples, plums, and cherries, producing their fruit upon ſpurs, which come out of the wood of five, ſix, and ſeven years old, ſhould not be ſhortened, becauſe thereby thoſe buds which were naturally diſpoſed to form theſe ſpurs, would produce wood-branches; by which means the trees would be filled with wood, but would never produce much fruit. The branches of ſtandard trees ſhould never be ſhortened unleſs where they are very luxuriant, and, by growing irregularly on one ſide of the trees, attract the greateſt part of the ſap, by which means the other parts are either unfurniſhed with branches, or are rendered very weak; in which caſe the branch ſhould be ſhortened down as low as is neceſſary, in order to obtain more branches to fill up the hollow of the tree: but this is only to be underſtood of pears and apples, which will produce ſhoots from wood of three, four, or more years old; whereas moſt ſorts of ſtone-fruit will gum and decay after ſuch amputations: whenever this happens to ſtone-fruit, it ſhould be remedied by ſtopping or pinching thoſe ſhoots in the ſpring, before they have obtained too much vigour, which will cauſe them to puſh out ſide-branches; but this muſt be done with caution. You muſt alſo cut out all dead or decaying branches, which cauſe their heads to look ragged, and alſo attract noxious particles from the air: in doing of this, you ſhould cut them cloſe down to the place where they were produced, otherwiſe that part of the branch which is left will alſo decay, and prove equally hurtful to the reſt of the tree; for it ſeldom happens, when a branch begins to decay, that it does not die quite down to the place where it was produced, and if permitted to remain long uncut, often infects ſome of the other parts of the tree. If the branches cut off are large, it will be very proper, after having ſmoothed the cut part exactly even with a knife, chiſſel, or hatchet, to put on a plaſter of grafting clay, which will prevent the wet from ſoaking into the tree at the wounded part. All ſuch branches as run acroſs each other, and occaſion a confuſion in the head of the tree ſhould be cut off; and as there are frequently young vigorous ſhoots on old trees, which riſe from the old branches near the trunk, and grow upright into the head, theſe ſhould be carefully cut out every year, leſt, by being permitted to grow, they fill the tree too full of wood.

As to the pruning of foreſt-trees, if they be large, it is beſt not to prune them at all; yet, if there be an abſolute neceſſity, avoid taking off large boughs as much as poſſible. And, 1. If the bough be ſmall, cut it ſmooth, cloſe, and ſloping. 2. If the branch be large, and the tree old, cut it off at three or four feet from the ſtem. 3. If the tree grow crooked, cut it off at the crook, ſloping upward, and nurſe up one of the moſt promiſing ſhoots for a new ſtem. 4. If the tree grow top-heavy, its head muſt be lightened, and that by thinning the boughs that grow out of the main branches. But if you would have them ſpring, rub off the buds, and ſhroud up the ſide-ſhoots. 5. If the ſide-bough ſtill break out, and the top be able to ſuſtain itſelf, give the boughs that put forth in ſpring a pruning after Midſummer, cutting them cloſe.

PRUNUS, in botany: A genus of the monogynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid, inferior; there are five petals; the fruit is a plum, having a kernel with prominent ſutures. There are 15 ſpecies, of which ſix are cultivated in Britain: they are originally natives of America and Siberia.

1. The *domeſtica*, or common plum-tree, grows 20 or 30 feet high, garniſhed with oval, ſpear-ſhaped leaves, and with the pedunculi for the moſt part ſingle, terminated by flowers, ſucceeded by plums of many different colours, ſizes, and ſhapes in the varieties. 2. The *inſititia*, wild-plum, or bullace-tree grows 12 or 15 feet high; the branches ſomewhat ſpinous; the leaves oval, hairy underneath; and the pedunculi by pairs, terminated by white flowers ſucceeded by ſmall, round, plum-like, fruit of different colours in the varieties. 3. The *ſpinoſa*, black-thorn, or ſloe-tree, grows 10 or 12 feet high, very branchy and buſhy quite from bottom, armed with ſtrong, ſharp ſpines, ſmall, ſpear-ſhaped, ſmooth leaves, pedunculi growing ſingly, terminated by flowers, ſucceeded by ſmall, round, black cherries in autumn. It grows wild everywhere in hedges and woods; and is very proper for planting field-hedges, being of very quick and cloſe growth. 4. The *ceraſus*, or common cherry-tree, grows 20 feet or more in height, garniſhed with oval cluſters of lanceolate, ſmooth leaves, umbellate flowers, ſucceeded by cluſters of red roundiſh fruit of different ſizes and properties in the varieties. Hanbury ſays, "were this tree ſcarce, and with much difficulty propagated, every man, though poſſeſſed of a ſingle tree only, would look upon it as a treaſure; for beſides the charming appearance theſe trees have, when beſnowed, as it were, all over with bloom in the ſpring, can any tree in the vegetable tribe be conceived more beautiful, ſtriking, and grand, than a well-grown and healthy cherry-tree, at that period when the fruit is ripe."

The many kinds of cherry-trees afford an almoſt endleſs variety; all differing in ſome reſpect in their manner of ſhooting, leaves, flowers, fruit: two in particular demand admiſſion into the pleaſure garden; the double-bloſſomed and the red-flowering. The pleaſing ſhow the common cherry-tree makes when in blow is known to all; but that of the double bloſſomed is much more enchanting. It bloſſoms like the other in May; the flowers are produced in large and noble cluſters; for each ſeparate flower is as double as a roſe, is very large, and placed on long and ſlender footſtalks, ſo as to occaſion the branches to have an air of eaſe and freedom. They are of a pure white; and the trees will be ſo profuſely covered with them, as to charm the imagination. Standards of theſe trees, when viewed at a diſtance, have been compared to balls of ſnow; and the nearer we approach, the greater pleaſure we receive. Theſe trees may be kept as dwarfs, or trained up to ſtandards; ſo that there is no garden or plantation to which they will not be ſuitable. By the multiplicity of the petals the organs of generation are deſtroyed; ſo that thoſe flowers which are really full are never ſucceeded by any fruit.

The red-flowering cherry-tree differs in no reſpect from the common cherry-tree, only that the flowers are of a pale red colour, and by many are eſteemed on that account. Beſides the ornament and utility afforded us by the flowers and fruit of the cherry, its timber is a further inducement for propagating it; more eſpecially that of the ſmall black wilding ſort; which may perhaps with propriety be conſidered as the genuine ſpecies, and a native of this iſland. Be this as it may, it will grow, in a ſoil and ſituation it affects, to be a large timber tree; which, if taken in its prime before it becomes tainted at the heart, will turn out perhaps not leſs than a ton of valuable materials, peculiarly adapted to the purpoſes of furniture. The grain is fine, and the colour nearly approaching to that of mahogany, to which valuable wood it comes nearer than any other which this country produces. 5. The *avium*, or great wild-cherry tree, grows 40 or 50 feet high, having oval ſpear-ſhaped leaves, downy underneath, with umbellate ſeſſile cluſters of white flowers, ſucceeded by ſmall round fruit of different properties in the varieties. 6. The *padus*, or common bird-cherry tree, grows 15 or 20 feet high, of a ſhrub-like growth, with a ſpreading head, large, oblong, rough, ſerrated leaves, having two glands at the back of the baſe like the other, and with ſhorter, more compact cluſter of flowers, ſucceeded by large red fruit. This grows wild in hedges in the north part of England. 7. The *Virginiana*, or Virginian bird-cherry, grows 30 feet high, dividing into a very branchy head, having a dark purple bark, oval, ſlightly ſerrated, ſhining green leaves, having two glands at the forepart of the baſe, and long cluſters of white flowers, ſucceeded by ſmall, round berry-like, black fruit. 8. *Canadenſis*, or Canada dwarf bird-cherry, grows but four or five feet high, branching horizontally near the ground with ſmooth branches; broad, ſpear-ſhaped, rough downy leaves without glands: and long cluſters of white flowers, ſucceeded by ſmall, round, berry-like black fruit, ripe in autumn. 9. The *mahaleb*, or perfumed cherry, grows 10 or 15 feet high, with ſmooth whitiſh branches, ſmall, oval, ſhining green leaves, and corymbous cluſters of white flowers, ſucceeded by ſmall fruit. 10. The *armeniaca*, or apricot tree, grows 20 feet high, with a large ſpreading head, having reddiſh ſhoots, large nearly heart-ſhaped leaves, cloſe-fitting pale red flowers riſing all along the ſides of the young branches; ſucceeded by large, roundiſh fruit of a yellow and reddiſh colour in different varieties The fruit and the kernels of the *Prunus Siberica*, when eaten, excite a continued head-ach: the kernels, infuſed in brandy, communicate an agreeable flavour.

All the different varieties of plums have at firſt been raiſed from the ſtones, and are afterwards preſerved by budding and grafting on any plum-ſtock. The ſame method is applicable to cherries; only theſe are grafted to moſt advantage upon ſtocks of the wild black and red cherry raiſed from the ſtones of the fruit. The apricot-trees are propagated by budding on any kind of plum-ſtocks.

PRUSA (anc. geog.) a town ſituated at mount Olympus in Myſia, built by Pruſias, who waged war with Crœſus, (Strabo); with Cyrus, (Stephanus); both cotemporary princes. Now called *Burſa* or *Pruſa*, capital of Bithynia, in Aſia Minor. E. Long. 29. 5. N. Lat. 39. 22.

PRUSIAS, the name of ſeveral kings of Bithynia.

Prusias, a town of Bithynia, anciently called *Cios*, from a cognominal river, and giving name to the Sinus Cianus of the Propontis; rebuilt by Pruſias the ſon of Zela, after having been deſtroyed by Philip the ſon of Demetrius: it ſtood on the Sinus Cianus, at the foot of mount Arganthonius. This is the Pruſias who harboured Annibal after the defeat of Antiochus. —Of this place was Aſclepiades, ſurnamed *Pruſieus*, the famous phyſician.

PRUSSIA, a country of Europe, bounded on the north by the Baltic, Lithuania, and Samogitia, on the eaſt by Lithuania, on the ſouth by Poland, and on the weſt by Pomerelia and the Baltic, about 160 miles in length, and where broadeſt ninety-ſix. As to the climate and temperature of the air, the laſt two months of the ſpring, and the two firſt ſummer months are temperate, warm, and pleaſant; and the weather generally very favourable to bring the fruits of the earth to maturity. But, before and after theſe months, the air is cold and piercing; the autumns being often wet, and the winters ſevere. The ſoil produces plenty of corn, eſculent herbs, fruit, and paſturage. Pruſſia alſo abounds with flocks and herds, and exceedingly fine horſes; its chief commodities are wool, honey, wax, pitch, pit-coal, flax, hemp, hops, and buck-wheat. This country affords plenty of game, as white and common hares, elks, deer, ſtags, roe-bucks, and wild-boars; but, at the ſame time, it is infeſted with beaſts of prey, as lynxes, wolves, foxes, and bears. Amber is found in vaſt quantities on the coaſt of the Baltic, in Pruſſia, eſpecially on the Samland ſhore. The profit ariſing from it is one of the Pruſſian regalia, and amounts annually to about 26,000 dollars. This country yields neither ſalt, wine, nor minerals, however, it contains iron ore in ſome places. It is for the moſt part a level champaign country. The lakes, rivers, and canals of this country, together with the neighbouring ſea, afford a variety of excellent fiſh; as ſalmon, ſturgeon, cod, turbots, ſoles, muræna (a kind of lampreys, which are peculiar to Pomerania and Pruſſia) hallybuts, pike, perch, plaiſe, eels, &c. The principal rivers of Pruſſia are the Viſtula, Pregel, Memel, Paſſarage, and Alle. As for the inland lakes of which this country has a great number, from four to thirty miles in length, and from four to eight in breadth, thoſe of Spirding, Angerburg, Rein, and Draufen, are the principal. The number of inhabitants in this kingdom were computed, in the year 1755, at 635,998 perſons capable of bearing arms. They conſiſt of native Pruſſians, who by their language and manners appear to be genuine deſcendants of the Germans; Lithuanians, whoſe anceſtors were the Sclavonians and Nadravians, and have their peculiar language; and Poles, who are deſcended from the Sudavians. Here are alſo a great number of French, Engliſh, and Hollanders. The inhabitants of this country, in general, are Lutherans; but a great number of the coloniſts are Calviniſts; they have churches appropriated for their uſe, while in ſome places they perform their ſervice in the Lutheran churches; the Roman Catholics are few. The manufactures are increaſing, eſpecially glaſs, iron, copper, braſs, paper, cloth, linen, &c. The ſituation is convenient for commerce, and, for the promotion of it, a college has been eſtabliſhed, which takes notice of and regulates all concerns relating to trade and navigation. The chief articles of exportation are grain of different kinds, maſts, deals, and other timber, tar, wood- and pot-aſhes, ſkins, leather, furs, amber, wax, honey, manna, linſeed oil, flax, hemp, linſeed, and hemp ſeed; alſo yarn, hogs'-briſtles, ſtags'-horns, and elks'-hoofs; oatmeal of all kinds, mead, dried fiſh, ſturgeon, caviar, lampreys, ſauſages, butter, and tallow. The ancient Pruſſian hiſtory is involved in obſcurity. About 300 years before the birth of Chriſt, it is ſaid that this country was poſſeſſed by the Æſtions, a Gothic people; and after that, by the Alanians, Vandals, Gallindians, Sudavians, and Sclavonians. Theſe different nations at laſt became one people, and were for a long time without any chief or ſovereign. The amber with which Pruſſia abounds, was the allurement which raiſed the curioſity of the ancient Romans; and induced them to penetrate into the country, and ſubdue it. That part of Pruſſia which lies beyond the Viſtula, and borders on Germany, ſubmitted to the emperor Charles the Great, and though, ſome time after, it recovered its liberty, it was again reduced, and obliged to pay tribute. From that æra the Pruſſian hiſtory begins to clear up; for the kings of Poland in that age took great pains, and even made uſe of compulſion and force of arms, for the converſion of the pagan Pruſſians to Chriſtianity. Boleſlaus I. began by chaſtizing the Pruſſians for the murder of St. Adalbert, who was deſirous of being the apoſtle of that nation. His ſucceſſors, from time to time, had ſeveral quarrels with the inhabitants of Pruſſia; and Boleſlaus IV. who committed dreadful ravages in their country, loſt his life, in an unſucceſsful battle which was fought in 1163. The Teutonic knights ſubdued the whole country, but, in the year 1454, one half of Pruſſia revolted from obedience to them, and declared for Caſimir III. king of Poland. This occaſioned freſh effuſions of blood; till, at laſt, in the year 1466, it was concluded, by treaty, that one part of Pruſſia, now called *Poliſh Pruſſia*, ſhould continue a free province, under the king's protection; and that the knights and the grand-maſter ſhould retain the other part, which they were to hold as a fief, and acknowledge themſelves vaſſals of Poland. The knights, ſoon after, endeavoured to throw off this yoke; but did not ſucceed in their attempt. In 1519 they ſtirred up new wars, which were terminated in 15 5, by a treaty of peace concluded at Cracow. It was then agreed that the margrave Albert, grand-maſter of the Teutonic order, ſhould be acknowledged duke or ſovereign of the eaſt part of Pruſſia, which he was to hold as a fief of Poland. Theſe territories, however, were to deſcend to his male heirs; and upon failure of male iſſue, to his brothers and their male heirs. Thus ended the ſovereignty of the Teutonic order in Pruſſia, after it had ſubſiſted 300 years. The new duke favoured the introducing of the reformed religion into his dominions; and, in 1544, founded an univerſity at Konigſberg. The elector Joachim added Pruſſia to the electoral houſe of Brandenburg, with which it had been cloſely connected for a long time before. The elector Frederick raiſed Pruſſia to a kingdom; and on the 18th of January, 1704, with his own hands put the crown on his head, and on that of his conſort, at Konigſberg. He was ſoon after acknowledged as king of Pruſſia by all the other Chriſtian powers. The kingdom of Pruſſia is divided into three parts, namely, Samland, Natangen, and Oberland; and each of theſe is ſubdivided into certain haupt-aemter, juriſdictions, or governments, beſides which a part of Lithuania called *Little Lithuania*, or *Pruſſian Lithuania* is added to it, thus forming two departments: the German, the capital of which is Konigſberg; and the Lithuanian, the principal places of which are Memel and Tilſit.

PRUSSIAN BLUE. See CHEMISTRY, p. 410.

PRUSSIC ACID, according to M. Berthollet, is a combination of azot of hydrogen and carbon. It appears much leſs akin to acids than to ammoniac; it has, however, too many properties in common with other acids not to place it in the ſame claſs, the rather becauſe our claſſifications are always in a degree arbitrary, and ought to be conſidered rather as uſeful methods, than as diviſions formed by nature. When the Pruſſic acid is combined with alkali and oxyd of iron, it cannot be ſeparated by any other acid, unleſs heat be employed, or it be expoſed to light; and nevertheleſs, when it is diſengaged by one of theſe means, it cannot ſeparate iron, even from the weakeſt acid, unleſs it be by a double affinity. It appears that this property is connected with the elaſtic ſtate, which is unfavourable to theſe combinations: it muſt have loſt this ſtate, in other words its ſpecific heat muſt be diminiſhed, in order that it may poſſeſs its affinities with metallic oxyds and alkalis. Nitrous gas, oxygenated muriatic acid, and ſulphureous acid, preſent analogous phenomena.

PRYNNE (WILLIAM), an Engliſh lawyer, much diſtinguiſhed in the civil commotions under Charles I. was born at Swainſwick in Somerſetſhire in 1600. His *Hiſtriomaſtix*, written againſt ſtage-plays in 1632, containing ſome reflections that offended the court, he was ſentenced by the ſtar-chamber to pay a fine of 5000 l. to ſtand in the pillory, to loſe his ears, and to perpetual impriſonment. During his confinement, he wrote ſeveral more books; particularly, in 1637, one entitled *News from Ipſwich*, which reflecting ſeverely on the biſhops, he was again ſentenced by the ſtar-chamber to another fine of

500l. to loſe the remainder of his ears in the pillory, to be branded on both cheeks with S. L. for ſeditious libeller, and to be perpetually impriſoned in Caernarvon caſtle. Nothing but cutting off his hands could have prevented Prynne from writing: he wrote ſtill; and in 1640, being ſet at liberty by the houſe of commons, he entered London in a kind of triumph, was elected into parliament for Newport in Cornwall, and oppoſed the biſhops with great vigour, being the chief manager of archbiſhop Laud's trial. In the long parliament he was zealous in the Preſbyterian cauſe; but when the Independents gained the aſcendency, he oppoſed them warmly, and promoted an agreement with the king. When the army garbled the houſe, and refuſed him entrance, he became a bitter enemy to them and their leader Cromwell, and attacked them with his pen ſo ſeverely, that he was again impriſoned: but he pleaded the liberty of the ſubject ſo ſucceſsfully, that he was enlarged, to write more controverſial books. Being reſtored to his ſeat after Cromwell's death, with the other ſecluded members, he aſſiſted in promoting the reſtoration, and was appointed keeper of the Tower records; a place excellently well calculated for him, and where he was very uſeful by the collections he publiſhed from them. He preſented 40 volumes of his works, in folio and 4to, to Lincoln's-inn library, of which ſociety he was a member; and, dying in 1669, was buried under the chapel.

PRYTANES, in Grecian antiquity, were the preſidents of the ſenate, whoſe authority conſiſted chiefly in aſſembling the ſenate; which, for the moſt part was done once every day. The ſenate conſiſted of 500, 50 ſenators being elected out of each tribe: after which, lots were caſt, to determine in what order the ſenators of each tribe ſhould preſide; which they did by turns, and during their preſidentſhip were called *prytanes*. However, all the 50 prytanes of the tribes did not govern at once, but one at a time, viz. for ſeven days; and after 35 days, another tribe came into play, and preſided for other five weeks, and ſo of the reſt.

PSALM, a divine ſong or hymn; but chiefly appropriated to the 150 pſalms of David, a canonical book of the Old Teſtament. Moſt of the pſalms have a particular title, ſignifying either the name of the author, the perſon who was to ſet it to muſic or ſing it, the inſtrument that was to be uſed, or the ſubject and occaſion of it. Some have imagined that David was the ſole author of the Book of Pſalms; but the titles of many of them prove the contrary, as pſalm xix. which appears to have been written by Moſes. Many of the pſalms are inſcribed with the names *Korah*, *Jeduthun*, &c. from the perſons who were to ſing them.

PSALMANAZAR (George), the fictitious name of a pretended Formoſan, a perſon of learning and ingenuity. He was born in France, and educated in a free-ſchool, and afterwards in a college of Jeſuits, in an archiepiſcopal city, the name of which, as likewiſe thoſe of his birth-place and of his parents, are unknown. Upon leaving the college, he was recommended as a tutor to a young gentleman; but ſoon fell into a mean rambling life, that involved him in diſappointments and misfortunes. His firſt pretence was that of being a ſufferer for religion. He procured a certificate that he was of Iriſh extraction, that he left that country for the ſake of the Catholic faith, and was going on a pilgrimage to Rome. Being unable to purchaſe a pilgrim's garb, and obſerving one in a chapel, dedicated to a miraculous ſaint, which had been ſet up as a monument of gratitude by ſome wandering pilgrim, he contrived to take both the ſtaff and cloak away; and, being thus accoutred, begged his way in fluent Latin, accoſting only clergymen or perſons of figure; whom he found ſo generous and credulous, that before he had gone 20 miles, he might eaſily have ſaved money, and put himſelf in a much better dreſs: but as ſoon as he had got what he thought was ſufficient, he begged no more; but viewed every thing worth ſeeing, and then retired to ſome inn, where he ſpent his money as freely as he had obtained it. Having heard the Jeſuits ſpeak much of China and Japan, he ſtarted the wild ſcheme, when he was in Germany, of paſſing for a native of the iſland of Formoſa; and what he wanted in knowledge, he ſupplied by a pregnant invention. He formed a new character and language on grammatical principles, which, like other oriental languages, he wrote from right to left with great readineſs; and planned a new religion, and a diviſion of the year into 20 months, with other novelties, to credit his pretenſions. He was now a Japaneſe convert to Chriſtianity, travelling for inſtruction, with an appearance more wretched than even that of common beggars. He then entered as a ſoldier in the Dutch ſervice: but, ſtill deſirous of paſſing for a Japaneſe, he altered his plan to that of being an unconverted heathen; and at Sluys, brigadier Lauder, a Scots colonel, introduced him to the chaplain, who, with a view of recommending himſelf to the biſhop of London, reſolved to carry him over to England. At Rotterdam, ſome perſons having put ſhrewd queſtions to him, that carried the air of doubt, he took one more whimſical ſtep, which was to live upon raw fleſh, roots, and herbs; which ſtrange food he thought would remove all ſcruples. The biſhop of London patronized him with credulous humanity; and Pſalmanazar found a large circle of friends, who extolled him as a prodigy. Yet were there ſome who entertained a juſt opinion of him, particularly the Drs. Halley, Mead, and Woodward; but their endeavours to expoſe him as a cheat only made others think the better of him, eſpecially as thoſe gentlemen were eſteemed no great admirers of revelation. But in this inſtance at leaſt, eaſineſs of belief was no great evidence of penetration. He was employed to tranſlate the church-catechiſm into the Formoſan language, which was examined, approved, and laid up as a valuable MS; and the author, after writing his well-known *Hiſtory of Formoſa*, was rewarded and ſent to Oxford to ſtudy what he liked, while his patrons and opponents were learnedly diſputing at London on the merits of his work. The learned members of the univerſity were no better agreed in their opinions than thoſe at London; but at length the ſceptics triumphed. Some abſurdities were diſcovered in his hiſtory, of ſuch a nature as to diſcredit the whole narration, and ſaved him the trouble of an open declaration of his impoſture; which however he owned at length to his private friends. For the remainder of his life, his learning and ingenuity enabled him to procure a comfortable ſupport by his pen; he being concerned in ſeveral works of credit particularly the *Univerſal Hiſtory*. He lived irreproachably for many years, and died in 1763.

PSALMIST, in the church of Rome, one of the leſſer eccleſiaſtical orders; the ſame with what among us is called *clerk*, *precentor*, or *ſinger*.

PSALMODY, the art or act of ſinging pſalms. See Psalm. Pſalmody was always eſteemed a conſiderable part of devotion, and uſually performed in the ſtanding poſture: and as to the manner of pronunciation, the plain ſong was ſometimes uſed, being a gentle inflection of the voice, not much different from reading, like the chaunt in cathedrals; at other times more artificial compoſitions were uſed, like our anthems.

As to the perſons concerned in ſinging, ſometimes a ſingle perſon ſung alone; ſometimes the whole aſſembly joined together, which was the moſt ancient and general practice. At other times, the pſalms were ſung alternately, the congregation dividing themſelves into two parts, and ſinging verſe about, in their turns. There was alſo a fourth way of ſinging, pretty common in the fourth century, which was, when a ſingle perſon began the verſe, and the people joined with him in the cloſe: this was often uſed for variety, in the ſame ſervice with alternate pſalmody.

The uſe of muſical inſtruments, in the ſinging of pſalms, ſeems to be as ancient as pſalmody itſelf; the firſt pſalm we read of being ſung to the timbrel, viz. that of Moſes and Miriam, after the deliverance of the Iſraelites from Egypt: and afterwards, muſical inſtruments were in conſtant uſe in the temple of Jeruſalem. See ORGAN.

PSALTER, the ſame with the book of pſalms. See the article PSALM. Among the religious in the Popiſh countries, the term *pſalter* is alſo given to a large chaplet or roſary, conſiſting of 150 beads, according to the number of pſalms in the pſalter.

PSALTERY, a muſical inſtrument, much in uſe among the ancient Hebrews, who called it *nebel*. We know little or nothing of the preciſe form of the ancient pſaltery. That now in uſe is a flat inſtrument, in form of a trapezium or triangle truncated at top: it is ſtrung with 13 wire-chords, ſet to uniſon or octave, and mounted on two bridges, on the two ſides: it is ſtruck with a plectrum, or little iron rod, and ſometimes with a crooked ſtick. Its cheſt or body reſembles that of a ſpinet. See NABLUM and Plate 33, Vol. VI.

PSAMMETICUS, or PSAMMITICHUS, a renowned conqueror, who, ſubduing 11 other petty kings of Egypt, became the founder of the kingdom of Egypt, about 670 B. C. He is memorable likewiſe for taking the city of Azot, after a ſiege of 29 years; and for diſcovering the ſources of the river Nile. See EGYPT.

PSATYRIANS, a ſect of Arians, who, in the council of Antioch, held in the year 360, maintained, that the Son was not like the Father as to will; that he was taken from nothing, or made of nothing; and that, in God, generation was not to be diſtinguiſhed from creation.

PSELLUS, (MICHAEL), a learned Chriſtian of the 11th century, was, by birth, a Conſtantinopolitan of conſular rank, and flouriſhed under the emperor Conſtantine Monomachus. His genius and induſtry raiſed him far above the level of his cotemporaries; and the female hiſtorian Anna Comnena ſpeaks of him as one who had been more indebted for his attainments to his own excellent talent than to the inſtructions of his preceptors; adding that, having made himſelf maſter of all the wiſdom of the Greeks and the Chaldæans, he was juſtly eſteemed the moſt learned man of the age. Thus furniſhed, he became the chief inſtructor of the Conſtantinopolitan youth. He was at the ſame time the companion and the preceptor of the emperor, who was ſo captivated by the ſtudies and amuſements in which Pſellus engaged him, that, according to Zonaras, he neglected the concerns of the empire. The Byzantine hiſtorians complain, that the emperor, deluded by the head of the philoſophers (the title with which Pſellus was honoured), loſt the world. Meeting, towards the cloſe of his life, with ſome diſappointment, Pſellus retired into a monaſtery, and ſoon afterwards died; the time of his death is uncertain. His works, which have been much celebrated, are, Commentaries upon Ariſtotle's Logic and Phyſics; a Compendium of Queſtions and Anſwers; and an Explanation of the Chaldæan Oracles. The two latter works prove him to have been converſant, not only with Grecian, but with Oriental, philoſophy.

PSEUDO, from ψευδος, a Greek term uſed in the compoſition of many words, to denote *falſe* or *ſpurious*: as the pſeudo-acacia, or baſtard acacia; pſeudo-fumaria, or baſtard-fumitory; pſeudo-ruta, or baſtard-rue, &c. We alſo ſay, a pſeudo-apoſtle, or falſe apoſtle; a pſeudo-prophet, or falſe prophet, &c.

PSEUDO-*China*. See SMILAX.

PSEUDO-*Galena*, or *Black-Jack*. See ZINC, and MINERALOGY.

PSEUDO-*Tinea*, in natural hiſtory, the name of a very remarkable ſpecies of inſect deſcribed by M. Reaumur, approaching to the nature of the *tinea*, or *clothes-moth* while in the worm-ſtate, but not making themſelves coats of the ſubſtance of leaves, cloth, &c. though they form a ſort of caſes for their defence againſt a very terrible enemy.

Theſe creatures are of the caterpillar kind, and have, in the manner of many of theſe inſects, 16 legs. They feed on wax, and for food enter the bee-hives; where they boldly engage the bees, and are not to be prevented by them from feeding, though at the expenſe of their habitations and the cells of their reſervoirs of honey: ſo that it is no uncommon thing for a ſwarm of bees to be forced to change their place of habitation, and make new combs elſewhere; leaving the old ones to this contemptible victor, whom they know not how to drive out or diſpoſſeſs.

Virgil and Ariſtotle, and all the authors who have written on bees, have complained of this deſtructive animal. It never eats the honey, but feeds only on the wax; attacking principally thoſe waxy cells where the female bee depoſits her eggs for the future progeny.

The bees, who are a match for moſt other creatures by means of their ſtings, would eaſily deſtroy theſe weak creatures, were it not for the impervious armour they are covered with. They form themſelves a coat of armour of a double matter. The firſt, which immediately covers the body, is of a kind of ſilk of their own ſpinning; and the outer covering over this is of the bees-wax: this is laid conſiderably thick; and the creature, juſt thruſting out its head to feed, goes on devouring the cells undiſturbed, while a whole army of the inhabitants are in vain buzzing about him, and attempting to pierce him with their ſtings. He never forſakes his covering, but lengthens and enlarges it as he goes; and gnawing down the ſides of the cells in his march, without ſtaying to eat them one by one, the havock and deſtruction he occaſions are ſcarce to be conceived. When the time of the change of this creature approaches, it contracts its body within its double covering, and there changes into the nymph ſtate; whence, after a proper time, it comes forth in form of a moth, with granulated horns and a crooked proboſcis.

The bees have cunning enough to know their deſtructive enemy in this new form; and as this is a weak and defenceleſs ſtate, they attack and deſtroy all the moths of this ſpecies they can meet with. They ſeldom are ſo fortunate, however, as to kill the whole race as ſoon as produced; and if only one eſcape, it is able to lay a foundation of revenge for the death of its brethren. All the flies of the moth kind lay a vaſt number of eggs, and this is behind hand with none of them in that particular: the young ones produced from the eggs of one ſurviving female of this ſpecies are ſufficient to deſtroy many honey-combs; nay, many hives of them. The moth produced by this caterpillar flies but little; yet it is very nimble in avoiding danger, by running, which it does with great ſwiftneſs.

There is a ſpecies of theſe pſeudo-tineæ, or wax-eating caterpillars, which infeſt the ſubterraneous hives of waſps and other creatures which make wax: the manner of living, feeding, and defending themſelves from their enemies, is the ſame in all the ſpecies. Theſe laſt, if they be at any time diſtreſſed for food, will eat their own dung; the wax having paſſed almoſt unaltered through their bodies, and being ſtill wax, and capable of affording them more nouriſhment on a ſecond digeſtion. Theſe ſpecies, though they naturally live on this ſoft food, yet if by any accident they meet with harder only, they know how to live upon it; and can eat a way into the covers and leaves of books, and make themſelves caſes and coverings of the fragments of theſe ſubſtances. The accurate author of theſe obſervations deſcribes alſo a kind of *pſeudo-tinea* which feeds on wool, and another that eats leather; both making themſelves houſes alſo of the materials they feed on.

There is alſo another kind very deſtructive to corn: theſe make themſelves a covering by faſtening together a great number of the grains, and there living and eating in ſecret. All theſe creatures, whatever be their food or habitation, finally become *phalenæ*, or moths; and may be diſtinguiſhed, even in this ſtate, from the other ſpecies, by having granulated horns of a remarkable ſtructure, and all of them a proboſcis, or trunk, more or leſs incurvated.

PSEUDONYMUS, among critics, an author who publiſhes a book under a falſe or feigned name; as *cryptonymus* is given to him who publiſhes one under a diſguiſed name, and *anonymous* to him who publiſhes without any name at all.

PSIDIUM, the GUAVA: A genus of the monogynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 19th order, *Heſperideæ*. The calyx is quinquefid, ſuperior; there are five petals; the berry is unilocular and monoſpermous. There are two ſpecies: 1. The *pyriferum*, or white guava; 2. The *pomiferum*, or red guava. Both theſe are thought to be only varieties of the ſame plant. The red guava riſes to the height of 20 feet, and is covered with a ſmooth bark; the branches are angular, covered with oval leaves, having a ſtrong midrib, and many veins running towards the ſides, of a light green colour, ſtanding oppoſite upon very ſhort footſtalks. From the wings of the leaves the flowers come out upon footſtalks an inch and a half long: they are compoſed of five large roundiſh concave petals, within which are a great number of ſtamina ſhorter than the petals, and tipped with pale yellow tops. After the flower is paſt, the germen becomes a large oval fruit ſhaped like a pomegranate.

A decoction of the roots of guava is employed with ſucceſs in dyſenteries: a bath of a decoction of the leaves is ſaid to cure the itch and other cutaneous eruptions. Guayava, or guava, is diſtinguiſhed from the colour of the pulp, into the two ſpecies above-mentioned, the white and the red; and, from the figure of the fruit, into the round, and the pear-faſhioned or perfumed guava. The latter has a thicker rind, and a more delicate taſte than the other. The fruit is about the bigneſs of a large tennis-ball; the rind or ſkin generally of a ruſſet ſtained with red. The pulp within the thick rind is of an agreeable flavour, and interſperſed with a number of ſmall white ſeeds. The rind, when ſtewed, is eaten with milk, and preferred to any other ſtewed fruit. From the ſame part is made marmalade; and from the whole fruit is prepared the fineſt jelly in the world. The fruit is very aſtringent, and nearly of the ſame quality with the pomegranate; ſo ſhould be avoided by all who are ſubject to coſtiveneſs. The ſeeds are ſo hard as not to be affected by the fermentation in the ſtomachs of animals; ſo that when voided with the excrements, they take root, germinate, and produce thriving trees. Whole meadows in the Weſt Indies are covered with guavas, which have been propagated in this manner. The buds of guava, boiled with barley and liquorice, produce an excellent ptiſan for diarrhœas, and even the bloody flux, when not too inveterate. The wood of the tree, employed as fuel, makes a lively, ardent, and laſting fire.

PSITTACUS, or PARROT, in ornithology; a genus belonging to the order of *picæ*. The bill in this genus is hooked from the baſe; and the upper mandible is moveable: the noſtrils are round, placed in the baſe of the bill, which in ſome ſpecies is furniſhed with a kind of cere: the tongue is broad, and blunt at one end: the head is large, and the crown flat: the legs are ſhort, the toes placed two before and two behind. It might ſeem a wonder why nature has deſtined to this, which is not naturally a bird of prey, but feeds on fruits and vegetable ſubſtances, the crooked beak allotted to the hawk and other carnivorous birds: but the reaſon ſeems to be, that the parrot being a heavy bird, and its legs not very fit for ſervice, it climbs up and down trees by the help of this ſharp and hooked bill, with which it lays hold of any thing and ſecures itſelf before it ſtirs a foot; and beſides this, it helps itſelf forward very much, by pulling its body on with this hold.

Of all animals, the parrot and the crocodile are the only ones which move the upper jaw; all creatures elſe moving the lower only. As ſome particular animals beſide are fond of particular foods, ſo the parrot loves nothing ſo much as the ſeeds of the carthamus, or baſtard-ſaffron; and eats them without any hurt, though they are a purge when given to other creatures.

Parrots are found almoſt everywhere within the tropics; and in their natural ſtate they live on fruits and ſeeds, though, when tame, they will eat fleſh, and even fiſh.

In the Eaſt and Weſt Indies they are very common, and in ſuch warm climates are very briſk and lively; here, however, they loſe much of their vigour. They ſeldom make neſts, but breed like owls in hollow trees; they lay two eggs. At particular times they fly in very large troops, but ſtill they keep two and two together. The genus conſiſts of infinite variety, not ſo much owing to mixture of ſpecies, however, as might be ſuppoſed. They ſeem to run vaſtly into one another, ſo as to appear to be related, though received from different parts of the world; this, however, may poſſibly be occaſioned by their being carried from one place to another for the ſake of ſale. This uncertainty of native place has prevented Mr. Latham from following Buffon's plan, and ranging them according to the places they are ſuppoſed to inhabit; he divides them therefore into thoſe with *uneven* and thoſe with *even* tails.

Buffon ranges the parrots in two great claſſes: the firſt of which comprehends thoſe of the Old Continent, and the ſecond thoſe of the New. The former he ſubdivides into five families, the Cockatoos, the Parrots, properly ſo called, the Lories, the long-tailed Paroquets, and the ſhort-tailed ones; and the latter into ſix, viz. the Macaos, the Amazonians, the Creeks, the Popinjays, the long-tailed Paroquets, and the ſhort-tailed ones.

Mr. Latham has increaſed the genus from 47 to 163; and ſince the time he wrote his *Index* at leaſt 20 more have been diſcovered. They are very generally divided into three kinds: 1. The larger, which are as big as a moderate fowl, called *macaos* and *cockatoons*; theſe have very long tails. The middle-ſized ones, commonly called *parrots*, which have ſhort tails, and are a little larger than a pigeon. And, 3. The ſmall ones, which are called *paroquets*, and have long tails, and are not larger than a lark or blackbird.

1. The *pſittacus macao*, or red and blue macao, is red, except the wing quills, which above are blue, before rufous: the ſcapular feathers are variegated with blue and green: the cheeks are naked and wrinkled. It is about two feet ſeven inches and a half long, and about as big as a capon. Edwards ſays, when perfect, it will meaſure a full yard from bill to tail. It inhabits Braſil, Guiana, and other parts of South America. It was formerly very common in St. Domingo, but is now rarely found there. It generally lives in moiſt woods, eſpecially ſuch as are planted with a particular kind of palm, perhaps what is called the *macaw* tree. It does not in general learn to ſpeak, and its voice is particularly rough and diſagreeable. The fleſh is hard, black, and unſavoury, but makes good ſoup, and is much uſed by the inhabitants of Cayenne and other places. This ſpecies, in common with other parrots, is ſubject to fits when tamed; and though it will live for many years though the returns be pretty frequent, it generally falls a victim to that diſeaſe at laſt. The Americans call it *gonzalo*. 2. The *pſittacus ararauna*, or blue and yellow macaw, is blue above, and yellow below, and the cheeks are naked, with feathery lines. It is about the ſame ſize with the laſt, and inhabits Jamaica, Guiana, Braſil, and Surinam. 3. The *pſittacus ſeverus*, or Braſilian green macaw, is black, with a greeniſh ſplendor; the bill and eyes are reddiſh, and the legs are yellow. It is about one foot and five inches

long, and is common in Jamaica, Guiana, and Braſil. It is however comparatively rare; but it is extremely beautiful, and of a very amiable and ſociable temper when familiar and acquainted; but it can neither bear ſtrangers nor rivals: its voice is not ſtrong, nor does it articulate very diſtinctly the word *ara*. See plate 21.

4. The *pſittacus aurora*, or yellow amazon, is about 12 inches long, of a green colour, with blue wing quills, and a white front; its orbits are ſnowy. It inhabits Mexico or Braſil; but in all probability the latter, from the one which Salerne ſaw, and which pronounced Portugueſe words. The pſittacus guineenſis, or yellow lory, is about ten inches long, and is an inhabitant of Guinea. The bill is of a black colour; the cere, the throat, and ſpace about the eyes, are white; above the eye there is a patch of yellow, and the reſt of the head and neck is crimſon. The breaſt is yellow, wing coverts green, and the quills are blue, edged with yellow. Under the wings, belly, thighs, vent, and to the under part of the tail, the colour is white, which laſt is tipped with red; the legs are duſky, and the claws black.

5. The *pſittacus pullarius*, red-headed Guinea parraket, or Guinea ſparrow, is about five inches and a half long. It inhabits Guinea, and is found in Ethiopia, the Eaſt Indies, and the iſland of Java, and ſometimes in Surinam. It is green, with a red front, fulvous tail, black bar, and cinereous orbits. The male of this ſpecies is peculiarly affectionate to the female.

In Mr. White's *Journal of a Voyage to New South Wales*, we find a deſcription, with excellent engravings, of ſeveral ſpecies of this extenſive genus; and in Governor Philip's Voyage to the ſame place, we find deſcriptions and prints of ſeveral of the ſame ſpecies. But the moſt particular of the later authors are Buffon and Latham, eſpecially the laſt; to whoſe extenſive and accurate work we therefore refer our readers for that information which our limits permit us not to give. See his *Synopſis*, vol. i. p. 194—323. See alſo *Buffon*, vol. vi. p. 63—245.

PSOAS, in anatomy. See ANATOMY, *Table of the Muſcles*.

PSOPHIA, in ornithology; a genus belonging to the order *gallinæ*. The bill is moderate; the upper mandible is convex; the noſtrils are oblong, ſunk, and pervious; the tongue is cartilaginous, flat, and fringed at the end; and the legs are naked a little above the knees. The toes are three before and one behind; the laſt of which is ſmall, with a round protuberance beneath it, which is at a little diſtance from the ground. Mr. Latham only enumerates two ſpecies: 1. *Pſophia crepitans*, or gold-breaſted trumpeter (ſee plate 21). Its head and breaſt are ſmooth and ſhining green. By the Spaniards of Maynas it is called *trompetero*, and by the French at Cayenne *agami*, under which laſt Buffon deſcribes it. It inhabits parts of South America, Braſil, Guiana, Surinam, &c but it is moſt plenty in the Amazons country. It is about 20 inches long, being about the ſize of a large fowl, and lays eggs rather larger, of a blue green colour. It is met with in the Carribee iſlands, where it is called a *pheaſant*, and its fleſh is reckoned as good as that of a pheaſant. The moſt characteriſtic and remarkable property of theſe birds conſiſts in the wonderful noiſe they make either of themſelves, or when urged by the keepers of the *menagerie*. Some have ſuppoſed it to proceed from the *anus*, and ſome from the belly. It is now certain, however, that this noiſe proceeds from the lungs. See Buffon, vol. iv. p. 390, &c. Another very remarkable circumſtance is, that they follow people through the ſtreets, and out of town, and that too even perfect ſtrangers. It is difficult to get rid of them; for if you enter a houſe, they will wait your return, and again join you, though often after an interval of three hours. "I have ſometimes (ſays M. de la Borde) betaken myſelf to my heels; but they ran faſter, and and always got before me; and when I ſtopped, they ſtopped alſo—I know one (continues he) which invariably follows all the ſtrangers who enter his maſter's houſe, accompanies them into the garden, takes as many turns as they do, and attends them back again." 2. *Pſophia undulata*, or undulated trumpeter, is about the ſize of a gooſe. The upper part of the body is of a pale reddiſh brown colour, beautifully undulated with black. The head is adorned with a dependent creſt. On each ſide of the neck, beneath the ears, begins a liſt of black, widening as it deſcends, and meeting on the lower part before, where the feathers become greatly elongated and hang looſely down. The under parts are generally white, the legs are of a duſky blue colour, like the bill. It is a native of Africa: Mr. Latham's ſpecimen came from Tripoli.

PSORALEA, in botany: A genus of the decandria order, belonging to the diadelphia claſs of plants; and in the natural method ranking under the 32d order, *Papilionaceæ*. The calyx is powdered with callous points, and as long as the monoſpermous legumen. The moſt remarkable ſpecies are, 1. The *primata*, or pinnated pſoralea, riſes with a woody ſoft ſtem, branching five or ſix feet high, pinnated leaves of three or four pair of narrow lobes terminated by an odd one, and at the axillas cloſe ſitting blue flowers with white keels. It is a native of Ethiopia. 2. The *bituminoſa*, or bituminous trifoliate pſoralea, riſes with a ſhrubby ſtalk, branching ſparingly about two or three feet high, with ternate or three-lobed leaves of a bituminous ſcent, and blue flowers in cloſe heads; it grows in Italy and in France. 3. The *aculeata*, or aculeated prickly pſoralea, riſes with a ſhrubby branching ſtem three or four feet high, with ternate leaves, having wedge-ſhaped lobes, terminating in a recurved ſharp point, and the branches terminated by roundiſh heads of blue flowers; it grows in Ethiopia. Theſe plants flower here every ſummer; the firſt ſort greateſt part of that ſeaſon, and the others in July and Auguſt; all of which are ſucceeded by ſeeds in autumn. Keep them in pots in order for removing into the green-houſe in winter. They are propagated by ſeeds, ſown in a hot-bed in the ſpring; and when the plants are two or three inches high, prick them in ſeparate ſmall pots and gradually harden them to the open air, ſo as to bear it fully by the end of May or beginning of June. They may alſo be propagated by cuttings any time in ſummer, planted in pots, and plunged in a little heat, or covered cloſe with hand-glaſſes, ſhaded from the ſun, and watered.

PSYCHOTRIA, in botany: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 47th order, *Stellatæ*. The calyx is quinquedentate, perſiſting, and crowning the fruit; the corolla is tubulated; the berry globoſe; with two hemiſpherical ſulcated ſeeds. The ſpecies are four, viz. 1. *Aſiatica*; 2. *Serpens*; 3. *Herbacea*; and, 4. *Emetica*. They are all natives of Jamaica. See IPECACUANHA.

PSYLLI, (Strabo, Ptolemy): a people in the ſouth of Cyrénaica, ſo called from king Pſyllus, (Agathargides, quoted by Pliny): almoſt all overwhelmed by ſand driven by a ſouth wind (Herodotus). They had ſomething in their bodies fatal to ſerpents, and their very ſmell proved a charm againſt them, according to Pliny, Lucan, &c. Though we may juſtly look upon it as fabulous, that theſe people had any thing in their bodies different from others; it is, however, certain that there are in Egypt at this day ſome perſons who have a method of handling the moſt poiſonous ſerpents without any hurt. Of theſe Mr. Haſſelquiſt has given an account.

PTARMIGAN, in ornithology. See TETRAO.

PTELEA, SHRUB-TREFOIL: A genus of the monogynia order, belonging to the tetrandria claſs of plants; and in the natural method ranking with thoſe of which the order is doubtful. The corolla is tetrapetalous; the calyx quadripartite inferior; the fruit is monoſpermous, with a roundiſh membrane in the middle.

The ſpecies are, 1. The *trifoliata*, or Carolina ſhrub-trefoil, hath a ſhrubby upright ſtem, dividing into a branchy head eight or ten feet high, covered with a ſmooth purpliſh bark, trifoliate leaves, formed of oval ſpear-ſhaped folioles, and the branches terminated by large bunches of greeniſh-white flowers, ſucceeded by roundiſh, bordered capſules. 2. The *viſcoſa*, or viſcous Indian ptelea, riſes with ſeveral ſtrong ſhrubby ſtems, branching erectly 12 or 15 feet high, having a light brown bark, ſpear-ſhaped, ſtiff, ſimple leaves, and the branches terminated by cluſters of greeniſh flowers. The *firſt* ſpecies is a hardy deciduous ſhrub, and a proper plant for the ſhrubbery and other ornamental plantations to increaſe the variety. It is propagated by ſeeds, layers, and cuttings. The *ſecond* ſpecies is a ſtove plant, and is propagated commonly by ſeeds.

PTERIS, in botany; a genus of the order of filices, belonging to the cryptogamia claſs of plants. The fructifications are in lines under the margin. There are 19 ſpecies: the moſt remarkable is the aquilina, or common female fern. The root of this is viſcid, nauſeous, and bitteriſh; and like all the reſt of the fern tribe, has a ſalt, mucilaginous taſte. It creeps under the ground in ſome rich ſoils to the depth of five or ſix feet, and is very difficult to be deſtroyed. Frequent mowing in paſture-grounds, plentiful dunging in arable lands, but above all, pouring urine upon it, are the moſt approved methods of killing it. It has, however, many good qualities to counterbalance the few bad ones. Fern cut while green, and left to rot upon the ground, is a good improver of land; for its aſhes, if burnt, will yield the double quantity of ſalt that moſt other vegetables will.—Fern is alſo an excellent manure for potatoes; for if buried beneath their roots, it never fails to produce a good crop.—Its aſtringency is ſo great, that it is uſed in many places abroad in dreſſing and preparing kid and chamois leather.—In ſeveral places in the north, the inhabitants mow it green, and, burning it to aſhes, make thoſe aſhes up into balls, with a little water, which they dry in the ſun, and make uſe of them to waſh their linen with inſtead of ſoap. In many of the Weſtern Iſles the people gain a very conſiderable profit from the ſale of the aſhes to ſoap- and glaſs-makers.—In Glen Elg in Inverneſsſhire, and other places, the people thatch their houſes with the ſtalks of this fern, and faſten them down with ropes made either of birk-bark or heath. Sometimes they uſe the whole plant for the ſame purpoſe, but that does not make ſo durable a covering.—Swine are fond of the roots, eſpecially if boiled in their waſh.—In ſome parts of Normandy we read that the poor have been reduced to the miſerable neceſſity of mixing them with their bread. And in Siberia, and ſome other northern countries, the inhabitants brew them in their ale, mixing one-third of the roots to two-thirds of malt.—The ancients uſed the root of this fern, and the whole plant, in decoctions and diet-drinks, in chronic diſorders of all kinds, ariſing from obſtructions of the viſcera and the ſpleen. Some of the moderns have given it a high character in the ſame intentions, but it is rarely uſed in the preſent practice. The country people, however, ſtill continue to retain ſome of its ancient uſes; for they give the powder of it to deſtroy worms, and look upon a bed of the green plant as a ſovereign cure for the rickets in children.

PTEROCARPUS, in botany: A genus of the decandria order, belonging to the diadelphia claſs of plants; and in the natural method ranking under the 32d order, *Papilionaceæ*. The calyx is quinquedentate, the capſule falcated, filiaceous, varicoſe. The ſeeds are few and ſolitary. There are four ſpecies, viz. 1. *Draco*; 2. *Ecaſtaphyllum*; 3. *Lunatus*; and, 4. *Santalinus*. This laſt is by ſome referred to the genus *Santalum*. It is called *red ſaunders*; and the wood is brought from the Eaſt Indies in large billets, of a compact texture, a dull red, almoſt blackiſh colour on the outſide, and a deep brighter red within. This wood has no manifeſt ſmell, and little or no taſte.

The principal uſe of red ſaunders is as a colouring drug; with which intention it is employed in ſome formulæ, particularly in the *tinctura lavendulæ compoſita*. It communicates a deep red to rectified ſpirit, but gives no tinge to aqueous liquors; a ſmall quantity of the reſin, extracted by means of ſpirit, tinges a large one of freſh ſpirit of an elegant blood-red. There is ſcarcely any oil, that of lavender excepted, to which it communicates its colour. Geoffroy and others take notice, that the Brazil woods are ſometimes ſubſtituted for red ſaunders; and the college of Bruſſels are in doubt whether all that is ſold among them for ſaunders be not really a wood of that kind. According to the account which they have given, their ſaunders is certainly the Brazil wood; the diſtinguiſhing character of which is, that it imparts its colour to water.

PTEROCOCEUS, in botany, is a ſpecies of the genus Calligonum. See CALLIGONUM.

PTERONIA, in botany: A genus of the polygamia æqualis order, belonging to the ſyngeneſia claſs of plants; and in the natural method ranking under the 49th order, *Compoſitæ*. The receptacle is full of multipartite briſtles; the pappus a little plumy; the calyx imbricated.

PTEROSPERMUM, in botany: A genus of the polyandria order, belonging to the monadelphia claſs of plants; and in the natural method ranking under the 37th order, *Columniferæ*. The calyx is quinquepartite; the corolla conſiſts of five oblong ſpreading petals. The filaments are about 15, which unite towards the baſe into a tube. The ſtyle is cylindrical; the capſule is oval, woody, and quinquelocular, each of which are bivalved, containing many oblong, compreſſed, and winged ſeeds. There is only one ſpecies, viz. the *Pentapetes*, a native of the Eaſt Indies; the wood of which is very hard, and very like that of the holly-tree.

PTINUS, a genus of inſects belonging to the order of coleoptera. The antennæ are filiform: The laſt or exterior articulations are longer than the others: The thorax is nearly round, without a margin, into which the head is drawn back or received: The feet are made for leaping. The moſt remarkable ſpecies are, 1. The *pectinicornis*. This is produced from a worm that lodges in wood and the trunks of trees, ſuch as the willow, where it makes deep round holes, turns to a winged inſect, takes flight, and rooſts upon flowers. It is diſtinguiſhed by its antennæ pectinated on one ſide, whence it has the name of *feathered*. The elytra and thorax are of a deep clay-coloured brown, the antennæ and legs are of a pale brown. 2. The *pertinax*. The form of this inſect reſembles the preceding one, ſaving that its antennæ are filiform. It is all over of a deep blackiſh brown colour reſembling ſoot. It attacks houſehold-furniture, clothes, furs, and eſpecially animals dried and preſerved in collections of natural hiſtory, where it makes great havock. When caught, this inſect bends its legs, draws back its head, and lies as if it were dead till it thinks itſelf out of danger. It cannot be forced out of this ſtate of inaction either by pricking or tearing: nothing but a ſtrong degree of heat can oblige it to reſume its motion and run away. There are many beautiful varieties of this genus; but they in general eſcape our attention by their minuteneſs, and living among hay, dried leaves, and divers other duſty matters, where they undergo their metamorphoſes. The larvæ of ſome are found in trunks of decayed trees, in old tables, chairs, &c. See plate 21.

PTISAN, is properly barley decorticated, or deprived of its hulls, by beating in a mortar, as was the ancient practice;

though the cooling potion obtained by boiling ſuch barley in water, and afterwards ſweetening the liquor with liquorice root, is what at preſent goes by the name of *ptiſan*; and to render it laxative, ſome add a little ſena or other ingredient of the ſame intention.

PTOLEMAIC *Syſtem of Aſtronomy*, is that invented by Claudius Ptolemæus. See Ptolemy (Claudius).

PTOLEMAIS, (anc. geog.); the port of Arſinoë, ſituated on the weſt branch of the Nile, which concurs to form the iſland called *Nomos Heracleotes*, to the ſouth of the vertex of the Delta.

Ptolemais, (Strabo); the largeſt and moſt conſiderable town of Thebais, or Higher Egypt, and in nothing ſhort of Memphis; governed in the manner of a Greek republic; ſituated on the weſt ſide of the Nile, almoſt oppoſite to Coptos. This town, which was built by Ptolemy Philadelphus, is now known by the name of *Ptolometa*. The walls and gates are ſtill entire, and there are a vaſt number of Greek inſcriptions, but only a few columns of the portico remain. There is likewiſe an Ionic temple, done in the moſt ancient manner of executing that order, of which Mr. Bruce took a drawing, which is preſerved in the king's collection.—Another, of Cyrenaica, anciently called *Barce*.—A third of the Troglodytica, ſurnamed *Epitheras*, from the chace of wild beaſts, as elephants: lying in the ſame parallel with Meroë (Strabo); on the Arabian gulf (Pliny); 4820 ſtadia to the ſouth of Berenice.—A fourth, of Galilee, anciently called *Aca*, or *Acon*; made a Roman colony under the emperor Claudius (Pliny).—A fifth of Pamphylia; ſituated near the river Melas, on the borders of Cilicia Aſpera.

PTOLEMY (Soter, or Lagus), king of Egypt, a renowned warrior, and an excellent prince: he eſtabliſhed an academy at Alexandria, and was himſelf a man of letters. Died 284 B. C. aged 92.

Ptolemy (Philadelphus), his ſecond ſon, ſucceeded him to the excluſion of Ptolemy Ceraunus. He was renowned as a conqueror, but more revered for his great virtues and political abilities. He eſtabliſhed and augmented the famous Alexandrian library, which had been begun by his father. He greatly increaſed the commerce of Egypt, and granted conſiderable privileges to the Jews, from whom he obtained a copy of the Old Teſtament, which he cauſed to be tranſlated into Greek, and depoſited in his library. This is ſuppoſed to have been the verſion called the *Septuagint*. He died 246 years B. C. aged 64.

Ptolemy (Ceraunus), the elder brother, fled to Seleucus king of Macedon, who received him hoſpitably; in return for which he aſſaſſinated him, and uſurped his crown. He then invited Arſinoë, who was his widow and his own ſiſter, to ſhare the government with him: but as ſoon as he got her in his power, he murdered her and her children. He was at length defeated, killed, and torn limb from limb by the Gauls, 279 B. C.

Ptolemy (Claudius), a celebrated mathematician and aſtrologer, was born at Peluſium, and ſurnamed by the Greeks *Moſt Divine* and *Moſt Wiſe*. He flouriſhed at Alexandria in the ſecond century, under the reigns of Adrian and Marcus Aurelius, about the 138th year before the Chriſtian æra. There are ſtill extant his Geography, and ſeveral learned works on aſtronomy. The principal of which are, 1. The Almageſt; 2. *De Judiciis Aſtrologicis*; 3. *Planiſphærium*. His ſyſtem of the world was for many years adopted by the philoſophers and aſtronomers; but the learned have rejected it for the ſyſtem of Copernicus. See Astromomy.

PTYALISM, in medicine, a ſalivation, or frequent and copious diſcharge of ſaliva. The word is Greek, formed from πτυω, "to ſpit."

PUBERTY, denotes the age at which a perſon is capable of procreating or begetting children. See Man.

Puberty, in law, is fixed at the age of 12 in females, and 14 in males; after which they are reckoned to be fit for marriage. But as to crimes and puniſhments, the age of puberty is fixed at 14 in both ſexes.

PUBES, in anatomy, denotes the middle part of the hypogaſtric region in men or women, lying between the two inguina or groins.

Section of the Pubes. See Midwifery and Sigaultian *Operation*.

Pubes, in botany, the hair or down on the leaves of ſome plants. See Hair.

PUBLICAN, among the Romans, one who farmed the taxes and public revenues.

PUBLICATION, the art of making a thing known to the world, the ſame with promulgation.

PUBLIUS Syrus, a Syrian mimic poet, who flouriſhed about 44 years before Chriſt. He was originally a ſlave ſold to a Roman patrician, called *Domitius*, who brought him up with great attention, and gave him his freedom when of age. He gained the eſteem of the moſt powerful men at Rome, and reckoned J. Cæſar among his patrons. He ſoon eclipſed the poet Laberius, whoſe burleſque compoſitions were in general eſteem. There remains of Publius, a collection of moral ſentences, written in iambics, and placed in alphabetical order.

Oak PUCERON, a name given by naturaliſts to a very remarkable ſpecies of animal of the puceron kind. They bury themſelves in the clefts of the oak and ſome other trees, and getting into the crevices, where the bark is a little ſeparated from the wood, they there live at eaſe, and feed to their fill, without being expoſed to their common enemies. They are larger than the other pucerons, the winged ones being nearly as large as a common houſe fly; and thoſe without wings are alſo larger than any other ſpecies of the ſame genus. The winged ones are black, and the others of a coffee colour. Their trunk is twice the length of their bodies, and, when walking, it is carried ſtraight along the belly, trailing behind it with the point up. When the creature has a mind to ſuck a part of the tree that is juſt before it, it draws up, and ſhortens the trunk, till it brings it to a proper length and direction; but when it ſucks in the common way, it crawls upon the inner ſurface of the bark, and the turned up end of the trunk, which reſembles a tail, fixes itſelf againſt the wood that is behind it, or contiguous to its back, and ſucks there. The extremity of this trunk holds ſo faſt by the wood, that when it is pulled away, it frequently brings a ſmall piece of the wood away with it.

The ants are as fond of theſe as of the other ſpecies of pucerons, and that for the ſame reaſon, not feeding upon them, but on their dung, which is a liquid matter of a ſweet taſte, and is the natural juice of the tree, very little altered. Theſe creatures are the ſureſt guides where to find this ſpecies of puceron; for if we at any time ſee a number of theſe crawling up an oak to a certain part, and there creeping into the clefts of the bark, we may be aſſured that in that place there are quantities of theſe oak pucerons. The ants are ſo extremely fond of the juices of the tree, when prepared for them by paſſing through the body of this animal, that when the puceron has a drop not yet evacuated, but hanging only in part out at the paſſage, an ant will often ſeize on it there.

Pucerons, *Vine-fretters*, or *Plant-lice*. See Aphis.

PUDENDA, the parts of generation in both ſexes. See Anatomy.

PUERILITY, in diſcourſe, is defined by Longinus to be a thought which, by being too far fetched, becomes flat and inſipid. Puerility, he adds, is the common fault of thoſe who affect to ſay nothing but what is brilliant and extraordinary.

PUFFENDORF (Samuel de) was born in 1631 at Fleh, a little village in Miſnia, a province in Upper Saxony; and was ſon of Elias Puffendorf, miniſter of that place. After having made great progreſs in the ſciences at Leipſic, he turned his thoughts to the ſtudy of the public law, which in Germany conſiſts of the knowledge of the rights of the empire over the princes and ſtates of which it is compoſed, and thoſe of the princes and ſtates with reſpect to each other. But though he uſed his utmoſt efforts to diſtinguiſh himſelf, he deſpiſed thoſe pompous titles which are ſo much ſought for at univerſities, and never would take the degree of doctor. He accepted the place of governor to the ſon of Mr. Coyet, a Swediſh nobleman, who was then ambaſſador from Sweden to the court of Denmark. For this purpoſe he went to Copenhagen, but continued not long at eaſe there; for the war being renewed ſome time after between Denmark and Sweden, he was ſeized with the whole family of the ambaſſador. During his confinement, which laſted eight months, as he had no books, and was allowed to ſee no perſon, he amuſed himſelf by meditating on what he read in Grotius's treatiſe *De Jure Belli et Pacis*, and the political writings of Mr. Hobbes. Out of theſe he drew up a ſhort ſyſtem, to which he added ſome thoughts of his own, and publiſhed it at the Hague in 1660, under the title of *Elementa Juriſprudentiæ Univerſalis*. This recommended him to the elector Palatine, who invited him to the univerſity of Heidelberg, where he founded in his favour a profeſſorſhip of the law of nature and nations, which was the firſt of that kind eſtabliſhed in Germany. Puffendorf remained at Heidelberg till 1673, when Charles XI. of Sweden gave him an invitation to be profeſſor of the law of nature and nations at Lunden; which place the elector Palatine reluctantly allowed him to accept. He went thither the ſame year; and after that time his reputation greatly increaſed. Some years after the king of Sweden ſent for him to Stockholm, and made him his hiſtoriographer, and one of his counſellors. In 1688, the elector of Brandenburg obtained the conſent of his Swediſh majeſty, that he ſhould come to Berlin, in order to write the hiſtory of the elector William the Great; and in 1694 made him a baron. But he died that ſame year of an inflammation in his feet, occaſioned by cutting his nails; having attained his grand climacteric. Of his works, which are numerous, the following are the principal: 1. A Treatiſe on the Law of Nature and Nations, written in German; of which there is an Engliſh tranſlation with Barbeyrac's Notes. 2. An Introduction to the Hiſtory of the Principal States which at preſent ſubſiſt in Europe; written in German; which has been alſo tranſlated into Engliſh. 3. The Hiſtory of Sweden from Guſtavus Adolphus's expedition into Germany to the abdication of Queen Chriſtina. 4. The Hiſtory of Charles Guſtavus, two volumes folio, &c.

PUFFIN. See Alca.

PUGET (Peter Paul), one of the greateſt painters and ſculptors France ever produced, though but little noticed by their own writers, was born at Marſeilles in 1623. In his youth he was the diſciple of Roman, an able ſculptor; and then went to Italy, where he ſtudied painting and architecture. In painting he ſo well imitated the manner of Peter de Cortona, that this painter deſired to ſee him, and entered into a friendſhip with him. In 1657, a dangerous diſorder obliged him to renounce the pencil, and devote himſelf to ſculpture; and his reputation cauſing him to be invited to Paris, he enjoyed a penſion of 1200 crowns as ſculptor and director of the works relating to veſſels and galleys. He died at Marſeilles in 1695, and has left a number of admirable ſtatues behind him both in France and Italy.

PUGIL, in phyſic, &c. ſuch a quantity of flowers, ſeeds, or the like, as may be taken up between the thumb and two fore-fingers. It is reckoned the eighth part of the manipulus or handful.

PULEGIUM, or Penny-*Royal*. See Mentha.

PULEX, the Flea, in zoology, a genus of inſects belonging to the order of aptera. It has two eyes, and ſix feet fitted for leaping; the feelers are like threads; the roſtrum is inflected, ſetaceous, and armed with a ſting; and the belly is compreſſed.

The generation of this familiar vermin affords ſomething very curious, firſt diſcovered by Sig. Diacinto Ceſtore. Fleas bring forth eggs, or nits, which they depoſit on animals that afford them a proper food: theſe eggs being very round and ſmooth, uſually ſlip ſtraight down; unleſs detained by the piles, or other inequalities, of the clothes, hairs, &c. Of theſe eggs are hatched white worms, of a ſhining pearl colour, which feed on the ſcurfy ſubſtance of the cuticle, the downy matter gathered in the piles of clothes, or other the like ſubſtances. In a fortnight they come to a tolerable ſize, and are very lively and active; and, if at any time diſturbed, they ſuddenly roll themſelves into a kind of ball. Soon after this, they come to creep, after the manner of ſilk-worms, with a very ſwift motion. When arrived at their ſize, they hide themſelves as much as poſſible, and ſpin a ſilken thread out of their mouth, wherewith they form themſelves a ſmall round bag, or caſe, white within as paper, but without always dirty, and fouled with duſt. Here, after a fortnight's reſt, the animalcule burſts out, transformed into a perfect flea; leaving its exuviæ in the bag. While it remains in the bag, it is milk-white, till the ſecond day before its eruption; when it becomes coloured, grows hard, and gets ſtrength; ſo that upon its firſt delivery it ſprings nimbly away.

The flea, when examined by the microſcope, affords a very pleaſing object. It is covered all over with black, hard, and ſhelly ſcales or plates, which are curiouſly jointed, and folded over one another in ſuch a manner as to comply with all the nimble motions of the creature. Theſe ſcales are all curiouſly poliſhed, and are beſet about the edges with ſhort ſpikes in a very beautiful and regular order. Its neck is finely arched, and much reſembles the tail of a lobſter: the head alſo is very extraordinary; for from the ſnout-part of it there proceed the two fore-legs, and between theſe is placed the piercer or ſucker with which it penetrates the ſkin to get its food. Its eyes are very large and beautiful, and it has two ſhort horns or feelers. It has four other legs joined all at the breaſt. Theſe, when it leaps, fold ſhort one within another; and then, exerting their ſpring all at the ſame inſtant, they carry the creature to a ſurpriſing diſtance. The legs have ſeveral joints, and are very hairy, and terminate in two long and hooked ſharp claws. The piercer or ſucker of the flea is lodged between its fore-legs, and includes a couple of darts or lancets; which, after the piercer has made an entrance, are thruſt further into the fleſh, to make the blood flow from the adjacent parts, and occaſion that round red ſpot, with a hole in the centre of it, vulgarly called a *flea-bite*. This piercer, its ſheath opening ſidewiſe and the two lancets within it, are very difficult to be ſeen; unleſs the two fore-legs, between which they are hid, be cut off cloſe to the head: for the flea rarely puts out its piercer, except at the time of feeding, but keeps it folded inwards; and the beſt way of ſeeing it is by cutting off firſt the head, and then the fore-legs, and then it is uſually ſeen thruſt out in convulſions.

By keeping fleas in a glaſs tube corked up at both ends, but ſo as to admit freſh air, their ſeveral actions may be obſerved, and particularly their way of coupling, which is performed tail to tail; the female, which is much the larger, ſtanding on the male. They may alſo be thus ſeen to lay their eggs, not all at once, but ten or twelve in a day, for ſeveral days ſucceſſively; which eggs will be afterwards found to hatch ſucceſſively in the ſame order. The flea may eaſily be diſſected in a drop of water; and by this means the ſtomach and bowels, with their periſtaltic motion, may be diſcovered very plainly, as alſo their teſtes and penis, with the veins and arteries, though minute beyond all conception. Mr. Lieuwenhoek affirms alſo, that he has ſeen innumerable animalcules, ſhaped like ſerpents, in the ſemen maſculinum of a flea. This blood-thirſty inſect, which fattens at the expenſe of the human ſpecies, prefers the more delicate ſkin of women; but preys neither upon epileptic perſons, nor upon the dead or dying. It loves to neſtle in the fur of dogs, cats, and rats. The neſts of river-ſwallows are ſometimes plentifully ſtored with them.

Fleas are apterous; walk but little, but leap to a height equal to 200 times that of their own body. This amazing motion is performed by means of the elaſticity of their feet, the articulations of which are ſo many ſprings. Thus it eludes, with ſurpriſing agility, the purſuit of the perſon on whom it riots.—Among the memorabilia of fleas, one, they ſay, has been ſeen to draw a ſmall ſilver piece of ordnance to which it was faſtened, the firing of the gun nowiſe daunting its intrepidity. The owner carried it about in a little box lined with velvet, every now and then placing it on her arm to let it feed; but winter put an end to the being of this martial flea. Another flea that became a ſlave to an Engliſhman, had, for its daily and eaſy taſk, to drag its golden chain and padlock, of the weight of one grain. A third flea ſerved as a thrill-horſe to an Engliſh artiſt, who had made an ivory coach and ſix, that carried a coachman with his dog between his legs, a poſtilion, two footmen, and four inſide riders. At Surat fleas, bugs, and other voracious vermin, are in ſo great veneration, that they have an hoſpital endowed, where every night a poor fellow, for hire, ſuffers himſelf to be preyed upon. He is faſtened naked on a bed, when the feaſt begins at his expenſe. In Turkey there is a ſimilar foundation for decayed dogs; an inſtitution leſs ridiculous than the other. Mercurial ointment, brimſtone, a fumigation with the leaves of penny-royal, or freſh-gathered leaves of that plant ſewed up in a bag, and laid in the bed, are remedies pointed out as deſtructive of fleas.

Pulex-*Arboreus*, in natural hiſtory, the name given by Mr. Reaumur to a a very large genus of ſmall animals. They are a kind of half-winged creatures: they have granulated antennæ; and ſome of them, in their moſt perfect ſtate, have complete wings. Theſe are diſtinguiſhed from the others by the name of *muſca-pulex* or the *winged-pulex*.

The ſeveral ſpecies of theſe creatures are of different colours: ſome are brown, others yellow; but the moſt frequent are green. They all feed upon the leaves of trees, which become withered and curled up on their eroding them; and they are ſo common, that wherever a leaf of a tree is found curled up, or of a different form from the others, it is highly probable theſe animals are on it, or that it is their work. Among trees the willow and the roſe are the moſt infected by them; and among plants, the bean and the poppy. They live a ſocial life, multitudes of males and females being found together. The females are eaſily diſtinguiſhed from the males, by their being thicker in the body, and having larger bellies.

It is very wonderful, that of all the known animals of the winged kind, theſe are the only ones which are viviparous. This is eaſily ſeen beyond a poſſibility of doubt; for, on examining a cluſter of them together, it is a common thing to ſee, by the help of a ſmall magnifier, a female in the act of parturition; and the author of this acccount frequently ſaw the young pulex protruded out, from a paſſage near the anus of the female, perfectly formed. He had ſuſpected this from the total want of eggs among ſo numerous a tribe of animals, and from their remarkably ſpeedy propagation, and was thus convinced of it by ocular demonſtration.

They are armed with a tender and flexile proboſcis; with which they ſeize hold of the young ſhoots of the tree they live upon, twiſting the proboſcis round it. Theſe creatures are always ſeen naked and expoſed, ſtanding on the outſide of the ſtalks and leaves, and ſucking in their juices for nouriſhment with their proboſcis. But there is another ſpecies of them, which are alike viviparous, and agree with them in all reſpects except in their manner of living. Theſe get into the inner ſubſtance of the leaves, like the worms called *aſcarides*; and feed on the parenchyma, being defended from all injuries by living between the integuments. In this caſe, the leaves they bury themſelves in become ſcabrous and deformed, and produce a ſort of galls: ſo that Malpighi erred in ſuppoſing all the galls of trees to be produced by the animals hatched of the eggs of ichneumon flies; ſince theſe animals, which are viviparous, and are of a very different kind from the worms of the ichneumon flies, equally produce them. A female of the ſpecies here treated of has been ſeen to bring forth ſeven young ones in a day: and thus, from reſiding alone in the tubercles which ſhe had formed on a leaf, ſhe in a little time becomes the mother of a numerous family; each of which raiſes its own tumour or galls on the leaf, which at firſt are ſmall and round, and of a beautiful red like kermes.

Such of theſe as are of the male ſpecies have a certain time of reſt, in which they lie buried in a ſilky matter, and afterwards become winged, flying nimbly about; whereas the females never are able to fly, but remain always half-winged. It is to be obſerved, however, that there is a different ſpecies of winged inſects frequently found flying about the female pulices, as well as their own males; ſo that all the ſmall-winged inſects about them are not to be thought of their own ſpecies. Theſe do not greatly differ in figure; but the one are harmleſs, and the others have ſtings, and hurt any part of the body on which they fix.

Pulex *Aquaticus auctorum (monoculus pulex* of Linnæus), in entomology, is a ſpecies of the genus Monoculus, which ſee. It is a moſt curious inſect of the ſize of a flea, and has been noticed by many writers who have examined its parts with accuracy, and is that which, uniting together in vaſt numbers, occaſions the beautiful red patches which may be obſerved in a dry ſummer ſeaſon on ſtagnant waters, giving riſe to reports of water being turned to blood, and in the minds of the leſs informed thought to portend dire events. The other ſpecies of the ſame genus collect on waters in a ſimilar way, and occaſion a ſimilar appearance, as has been mentioned under the generic name, to which we refer our readers. See alſo Swammerdam's *Book of Nature*, p. 39.; Baker's *Employment for the Microſcope*, p. 302.; Schœffer's *Icon. Inſ.*; Sultz. *Inſ.* p. 30; De Seer's *Inſ.* vol. 7. &c. where there are alſo excellent figures of it. We have given a figure of it magnified and drawn from life in plate 21: The outward form of the body, Swammerdam ſays, is a kind of ſquare; under the eye there is a ſharp beak; on the breaſt are a kind of arms divided into branches like the boughs of trees, and in the abdomen there is a tranſparent ſubſtance with the legs and tail, and in the hinder part of the body, its legs appear placed as it were on the middle of the back: The eyes are almoſt cloſe together, and are reticulated; the beak is tranſparent.

It appears that inſects of this tribe are enabled to bear the extremes of heat and cold: for Ray, in his *Hiſtoria Inſectorum*, p. 41. obſerves, that the *pulex fluviatilis* was met with by Mr. Willoughby in a hot-bath near Vicenza in Italy, the temperature of which was ſuch as to prevent any other living therein; and, on the contrary, O. Fabricius, in his *Fauna Grœnlandiæ*, p. 264. mentions the circumſtance of the *monoculus pulex* being frequently found under the ice in the ſtagnant waters of Greenland.

The *chego*, or *pulex minimus*, *cutem penetrans*, *Americanus* of Cateſby, is a very ſmall animal found in warm climates. It is a very troubleſome inſect, eſpecially to negroes and ſuch as are ſlovenly or go barefooted. They penetrate the ſkin, under which they lay a bunch of eggs, which ſwell to the bigneſs of a ſmall pea or tare. They are exceedingly painful; and unleſs great care is uſed in taking them out, they are dangerous. It is about one-fourth the ſize of a common flea; the figure is conſiderably magnified, (ſee pl. 21). From the mouth iſſues a hollow tube like that of a common flea, between a pair of antennæ. It has ſix jointed legs, and ſomething like a tail. Under it is one of its eggs, which is ſcarcely viſible to the naked eye. Theſe animals are a great nuiſance to moſt parts of America between the tropics. See Sir Hans Sloane's *Hiſtory of Jamaica*, Introd. p. cxxiv. and vol. ii. p. 191, 192.

PULEX-*Eaters*, a name given by naturaliſts to a ſort of worms frequently found on the leaves of trees, where they devour the animals called *pulices arborei*. Of theſe there are ſeveral ſpecies, which owe their origin to the eggs of different creatures; for there are none of them in their ultimate ſtate in this their time of feeding. According to the different animals whoſe eggs they are hatched from, theſe are of different form and ſtructure. Some are hexapodes, or endued with ſix feet; theſe belong to the beetle-tribe, and finally change into beetles like the parent animal from whoſe eggs they ſprung. Others have no legs, and are produced from the eggs of flies of various kinds. And, finally, others are genuine caterpillars, though ſmall; but theſe are the moſt rare of all.

The two general kinds are the *hexapodes*, or beetle-worms; and the *apodes*, or fly-worms. The fly which gives origin to the laſt of theſe is a four-winged one; and takes care always to depoſit her eggs in a place where there are plenty of the pulices, uſually on the ſtalk or young branches of a tree in the midſt of large families of them. The worm, as ſoon as hatched, finds itſelf in the midſt of food, preying at pleaſure on theſe animals, which are wholly defenceleſs. The ſtalks of the elder and woodbine are frequently found covered over with theſe pulices; and among them there may uſually be found one or more of theſe deſtroyers feeding at will, ſucking in the juices from their bodies, and then throwing away the dry ſkins. Beſides the worms of this four-winged fly, there is one of a two-winged waſp-fly, very deſtructive of theſe animals.

PULLEY, in mechanics, one of the five mechanical powers. See MECHANICS.

PULMO, the LUNGS, in ANATOMY. See ANATOMY.

PULMONARIA, LUNGWORT: A genus of the monogynia order, belong to the pentandria claſs of plants; and in the natural method ranking under the 41ſt order, *Aſperifoliæ*. The corolla is funnel-ſhaped, with its throat pervious; the calyx is priſmatic and pentagonal. There are ſeveral ſpecies; of which the moſt remarkable is the officinalis, common ſpotted lungwort, or Jeruſalem cowſlip. This is a native of woods and ſhady places in Italy and Germany, but has been cultivated in Britain for medical uſe. The leaves are of a green colour, ſpotted with white; and of a mucilaginous taſte, without any ſmell. They are recommended in phthiſis, ulcers of the lungs, &c. but their virtues in theſe diſeaſes are not warranted by experience.

PULO PINANG. See PRINCE *of Wales's Iſland*.

PULP, in pharmacy, the fleſhy and ſucculent parts of fruits extracted by infuſion or boiling, and paſſed through a ſieve.

PULPIT, an elevated place in a church, whence ſermons are delivered. The French give the ſame name to a reading-deſk.

PULPITUM, in the Grecian and Roman theatres, was a place where the players performed their parts. It was lower than the ſcena, and higher than the orcheſtra. It nearly anſwered to what we call the ſtage, as diſtinguiſhed from the pit and galleries.—*Pulpitum* was alſo a moveable deſk or pulpit, from which diſputants pronounced their diſſertations, and authors recited their works.

PULSE, in the animal economy, denotes the beating or throbbing of the heart and arteries. No doctrine has been involved in more difficulties than that of pulſes; ſince, in giving a phyſiological account of them, phyſicians have eſpouſed quite oppoſite ſentiments; whilſt ſome doubt whether the pulſe is owing to the ſyſtole or diaſtole; as alſo, whether the motion of the heart and arteries is one and the ſame, for a moment of time.

With regard to motion, the pulſes are reckoned only four; great and little, quick and ſlow. When quickneſs and greatneſs are joined together, it becomes violent; and when it is little and ſlow it is called a *weak pulſe*. They are alſo ſaid to be *frequent* and *rare*, *equal* and *unequal*; but theſe are not the eſſential affections of motion. Frequency and quickneſs are often confounded with each other. A pulſe is ſaid to be *hard* or *ſoft*, with regard to the artery, according as it is tenſe, renitent, and hard, or flaccid, ſoft, and lax: for the diſpoſition of the arteries contribute greatly to the change of the pulſe; wherefore it ſometimes happens, that the pulſe in both arms is not alike, which is very common in a hemiplexy. Add to theſe a convulſive pulſe, which does not proceed from the blood, but from the ſtate of the artery; and is known by a tremulous ſubſultory motion, and the artery ſeems tobe drawn upwards: this, in acute fevers, is the ſign of death; and is ſaid to be the pulſe in dying perſons, which is likewiſe generally unequal and intermitting. A *great* pulſe ſhows a more copious afflux of the blood to the heart, and from thence into the arteries: a *little* pulſe the contrary.

The pulſes of perſons differ according to the largeneſs of the heart and veſſels, the quantity and temperies of the blood, the elaſtic force of the canals; as alſo with regard to the ſex, age, ſeaſon, air, motion, food, ſleep, watchings, and paſſions of the mind. The pulſe is larger and more quick in men than in women; in the bilious and ſanguineo bilious, than in the phlegmatic and melancholic. Thoſe who are lean, with tenſe fibres and large veſſels, have a greater and a ſtronger pulſe, than thoſe that are obeſe, with lax fibres and ſmall veſſels; whence they are more healthy, robuſt, and apt for labour. In children, the pulſe is quick and ſoft; in adults greater and more violent. In the old, it is commonly great, hard, and ſlow. Labour, motion, and exerciſe of the body, increaſe the circulation of the blood, the excretions, and particularly reſpiration; reſt renders the circulation ſlow and weak; intenſe ſpeaking increaſes the circulation, and conſequently renders the pulſe large and quick. In watching, the pulſe is more evident; in ſleep, more ſlow and languid. After drinking hot things, ſuch as coffee and tea, or hot bath-waters, as well as after meals, the pulſe vibrates more quickly. But nothing produces a greater change in the pulſe than affections of the mind: in terror, it is unequal, ſmall and contracted; in joy, frequent and great; in anger, quick and hard; in ſadneſs, ſlow, ſmall, deep, and weak; and in intenſe ſtudy, languid and weak. With regard to the air, when, after the predominancy of a weſt or ſouth wind, it becomes north or eaſt; the pulſe is ſtronger and larger; as alſo when the quickſilver riſes in the barometer. But when the atmoſphere is denſe, humid, rainy, with a long ſouth wind; as alſo where the life is ſedentary, the ſleep long, and the ſeaſon autumnal, the pulſe is languid and ſmall, and the perſpiration decreaſed. In May it is great, and ſometimes violent; in the middle of ſummer, quick but weak; in the autumn, ſlow, ſoft, and weak; in the winter, hard and great. A draſtic purge and an emetic render the pulſe hard, quick, and weak, with loſs of ſtrength; chalybeates, and the bark, render it great and robuſt, and the complexion lively; volatiles amplify and increaſe the pulſe; acids and nitrous remedies refrigerate the body, and appeaſe the pulſe; opiates and the like render it ſmall and weak, and decreaſe the elaſticity of the ſolids; and poiſons render it ſmall, contracted, and hard. When the quantity of the blood is too great, bleeding raiſes the pulſe.

Pulse, is alſo uſed for the ſtroke with which any medium is affected by the motion of light, ſound, &c. through it. Sir Iſaac Newton demonſtrates, that the velocities of the pulſes in an elaſtic fluid medium (whoſe elaſticity is proportionable to its denſity) are in a ratio compounded of half the ratio of the elaſtic force directly, and half the ratio of the denſity inverſely; ſo that in a medium whoſe elaſticity is equal to its denſity, all pulſes will be equally ſwift.

Pulse, in botany, a term applied to all thoſe grains or ſeeds which are gathered with the hand; in contradiſtinction to corn, &c. which are reaped, or mowed: or, It is the ſeed of the leguminous kind of plants, as beans, vetches, &c. but is by ſome uſed for artichokes, aſparagus, &c.

PULTENEY (William), the famous oppoſer of Sir Robert Walpole in parliament, and afterward earl of Bath, was deſcended from one of the moſt ancient families in the kingdom, and was born in 168[illegible]. Being well qualified in fortune, he early procured a ſeat in the houſe of commons, and diſtinguiſhed himſelf as a warm partiſan againſt queen Anne's miniſtry; whoſe errors he had ſagacity to detect, and ſpirited eloquence to expoſe. When king George I. came to the throne, Mr. Pulteney was made ſecretary at war, and ſoon after cofferer to the king's houſehold; but the good underſtanding between this gentleman and Sir Robert Walpole, who then acted as prime miniſter, was interrupted in 1725, on a ſuſpicion that Walpole was deſirous of extending the limits of prerogative, and of promoting the intereſts of Hanover, to the prejudice of thoſe of Britain. His oppoſition to Sir Robert was indeed carried to ſuch indiſcriminate lengths, that ſome have been of opinion he often acted againſt meaſures beneficial to the public, merely from perſonal motives. It would be impracticable here to trace his parliamentary conduct: ſo it muſt ſuffice to obſerve in general, that he became ſo obnoxious to the crown, that in 1731 the king called for the council book, and with his own hand ſtruck out his name from the liſt of privy counſellors, a proceeding that only ſerved to inflame his reſentment and increaſe his popularity. Thus he ſtill continued to attack the miniſter with a ſeverity of eloquence and ſarcaſm that worſted every antagoniſt; ſo that Sir Robert was heard to declare, he dreaded that man's tongue more than another man's ſword. At length, when Walpole found the place of prime miniſter no longer tenable, and reſigned in 1741, among other promotions Mr. Pulteney reſumed his place in the privy-council, and was created earl of Bath; a title purchaſed at the expenſe of that popularity which afterward he naturally enough affected to contemn. In 1760, toward the cloſe of the war, he publiſhed *A Letter to two Great Men*, recommending proper articles to be inſiſted on in a treaty of peace; which, though the writer was then unknown, was greatly applauded, and went through ſeveral impreſſions. He died in 1764; and as his only ſon died before him, the title became extinct.

PULVERIZATION, the art of pulverizing, or reducing a dry body into a fine powder; which is performed in friable bodies by pounding or beating them in a mortar, &c.; but to pulverize malleable ones, other methods muſt be taken. To pulverize lead, or tin, the method is this; Rub a round wooden box all over the inſide with chalk; pour a little of the melted metal nimbly into the box; when ſhutting the lid, and ſhaking the box briſkly, the metal will be reduced to powder.

PUMEX, the Pumice-stone, a ſubſtance frequently thrown out of volcanoes, though there are many which are never known to throw it out. It is very full of pores and bliſters; in conſequence of which it is ſpecifically very light, and reſembles the frothy ſlag produced in our iron furnaces. It is of two colours, black and white; the former being that which it has when thrown out of the volcano; the latter, as Cronſtedt conjectures, being perhaps faded and bleached. M. Magellan conſiders it rather as a volcanic ejection than a volcanic production; and deſcribes it as of a white, reddiſh-brown, gray, or black colour. It is of a rough and porous conſiſtence, being made up of ſlender fibres parallel to each other, and very light, ſo that it ſwims on water. It ſtrikes fire with ſteel, though with difficulty, and ſeems originally to have been an aſbeſtos decompoſed by the action of fire; but, on obſerving the appearance of that glaſſy ſlag produced in the iron-furnaces, which entirely reſembles the pumice-ſtone, and is produced from the calcareous fluxes uſed to promote the fuſion of the ore, our author is of opinion that the formation of pumice may be rather attributed to that kind of froth which muſt be formed at the top of the melted matters in the volcanic crater. A hundred parts, according to Bergman, contain from 6 to 15 of magneſia, with a ſmall proportion of calcareous earth, and the greateſt part ſilex. Another kind of pumice, which ſeems to be a ferruginous granite altered by fire, has been diſcovered by Dolomieu at Stromboli. Pumice-ſtone is uſed in ſome mechanical arts; as for rubbing and ſmoothing the ſurface of metals, wood, paſteboard, and ſtone; for which it is well fitted by reaſon of its harſh and brittle texture; thus ſcouring and carrying off the little inequalities from the ſurfaces juſt mentioned.

PUMICE-stone. See the preceding article.

PUMP, a hydraulic machine for raiſing water by means of the preſſure of the atmoſphere. It would be an entertaining and not an uninſtructive piece of information to learn the progreſſive ſteps by which the ingenuity of man has invented the various methods of raiſing water. A pump muſt be conſidered as the laſt ſtep of this progreſs. Common as it is, and overlooked even by the curious, it is a very abſtruſe and refined invention. Nothing like it has been found in any of the rude nations whom the reſtleſs ſpirit of the Europeans has diſcovered, either in the new continent of America or the iſlands of the Pacific Ocean. Nay, it was unknown in the cultivated empire of China at the time of our arrival there by ſea; and it is ſtill a rarity everywhere in Aſia, in places unfrequented by the Europeans. It does not appear to have been known by the Greeks and Romans in early times; and perhaps it came from Alexandria, where phyſical and mathematical ſcience was much cultivated by the Greek ſchool under the protection of the Ptolemies. The performances of Cteſibius and Hero are ſpoken of by Pliny and Vitruvius as curious novelties [*]. It is perhaps not difficult to trace the ſteps by which thoſe mechanicians were led to the invention. The Egyptian wheel was a common machine all over Aſia, and is ſtill in uſe in the remoteſt corners, and was brought by the Saracens into Spain, where it is ſtill very common under its common name NORIA. The Daniſh miſſionaries found in a remote village in the kingdom of Siam the immediate offspring of the noria (*Lettres Edifiantes et Curieuſes*). It was a wheel turned by an aſs, and carrying round, not a ſtring of earthen pots, but a ſtring of wiſps of hay, which it drew through a wooden trunk. This rude chain-pump was in frequent uſe for watering the rice fields. It is highly probable that it is of great antiquity, although we do not recollect its being mentioned by any of the Greek or Roman writers. The Arabs and Indians were nothing leſs than innovators; and we may ſuppoſe with great ſafety, that what arts we now find among them they poſſeſſed in very remote periods. Now the ſtep from this to the pump is but ſhort, though it is nice and refined; and the forcing pump of Cteſibius is the eaſieſt and moſt natural.

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[*] In the early Greek writings, it does not appear that the words αντλος, αντλειν, αντλια, &c. were uſed to expreſs any thing like what we call a pump. In all theſe paſſages the words either expreſs generally the drawing of water, or, more particularly, the drawing it with a bucket or ſomething ſimilar. Αντλος, which is the primitive, is a drain, ſink, or receptacle for collecting ſcattered water, either for uſe, or to get rid of it; hence it came to ſignify the ſink or well of a ſhip; and αντλειν was ſynonymous with our verb "to bale the boat." (*Odyſſ.* O. 476. M. 411. *Euryp. Hecuba*, 1025). Αντλιον is the *veſſel* or *bucket* with which water is drawn. Αντλια is the ſervice (generally a puniſhment) of drawing water. Αντλειν, "to draw water with a bucket": hence the force of Ariſtotle's expreſſion (*Oecon.* I.) τῳ γαρ ηθμῳ αντλειν τουτ' εϛι. See even the late authority of the New Teſtament, John ii. 8.; iv. 7. 11. Here αντλημα is evidently ſomething which the woman brought along with her; probably a bucket and rope.

Let AB (plate 29. fig. 1.) be the ſurface of the water in the well, and D the height where it is to be delivered. Let DC be a long wooden trunk, reaching as deep under water as poſſible. Let the rope EF be fitted with its knot of hay F. When it is drawn up through the trunk, it will bring up along with it all the water lying between C and A, which will begin to run out by the ſpout D as ſoon as the knot gets to G, as far below D as C is below A. All this is very obvious; and it required but little reflection to be aſſured, that if F was let down again, or puſhed down, by a rod inſtead of a rope, it would again perform the ſame office. Here is a very ſimple pump. And if it was ever put in practice, it behoved to ſhow the ſupporting power of the atmoſphere, becauſe the water would not only be lifted by the knot, but would even follow it. The imperfection of this pump behoved to appear at firſt ſight, and to ſuggeſt its remedy. By puſhing down the knot F, which we ſhall henceforward call the *piſton*, all the force expended in lifting up the water between A and G is thrown away, becauſe it is again let down. A valve G, at the bottom, would prevent this. But then there muſt be a paſſage made for the water by a lateral tube KBD (fig. 2.). And if this be alſo furniſhed with a valve H, to prevent its loſing the water, we have the pump of Cteſibius, as ſketched in fig. 2. The valve is the great refinement: but perhaps even this had made its appearance before in the noria. For, in the more perfect kinds of theſe machines, the pots have a ſtop or valve in their bottom, which hangs open while the pot deſcends with its mouth downwards, and then allows it to fill readily in the ciſtern; whereas without the valve, it would occaſion a double load to the wheel. If we ſuppoſe that the valve had made its appearance ſo early, it is not improbable that the common pump ſketched in fig. 3. was as old as that of Cteſibius. In this place we ſhall firſt give a ſhort deſcription of the chief varieties of theſe engines, conſidering them in their ſimpleſt form, and we ſhall explain in very general terms their mode of operation. We ſhall then give a conciſe and popular theory of their operation, furniſhing principles to direct us in their conſtruction; and we ſhall conclude with the deſcription of a few peculiarities which may contribute to their improvement or perfection.

There are but two ſorts of pumps which eſſentially differ; and all the varieties that we ſee are only modifications of theſe. One of theſe original pumps has a ſolid piſton; the other has a piſton with a perforation and a valve. We uſually call the firſt a FORCING PUMP, and the ſecond a LIFTING or SUCKING PUMP. See the article HYDROSTATICS.

Fig. 2. is a ſketch of the forcing pump in its moſt ſimple form and ſituation. It conſiſts of a hollow cylinder AC *c a*, called the WORKING BARREL, open at both ends, and having a valve G at the bottom, opening upwards. This cylinder is filled by a ſolid piſton EF, covered externally with leather or tow, by which means it fits the box of the cylinder exactly, and allows no water to eſcape by its ſides. There is a pipe KHD, which communicates laterally with this cylinder, and has a valve at ſome convenient place H, as near as poſſible to its junction with the cylinder. This valve alſo opens upwards. This pipe, uſually called the RISING PIPE, or MAIN, terminates at the place D, where the water muſt be delivered.

Now ſuppoſe this apparatus ſet into the water, ſo that the upper end of the cylinder may be under or even with the ſurface of the water AB; the water will open the valve G, and after filling the barrel and lateral pipe, will alſo open the valve H, and at laſt ſtand at an equal height within and without. Now let the piſton be put in at the top of the working barrel, and thruſt down to K. It will puſh the water before it. This will ſhut the valve G, and the water will make its way through the valve H, and fill a part B *b* of the riſing pipe, equal to the internal capacity of the working barrel. When this downward motion of the piſton ceaſes, the valve H will fall down by its own weight and ſhut this paſſage. Now let the piſton be drawn up again: The valve H hinders the water in the riſing pipe from returning into the working barrel. But now the valve G is opened by the preſſure of the external water, and the water enters and fills the cylinder as the piſton riſes. When the piſton has got to the top, let it be thruſt down again: the valve G will again be ſhut, and the water will be forced through the paſſage at H, and riſe along the main, puſhing before it the water already there, and will now have its ſurface at L. Repeating this operation, the water muſt at laſt arrive at D, however remote, and the next ſtroke would raiſe it to *e*; ſo that during the next riſe of the piſton the water in *e* D will be running off by the ſpout.

The effect will be the ſame whatever is the poſition of the working barrel, provided only that it be under water. It may lie horizontally or ſloping, or it may be with its mouth and piſton rod undermoſt. It is ſtill the ſame forcing pump, and operates in the ſame manner and by the ſame means, viz. the preſſure of the ſurrounding water.

The external force which muſt be applied to produce this effect is oppoſed by the preſſure exerted by the water on the oppoſite face of the piſton. It is evident, from the common laws of hydroſtatics, that this oppoſing preſſure is equal to the weight of a pillar of water, having the face of the piſton for its baſe, and the perpendicular height *d* A of the place of delivery above the ſurface of the water AB in the ciſtern for its height. The form and dimenſions of the riſing pipe are indifferent in this reſpect, becauſe heavy fluids preſs only in the proportion of their perpendicular height. Obſerve that it is not *d* F, but *d* A, which meaſures this preſſure, which the moving force muſt balance and ſurmount. The whole preſſure on the under ſurface F *f* of the piſton is indeed equal to the weight of the pillar *d* F *f δ*; but part of this is balanced by the water AF *f a*. If indeed the water does not get into the upper part of the working barrel, this compenſation does not obtain. While we draw up the piſton, this preſſure is removed, becauſe all communication is cut off by the valve H, which now bears the whole preſſure of the water in the main. Nay, the aſcent of the piſton is even aſſiſted by the preſſure of the ſurrounding water. It is only during the deſcent of the piſton therefore that the external force is neceſſary.

Obſerve that the meaſure now given of the external force is only what is neceſſary for *balancing* the preſſure of the water in the riſing pipe. But in order that the pump may perform work, it muſt *ſurmount* this preſſure, and cauſe the water to iſſue at D with ſuch a velocity that the required quantity of water may be delivered in a given time. This requires force, even although there were no oppoſing preſſure; which would be the caſe if the main were horizontal. The water fills it, but it is at reſt. In order that a gallon, for inſtance, may be delivered in a ſecond, the whole water in the horizontal main muſt be put in motion with a certain velocity. This requires force. We muſt therefore always diſtinguiſh between the ſtate of equilibrium and the ſtate of actual working. It is the equilibrium only that we conſider at preſent; and no more is neceſſary for underſtanding the operation of the different ſpecies of pumps. The other force is of much more intricate inveſtigation, and will be conſidered by itſelf.

The ſimpleſt form and ſituation of the lifting pump is repreſented by the ſketch fig. 3. The pump is immerſed in the ciſtern till both the valve G and piſton F are under the ſurface AB of the ſurrounding water. By this means the water enters the pump, opening both valves, and finally ſtands on a level within and without.

Now draw up the piſton to the ſurface A. It muſt lift up the water which is above it (becauſe the valve in the piſton remains ſhut by its own weight); ſo that its ſurface will now be at *a*. A *a* being made equal to AF. In the mean time, the preſſure of the ſurrounding water forces it into the working barrel, through the valve G; and the barrel is now filled with water. Now, let the piſton be puſhed down again; the valve G immediately ſhuts by its own weight, and in oppoſition to the endeavours which the water in the barrel makes to eſcape this way. This attempt to compreſs the water in the barrel cauſes it to open the valve F in the piſton; or rather, this valve yields to our endeavour to puſh the piſton down through the water in the working barrel. By this means we get the piſton to the bottom of the barrel; and it has now above it the whole pillar of water reaching to the height *a*. Drawing up the piſton to the ſurface A a ſecond time, muſt lift this double column along with it, and its ſurface now will be at *b*. The piſton may again be thruſt down through the water in the barrel, and again drawn up to the ſurface; which will raiſe the water to *c*. Another repetition will raiſe it to *d*; and it will now ſhow itſelf at the intended place of delivery. Another repetition will raiſe it to *e*; and while the piſton is now deſcending to make another ſtroke, the water in *e d* will be running off through the ſpout D; and thus a ſtream will be produced, in ſome degree continual, but very unequal. This is inconvenient in many caſes: thus, in a pump for domeſtic uſes, ſuch a hobbling ſtream would make it very troubleſome to fill a bucket. It is therefore uſual to terminate the main by a ciſtern LMNO, and to make the ſpout ſmall. By this means the water brought up by the ſucceſſive ſtrokes of the piſton riſes to ſuch a height in this ciſtern, as to produce an efflux by the ſpout nearly equable. The ſmaller we make the ſpout D the more equable will be the ſtream; for when the piſton brings up more water than can be diſcharged during its deſcent, ſome of it remains in the ciſtern. This, added to the ſupply of next ſtroke, makes the water riſe higher in the ciſtern than it did by the preceding ſtroke. This will cauſe the efflux to be quicker during the deſcent of the piſton, but perhaps not yet ſufficiently quick to diſcharge the whole ſupply. It therefore riſes higher next ſtroke: and at laſt it riſes ſo high, that the increaſed velocity of efflux makes the diſcharge preciſely balance the ſupply. Now the quantity ſupplied in each ſtroke is the ſame, and occupies the ſame room in the ciſtern at top; and the ſurface will ſink the ſame number of inches during the deſcent of the piſton, whether that ſurface has been high or low at the beginning. But becauſe the velocities of the efflux are as the ſquare roots of the heights of the water above the ſpout, it is evident that a ſink of two or three inches will make a ſmaller change in the velocity of efflux when this height and velocity are great. This ſeems but a trifling obſervation; but it ſerves to illuſtrate a thing to be conſidered afterwards, which is important and abſtruſe, but perfectly ſimilar to this.

It is evident, that the force neceſſary for this operation muſt be equal to the weight of the pillar of water *d* A *a* D, if the pipe be perpendicular. If the pump be ſtanding aſlope, the preſſure which is to be balanced is ſtill equal to the weight of a pillar of water of this perpendicular height, and having the ſurface of the piſton for its baſe.

Such is the ſimpleſt, and, we may add, by far the beſt, form of the forcing and lifting pumps; but it is not the moſt uſual. Circumſtances of convenience, economy, and more frequently of fancy and habit, have cauſed the pump-makers to deviate greatly from this form. It is not uſual to have the working barrel in the water; this, eſpecially in deep wells, makes it of difficult acceſs for repairs, and requires long piſton rods. This would not do in a forcing pump, becauſe they would bend.

We have ſuppoſed, in our account of the lifting pump, that the riſe of the piſton always terminated at the ſurface of the water in the ciſtern. This we did in order that the barrel might always be filled by the preſſure of the ſurrounding water. But let us ſuppoſe that the riſe of the piſton does not end here, and that it is gradually drawn up to the very top: it is plain that the preſſure of the atmoſphere is by this means taken off from the water in the pipe (ſee PNEUMATICS), while it remains preſſing on the water of the ciſtern. It will therefore cauſe the water to follow the piſton as it riſes through the pipe, and it will raiſe it in this way 33 feet at a medium. If, therefore, the ſpout D is not more than 33 feet above the ſurface of the water in the ciſtern, the pipe will be full of water when the piſton is at D. Let it be puſhed down to the bottom; the water will remain in the pipe, becauſe the valve G will ſhut: and thus we may give the piſton a ſtroke of any length not exceeding 33 feet. If we raiſe it higher than this, the water will not follow; but it will remain in the pipe, to be lifted by the piſton, after it has been puſhed down through it to the bottom.

But it is not neceſſary, and would be very inconvenient, to give the piſton ſo long a ſtroke. The great uſe of a pump is to render effectual the reciprocation of a ſhort ſtroke which we can command, while ſuch a long ſtroke is generally out of our power. Suppoſe that the piſton is puſhed down only to *b*; it will then have a column *b f* incumbent on it, and it will lift this column when again drawn up. And this operation may be repeated like the former, when the piſton was always under water; for the preſſure of the atmoſphere will always cauſe the water to follow the piſton to the height of 33 feet.

Nor is it neceſſary that the fixed valve G be placed at the lower orifice of the pipe, nor even under water. For, while things are in the ſtate now deſcribed, the piſton drawn up to *f*, and the whole pipe full of water; if we ſuppoſe another valve placed at *b* above the ſurface of the ciſtern, this valve can do no harm. Now let the piſton deſcend, both valves G and *b* will ſhut. G may now be removed, and the water will remain ſupported in the ſpace *b* G by the air; and now the alternate motions of the piſton will produce the ſame effect as before.

We found in the former caſe that the piſton was carrying a load equal to the weight of a pillar of water of the height AD, becauſe the ſurrounding water could only ſupport it at its own level. Let us ſee what change is produced by the aſſiſtance of the preſſure of the atmoſphere. Let the under ſurface of the piſton be at *b*; when the piſton was at *f*, 33 feet above the ſurface of the ciſtern, the water was raiſed to that height by the preſſure of the atmoſphere. Suppoſe a partition made at *b* by a thin plate, and all the water above it taken away. Now pierce a hole in this plate. The preſſure of the atmoſphere was able to carry the whole column *f a*. Part of this column is now removed, and the remainder is not a balance for the air's preſſure. This will therefore cauſe the water to ſpout up through this hole and riſe to f. Therefore the under ſurface of this plate is preſſed up by the contiguous water with a force equal to the weight of that pillar of water which it formerly ſupported; that is, with a force equal to the weight of the pillar fb. Now, the under ſurface of the piſton, when at b, is in the ſame ſituation. It is preſſed upwards by the water below it, with a force equal to the weight of the column fb: But it is preſſed downwards by the whole preſſure of the atmoſphere, which preſſes on all bodies; that is, with the weight of the pillar fa. On the whole, therefore, it is preſſed downwards by a force equal to the difference of the weights of the pillars fa and fb; that is, by a force equal to the weight of the pillar ba.

It may be conceived better perhaps in this way. When the piſton was under the ſurface of the water in the ciſtern, it was equally preſſed on both ſides, both by the water and atmoſphere. The atmoſphere exerted its preſſure on it by the intervention of the water; which being, to all ſenſe, a perfect fluid, propagates every external preſſure undiminiſhed. When the piſton is drawn up above the ſurface of the pit-water, the atmoſphere continues to preſs on its upper ſurface with its whole weight, through the intervention of the water which lies above it; and its preſſure muſt therefore be added to that of the incumbent water. It alſo continues to preſs on the under ſurface of the piſton by the intervention of the water; that is, it preſſes this water to the piſton. But, in doing this, it carries the weight of this water which it is preſſing on the piſton. The preſſure on the piſton therefore is only the exceſs of the whole preſſure of the atmoſphere above the weight of the column of water which it is ſupporting. Therefore the difference of atmoſpheric preſſure on the upper and under ſurfaces of the piſton is preciſely equal to the weight of the column of water ſupported in the pipe by the air. It is not, however, the individual weight of this column that loads the piſton; it is the part of the preſſure of the atmoſphere on its upper ſurface, which is not balanced by its preſſure on the under ſurface.

In attempting therefore to draw up the piſton, we have to ſurmount this unbalanced part of the preſſure of the atmoſphere, and alſo the weight of the water which lies above the piſton, and muſt be lifted by it: and thus the whole oppoſing preſſure is the ſame as before, namely, the weight of the whole vertical pillar reaching from the ſurface of the water in the ciſtern to the place of delivery. Part of this weight is immediately carried by the preſſure of the atmoſphere; but, in lieu of it, there is an equal part of this preſſure of the atmoſphere abſtracted from the under ſurface of the piſton, while its upper ſurface ſuſtains its whole preſſure.

So far, then, theſe two ſtates of the pump agree.—But they differ exceedingly in their mode of operation; and there are ſome circumſtances not very obvious which muſt be attended to, in order that the pump may deliver any water at the ſpout D. This requires, therefore, a ſerious examination.

Let the fixed valve G (fig. 4.) be ſuppoſed at the ſurface of the ciſtern water. Let M m be the loweſt, and N n the higheſt, poſitions of the piſton, and let HA = b be the height of a column of water equiponderant with the atmoſphere.

When the pump is filled, not with water, but with air, and the piſton is in its loweſt poſition, and all in equilibrio, the internal air has the ſame denſity and elaſticity with the external. The ſpace MA am, therefore, contains air of the common denſity and elaſticity. Theſe may be meaſured by b, or the weight of a column of water whoſe height is b. Now, let the piſton be drawn up to N n. The air which occupied the ſpace MA am now occupies the ſpace NA an, and its denſity is now $\frac{\text{MA}\;am}{\text{NA}\;an}$. Its elaſticity is now diminiſhed, being proportionable to its denſity (ſee Pneumatics), and no longer balances the preſſure of the atmoſphere. The valve G will therefore be forced up by the water, which will riſe to ſome height SA. Now let the piſton again deſcend to M m. It cannot do this with its valve ſhut; for when it comes down ſo far as to reduce the air again to its common denſity, it is not yet at M, becauſe the ſpace below it has been diminiſhed by the water which got into the pipe, and is retained there by the valve G. The piſton valve, therefore, opens by the air which we thus attempt to compreſs, and the ſuperfluous air eſcapes. When the piſton has got to M, the air is again of the common denſity, and occupies the ſpace MS sm. Now draw the piſton up to N. This air will expand into the ſpace NS sn, and its denſity will be reduced to $\frac{\text{MS}\;sm}{\text{NS}\;sn}$, and its elaſticity will no longer balance the preſſure of the atmoſphere, and more water will enter, and it will riſe higher. This will go on continually. But it may happen that the water will never riſe ſo high as to reach the piſton, even though not 33 feet above the water in the ciſtern: For the ſucceſſive diminutions of denſity and elaſticity are a ſeries of quantities that decreaſe geometrically, and therefore will have a limit. Let us ſee what determines this limit.

At whatever height the water ſtands in the lower part of the pipe, the weight of the column of water SA as, together with the remaining elaſticity of the air above it, exactly balances the preſſure of the atmoſphere (ſee Pneumatics). Now the elaſticity of the air in the ſpace NS sn is equal to $b \times \frac{\text{MS}\;sm}{\text{NS}\;sn}$. Therefore, in the caſe where the limit obtains, and the water riſes no further, we muſt have $b = \text{AS} \times b\,\frac{\text{MS}\;sm}{\text{N}\quad sn}$, or, becauſe the column is of the ſame diameter throughout, $b = \text{AS} + b\,\frac{\text{MS}}{\text{NS}}$ and $\frac{\text{MS}}{\text{NS}}\,b = b - \text{AS}, = \text{HS}$, and NS : MS = HA : HS, and NS − MS : NS = HA − HS : HA, or NM : NS = AS : AH, and NM × AH = NS × AS.—Therefore, if AN, the diſtance of the piſton in its higheſt poſition from the water in the ciſtern, and NM the length of its ſtroke, be given, there is a certain determined height AS to which the water can be raiſed by the preſſure of the air: For AH is a conſtant quantity; and therefore when MN is given, the rectangle AS × SN is given. If this height AS be leſs than that of the piſton in its loweſt poſition, the pump will raiſe no water, although AN may be leſs than AH. Yet the ſame pump will raiſe water very effectually, if it be firſt of all filled with water; and we have ſeen profeſſional engineers much puzzled by this capricious failure of their pumps. A little knowledge of the principles would have prevented their diſappointment.

To inſure the delivery of water by the pump, the ſtroke muſt be ſuch that the rectangle MN × AH may be greater than any rectangle that can be made of the parts of AN, that is, greater than the ſquare of half AN. Or, if the length of the ſtroke be already fixed by other circumſtances, which is a common caſe, we muſt make AN ſo ſhort that the ſquare of its half, meaſured in feet, ſhall be leſs than 33 times the ſtroke of the piſton.

Suppoſe that the fixed valve, inſtead of being at the ſurface of the water in the ciſtern, is at S, or any where between S and A, the performance of the pump will be the ſame as before: But if it be placed any where above S, it will be very different. Let it be at T. It is plain that when the piſton is puſhed down from N to M, the valve at T prevents any air from getting down; and therefore, when the piſton is drawn up again, the air contained in the ſpace MT tm will expand into the ſpace NT tn, and its denſity will be $\frac{\text{MT}}{\text{NT}}$. This is leſs than $\frac{\text{MS}}{\text{NS}}$, which expreſſes the denſity of the air which was left in the ſpace TS st by the former operations.—The air, therefore, in

TS *s t* will alſo expand, will open the valve, and now the water will riſe above S. The proportion of NS to NT may evidently be ſuch that the water will even get above the valve T. This diminiſhes the ſpace NT *t n*; and therefore, when the piſton has been puſhed down to M, and again drawn up to N, the air will be ſtill more rarefied, and the water will riſe ſtill higher. The foregoing reaſoning, however, is ſufficient to ſhow that there may ſtill be a height which the water will not paſs, and that this height depends on the proportion between the ſtroke of the piſton and its diſtance from the water in the ciſtern. We need not give the determination, becauſe it will come in afterwards in combination with other circumſtances. It is enough that the reader ſees the phyſical cauſes of this limitation: And, laſtly, we ſee plainly that the utmoſt ſecurity will be given for the performance of the pump, when the fixed valve is ſo placed that the piſton, when in its loweſt poſition, ſhall come into contact with it. In this caſe, the rarefaction of the air will be the completeſt poſſible; and, if there were no ſpace left between the piſton and valve, and all were perfectly air tight, the rarefaction would be complete, and the valve might be any thing leſs than 33 feet from the ſurface of the water in the ciſtern.

But this perfect contact and tightneſs is unattainable; and though the pump may be full of water, its continual downward preſſure cauſes it to filtrate ſlowly through every crevice, and the air enters through every pore, and even diſengages itſelf from the water, with which a conſiderable portion had been chemically combined. The pump by this means loſes water, and it requires ſeveral ſtrokes of briſk working to fill it again: and if the leathers have become dry, ſo much admiſſion may be given to the air, that the pump will not fill itſelf with water by *any working*. It is then neceſſary to pour water into it, which ſhuts up theſe paſſages, and ſoon ſets all to rights again. For theſe reaſons, it is always prudent to place the fixed valve as low as other circumſtances will permit, and to make the piſton-rod of ſuch a length, that when it is at the bottom of its ſtroke it ſhall be almoſt in contact with the valve. When we are not limited by other circumſtances, it is evident that the beſt poſſible form is to have both the piſton and the fixed valve under the ſurface of the water of the ciſtern. In this ſituation they are always wet and air-tight. The chief objection is, that by this diſpoſition they are not eaſily come at when needing repair. This is a material objection in deep mines. In ſuch ſituations, therefore, we muſt make the beſt compenſation of different circumſtances that we can. It is uſual to place the fixed valve at a moderate diſtance from the ſurface of the water, and to have a hole in the ſide of the pipe, by which it may be got out. This is carefully ſhut up by a plate firmly ſcrewed on, with leather or cement between the parts. This is called the *clack door*. It would, in every caſe, be very proper to have a fixed valve in the lower end of the pipe. This would combine all advantages. Being always tight, the pipe would retain the water, and it would leave to the valve above it its full effect of increaſing the rarefaction. A ſimilar hole is made in the working barrel, a little above the higheſt poſition of the piſton. When this needs repair, it can be got at through this hole, without the immenſe trouble of drawing up the whole rods.

Thus we have conducted the reader ſtep by ſtep, from the ſimpleſt form of the pump to that which long experience has at laſt ſelected as the moſt generally convenient. This we ſhall now deſcribe in ſome detail.

The Sucking Pump conſiſts of two pipes DCCD, BAAB (plate 29. fig. 5.); of which the former is called the *Barrel*, or the *Working Barrel*, and the other is called the *Suction-pipe*, and is commonly of a ſmaller diameter.—Theſe are joined by means of ſlanches E, F, pierced with holes to receive ſcrewed bolts. A ring of leather, or of lead, covered with a proper cement, is put between them; which, being ſtrongly compreſſed by the ſcrew-bolts, renders the joint perfectly air-tight.—The lower end A of the ſuction-pipe is commonly ſpread out a little to facilitate the entry of the water, and frequently has a grating acroſs it at AA to keep out filth or gravel. This is immerged in the ſtanding water YZ. The working barrel is cylindrical, as evenly and ſmoothly bored as poſſible, that the piſton may fill it exactly through its whole length, and move along it with as little friction as may be conſiſtent with air-tightneſs.

The piſton is a ſort of truncated cone OPKL, generally made of wood not apt to ſplit, ſuch as elm or beech. The ſmall end of it is cut off at the ſides, ſo as to form a ſort of arch OQP, by which it is faſtened to the iron rod or ſpear. It is exhibited in different poſitions in figures 6, 7. which will give a more diſtinct notion of it than any deſcription. The two ends of the conical part may be hooped with braſs. This cone has its larger end ſurrounded with a ring or band of ſtrong leather faſtened with nails, or by a copper hoop, which is driven on it at the ſmaller end. This band ſhould reach to ſome diſtance beyond the baſe of the cone; the further the better: and the whole muſt be of uniform thickneſs all round, ſo as to ſuffer equal compreſſion between the cone and the working barrel. The ſeam or joint of the two ends of this band muſt be made very cloſe, but not ſewed or ſtitched together. This would occaſion bumps or inequalities, which would ſpoil its tightneſs; and no harm can reſult from the want of it, becauſe the two edges will be ſqueezed cloſe together by the compreſſion in the barrel. It is by no means neceſſary that this compreſſion be great. This is a very detrimental error of the pump-makers. It occaſions enormous friction, and deſtroys the very purpoſe which they have in view, viz. rendering the piſton air-tight; for it cauſes the leather to wear through very ſoon at the edge of the cone, and it alſo wears the working barrel. This very ſoon becomes wide in that part which is continually paſſed over by the piſton, while the mouth remains of its original diameter, and it becomes impoſſible to thruſt in a piſton which ſhall completely fill the worn part. Now, a very moderate preſſure is ſufficient for rendering the pump perfectly tight, and a piece of glove leather would be ſufficient for this purpoſe, if looſe or detached from the ſolid cone; for ſuppoſe ſuch a looſe and flexible, but impervious, band of leather put round the piſton, and put into the barrel; and let it even be ſuppoſed that the cone does not compreſs it in the ſmalleſt degree to its internal ſurface. Pour a little water carefully into the inſide of this ſort of cup or diſh; it will cauſe it to ſwell out a little, and apply itſelf cloſe to the barrel all round, and even adjuſt itſelf to all its inequalities. Let us ſuppoſe it to touch the barrel in a ring of an inch broad all round. We can eaſily compute the force with which it is preſſed. It is half the weight of a ring of water an inch deep and an inch broad. This is a trifle, and the friction occaſioned by it not worth regarding; yet this trifling preſſure is ſufficient to make the paſſage perfectly impervious, even by the moſt enormous preſſure of a high column of incumbent water: for let this preſſure be ever ſo great, the preſſure by which the leather adheres to the barrel always exceeds it, becauſe the incumbent fluid has no *preponderating* power by which it can force its way between them, and it muſt inſinuate itſelf preciſely ſo far, that its preſſure on the inſide of the leather ſhall ſtill exceed, and only exceed, the preſſure by which it endeavours to inſinuate itſelf; and thus the piſton becomes perfectly tight with the ſmalleſt poſſible friction. This reaſoning is perhaps too refined for the uninſtructed artiſt, and probably will not perſuade him: To ſuch we would recommend an examination of the piſtons and valves contrived and executed by that artiſt, whoſe ſkill far ſurpaſſes our higheſt conceptions, the all-wiſe Creator of this world. The valves which ſhut up the paſſages of the veins, and this in places where an extravaſation would be followed by inſtant death, are cups of thin membrane, which adhere to the ſides of the channel about half way round, and are detached in the reſt of their circumference. When the blood comes in the oppoſite direction, it puſhes the membrane aſide, and has a paſſage perfectly free. But a ſtagnation of motion allows the tone of the muſcular (perhaps) membrane, to reſtore it to its natural ſhape, and the leaſt *motion* in the oppoſite direction cauſes it inſtantly to clap cloſe to the ſides of the vien, and then no preſſure whatever can force a paſſage. We ſhall recur to this again when deſcribing the various contrivances of valves. &c. What we have ſaid is enough for ſupporting our directions for conſtructing a tight piſton. But we recommend thick and ſtrong leather, while our preſent reaſoning ſeems to render thin leather preferable. If the leather be thin, and the ſolid piſton in any part does not preſs it gently to the barrel, there will be in this part an unbalanced preſſure of the incumbent column of water, which would inſtantly burſt even a ſtrong leather bag; but when the ſolid piſton, covered with leather, exactly fills the barrel, and is even preſſed a little to it, there is no ſuch riſk; and now that part of the leather band which reaches beyond the ſolid piſton performs its office in the completeſt manner. We do not heſitate, therefore, to recommend this form of a piſton, which is the moſt common and ſimple of all, as preferable, when well executed, to any of thoſe more artificial, and frequently very ingenious, conſtructions, which we have met with in the works of the firſt engineers. To proceed, then, with our deſcription of the ſucking-pump.

At the joining of the working barrel with the ſuction-pipe there is a hole H, covered with a valve opening upwards. This hole H is either made in a plate which makes a part of the ſuction-pipe, being caſt along with it, or it is made in a ſeparate plate. This laſt is the moſt convenient, being eaſily removed and replaced. Different views are given of this valve in fig. 8, 9, 10. The diameter EF (fig. 10.) of this plate is the ſame with that of the flanches, and it has holes correſponding to them, through which their bolts paſs which keep all together. A ring of thick leather NKL is applied to this plate, having a part cut out between N and L, to make room for another piece of ſtrong leather NR (fig 9.) which compoſes the valve. The circular part of this valve is broader than the hole in the middle of fig. 10. but not quite ſo broad as to fill up the inſide of the ring leather OQP of this fig. which is the ſame with GKI of fig. 10. The middle of this leather valve is ſtrengthened by two braſs (not iron) plates, the uppermoſt of which is ſeen at R of fig. 9: the one on its underſide is a little ſmaller than the hole in the valve-plate, that it may go freely in; and the upper plate R is larger than this hole, that it may compreſs the leather to its brim all round. It is evident, that when this plate with its leathers is put between the joint flanches, and all is ſcrewed together, the tail of leather N of fig. 9. will be compreſſed between the plates, and form a hinge, on which the valve can turn, riſing and falling. There is a ſimilar valve faſtened to the upper ſide, or broadeſt baſe of the piſton. This deſcription ſerves for both valves, and in general for moſt valves which are to be found in any parts of a pump.

The reader will now underſtand, without any repetition, the proceſs of the whole operation of a ſucking-pump. The piſton rarefies the air in the working barrel, and that in the ſuction-pipe expands through the valve into the barrel; and, being no longer a balance for the atmoſpheric preſſure, the water riſes into the ſuction-pipe: another ſtroke of the piſton produces a ſimilar effect, and the water riſes further, but by a ſmaller ſtep than by the preceding ſtroke: by repeating the ſtrokes of the piſton, the water gets into the barrel; and when the piſton is now puſhed down through it, it gets above the piſton, and muſt now be lifted up to any height. The ſuction-pipe is commonly of ſmaller ſize than the working barrel, for the ſake of economy. It is not neceſſary that it be ſo wide: but it may be, and often is, made too ſmall. It ſhould be of ſuch a ſize, that the preſſure of the atmoſphere may be able to fill the barrel with water as faſt as the piſton riſes. If a void be left below the piſton, it is evident that the piſton muſt be carrying the whole weight of the atmoſphere, beſides the water which is lying above it. Nay, if the pipe be only ſo wide, that the barrel ſhall fill preciſely as faſt as the piſton riſes, it muſt ſuſtain all this preſſure. The ſuction-pipe ſhould be wider than this, that all the preſſure of the atmoſphere which exceeds the weight of the pillar in the ſuction-pipe may be employed in preſſing it on the under ſurface of the piſton, and thus diminiſh the load. It cannot be made too wide; and too ſtrict an economy in this reſpect may very ſenſibly diminiſh the performance of the pump, and more than defeat its own purpoſe. This is moſt likely when the ſuction pipe is long, becauſe there the length of the pillar of water nearly balances the air's preſſure, and leaves very little accelerating force; ſo that water will riſe but ſlowly even in the wideſt pipe. All theſe things will be made the ſubjects of computation afterwards.

It is plain that there will be limitations to the riſe of the water in the ſuction-pipe, ſimilar to what we found when the whole pump was an uniform cylinder. Let a be the height of the fixed valve above the water in the ciſtern: let B and b be the ſpaces in cubic meaſure between this valve and the piſton in its higheſt and loweſt poſitions, and therefore expreſs the bulks of the air which may occupy theſe ſpaces: let y be the diſtance between the fixed valve and the water in the ſuction-pipe, when it has attained its greateſt height by the rarefaction of the air above it: let b be the height of a column of water in equilibrio with the whole preſſure of the atmoſphere, and therefore having its weight in equilibrio with the elaſticity of common air: and let x be the height of the column whoſe weight balances the elaſticity of the air in the ſuction-pipe, when rarefied as much as it can be by the action of the piſton, the water ſtanding at the height $a - y$.

Then, becauſe this elaſticity, together with the column $a - y$ in the ſuction-pipe, muſt balance the whole preſſure of the atmoſphere, (ſee Pneumatics), we muſt have $b = x + a - y$ and $y = a + x - b$.

When the piſton was in its loweſt poſition, the bulk of the air between it and the fixed valve was b. Suppoſe the valve kept ſhut, and the piſton raiſed to its higheſt poſition, the bulk will be B, and its denſity $\frac{b}{\mathrm{B}}$, and its elaſticity, or the height of the column whoſe weight will balance it, will be $b\frac{b}{\mathrm{B}}$. If the air in the ſuction-pipe be denſer than this, and conſequently more elaſtic, it will lift the valve, and ſome will come in; therefore, when the pump has rarefied the air as much as it can, ſo that none does, in fact, come in, the elaſticity of the air in the ſuction pipe *muſt* be the ſame. Therefore $x = b\frac{b}{\mathrm{B}}$.

We had $y = a + x - b$. Therefore $y = a + b\frac{b}{\mathrm{B}} - b$, $= a + \frac{b - \mathrm{B}}{\mathrm{B}}b, = a = \frac{\mathrm{B} - b}{\mathrm{B}}b$.

Therefore when $\frac{B-b}{B}b$, is leſs than *a*, the water will ſtop before it reaches the fixed valve. But when *a* is leſs than $\frac{B-b}{B}b$, the water will get above the fixed valve, *y* becoming negative.

But it does not follow that the water will reach the piſton, that is, will riſe ſo high that the piſton will paſs through it in its deſcent. Things now come into the condition of a pump of uniform dimenſions from top to bottom; and this point will be determined by what was ſaid when treating of ſuch a pump.

There is another form of the ſucking-pump which is much uſed in great water-works, and is of equal efficacy with the one now deſcribed. It is indeed the ſame pump in an inverted poſition. It is repreſented in fig. 11. where ABCD is the working barrel, immerſed, with its mouth downwards, in the water of the ciſtern. It is joined by means of flanches to the riſing pipe or MAIN.

This uſually conſiſts of two parts. The firſt, BEFC, is bent to one ſide, that it may give room for the iron frames TXYV, which carries the rod NO of the piſton M, attached to the traverſes RS, TOV of this frame. The other part, EGHF, is uſually of a leſs diameter, and is continued to the place of delivery. The piſton frame XTVY hangs by the rod Z, at the arm of a lever or working beam, not brought into the figure. The piſton is perforated like the former, and is ſurrounded like it with a band of leather in form of a taper-diſh. It has a valve K on its broad or upper baſe, opening when preſſed from below. The upper end of the working barrel is pierced with a hole, covered with a valve I, alſo opening upwards.

Now ſuppoſe this apparatus immerſed into the ciſtern till the water is above it, as marked by the line 2, 3, and the piſton drawn up till it touch the end of the barrel. When the piſton is allowed to deſcend by its own weight, the water riſes up through its valve K, and fills the barrel. If the piſton be now drawn up by the moving power of the machinery with which it is connected, the valve K ſhuts, and the piſton puſhes the water before it through the valve I into the main pipe EFGH. When the piſton is again let down, the valve I ſhuts by its own weight and the preſſure of the water incumbent on it, and the barrel is again filled by the water of the ciſtern. Drawing up the piſton puſhes this water into the main pipe, &c. and then the water is at length delivered at the place required.

This pump is uſually called the *lifting pump*; perhaps the ſimpleſt of all in its principle and operation.—It needs no further explanation: and we proceed to deſcribe

The FORCING PUMP, repreſented in fig. 12. It conſiſts of a working barrel ABCD, a ſuction-pipe CDEF, and a main or riſing pipe. This laſt is uſually in three joints. The firſt GHKI may be conſidered as making part of the working barrel, and is commonly caſt in one piece with it. The ſecond IKLM is joined to it by flanches, and forms the elbow which this pipe muſt generally have. The third LNOM is properly the beginning of the main, and is continued to the place of delivery. At the joint IK there is a hanging valve or clack S; and there is a valve R on the top of the ſuction-pipe.

The piſton PQTV is ſolid, and is faſtened to a ſtout iron rod which goes through it, and is fixed by a key drawn through its end. The body of the piſton is a ſort of double cone, widening from the middle to each end, and is covered with two bands of very ſtrong leather, fitted to it in the manner already deſcribed.

The operation of this pump is abundantly ſimple. When the piſton is thruſt into the pump, it puſhes the air before it through the valve S, for the valve R remains ſhut by its own weight. When it has reached near the bottom, and is drawn up again, the air which filled the ſmall ſpace between the piſton and the valve S now expands into the barrel; for as ſoon as the air begins to expand, it ceaſes to balance the preſſure of the atmoſphere, which therefore ſhuts the valve S. By the expanſion of the air in the barrel the equilibrium at the valve R is deſtroyed, and the air in the ſuction-pipe lifts the valve, and expands into the barrel; conſequently it ceaſes to be a balance for the preſſure of the atmoſphere, and the water is forced into the ſuction-pipe. Puſhing the piſton down again forces the air in the barrel through the valve S, the valve R in the mean time ſhutting. When the piſton is again drawn up, S ſhuts, R opens, the air in the ſuction-pipe dilates anew, and the water riſes higher in it. Repeating theſe operations, the water gets at laſt into the working barrel, and is forced into the main by puſhing down the piſton, and is puſhed along to the place of delivery.

The operation of this pump is therefore two-fold, ſucking and forcing. In the firſt operation, the ſame force muſt be employed as in the ſucking-pump, namely, a force equal to the weight of a column of water having the ſection of the piſton for its baſe, and the height of the piſton above the water in the ciſtern for its height. It is for the ſake of this part of the operation that the upper cone is added to the piſton. The air and water would paſs by the ſides of the lower cone while the piſton is drawn up; but the leather of the upper cone applies to the ſurface of the barrel, and prevents this. The ſpace contained between the barrel and the valve S is a great obſtruction to this part of the operation, becauſe this air cannot be rarefied to a very great degree. For this reaſon the ſuction-pipe of a forcing-pump muſt not be made long. It is not indeed neceſſary; for by placing the pump a few feet lower, the water will riſe into it without difficulty, and the labour of ſuction is as much diminiſhed as that of impulſion is increaſed. However, an intelligent artiſt will always endeavour to make this ſpace between the valve S and the loweſt place of the piſton as ſmall as poſſible.

The power employed in forcing muſt evidently ſurmount the preſſure of the whole water in the riſing pipe, and (independent of what is neceſſary for giving the water the required velocity, ſo that the proper quantity per hour may be delivered), the piſton has to withſtand a force equal to the weight of a column of water having the ſection of the piſton for its baſe, and the perpendicular altitude of the place of delivery above the lower ſurface of the piſton for its height. It is quite indifferent in this reſpect what is the diameter of the riſing pipe; becauſe the preſſure on the piſton depends on the altitude of the water only, independent of its quantity. We ſhall even ſee that a ſmall riſing pipe will require a greater force to convey the water along it to any given height or diſtance.

When we would employ a pump to raiſe water in a crooked pipe, or in any pipe of moderate dimenſions, this form of pump, or ſomething equivalent, muſt be uſed. In bringing up great quantities of water from mines, the common ſucking-pump is generally employed, as really the beſt of them all: but it is the moſt expenſive, becauſe it requires the pipe to be perpendicular, ſtraight, and of great dimenſions, that it may contain the piſton rods. But this is impracticable when the pipe is crooked.

If the forcing pump, conſtructed in the manner now deſcribed, be employed, we cannot uſe forces with long rods. Theſe would bend when puſhed down by their further extremity. In this caſe, it is uſual to employ only a ſhort and ſtiff rod, and to hang it by a chain, and load it with a weight ſuperior to the weight of water to be raiſed by it. The machinery therefore is employed, not in forcing the water along the riſing-pipe, but in raiſing the weight which is to produce this effect by its ſubſequent deſcent.

In this caſe, it would be much better to employ the lifting-pump of fig. 11. For as the load on the forcers muſt be greater than the reſiſtances which it muſt ſurmount, the force exerted by the machine muſt in like manner be greater than this load. This double exceſs would be avoided by uſing the lifting-pump.

It will readily occur to the reader that the quantity of water delivered by any pump will be in the joint proportion of the ſurface or baſe of the piſton and its velocity: for this meaſures the capacity of that part of the working barrel which the piſton paſſes over. The velocity of the water in the conduit pipe, and in its paſſage through every valve, will be greater or leſs than the velocity of the piſton in the ſame proportion that the area of the piſton or working barrel is greater or leſs than the area of the conduit or valve. For whatever quantity of water paſſes through any ſection of the working-barrel in a ſecond, the ſame quantity muſt go through any one of theſe paſſages. This enables us to modify the velocity of the water as we pleaſe: we can increaſe it to any degree at the place of delivery by diminiſhing the aperture through which it paſſes, provided we apply ſufficient force to the piſton.

It is evident that the operation of a pump is by ſtarts, and that the water in the main remains at reſt, preſſing on the valve during the time that the piſton is withdrawn from the bottom of the working barrel. It is in moſt caſes deſirable to have this motion equable, and in ſome caſes it is abſolutely neceſſary. Thus, in the engine for extinguiſhing fires, the ſpout of water going by jerks could never be directed with a certain aim, and half of the water would be loſt by the way; becauſe a body at reſt cannot in an inſtant be put in rapid motion, and the firſt portion of every jerk of water would have but a ſmall velocity. A very ingenious contrivance has been fallen upon for obviating this inconvenience, and procuring a ſtream nearly equable. We have not been able to diſcover the author. At any convenient part of the riſing pipe beyond the valve S there is annexed a capacious veſſel VZ (fig. 13. n° 1 and 2.) cloſe at top, and of great ſtrength. When the water is forced along this pipe, part of it gets into this veſſel, keeping the air confined above it, and it fills it to ſuch a height V, that the elaſticity of the confined air balances a column reaching to T, we ſhall ſuppoſe, in the riſing pipe. The next ſtroke of the piſton ſends forward more water, which would fill the riſing pipe to ſome height above T. But the preſſure of this additional column cauſes ſome more of it to go into the air veſſel, and compreſs its air ſo much more that its elaſticity now balances a longer column. Every ſucceeding ſtroke of the piſton produces a like effect. The water riſes higher in the main pipe, but ſome more of it goes into the air-veſſel. At laſt the water *appears* at the place of delivery; and the air in the air-veſſel is now ſo much compreſſed that its elaſticity balances the preſſure of the whole column. The next ſtroke of the piſton ſends forward ſome more water. If the diameter of the orifice of the main be ſufficient to let the water flow out with a velocity equal to that of the piſton, it will ſo flow out, riſing no higher, and producing no ſenſible addition to the compreſſion in the air-veſſel. But if the orifice of the main be contracted to half its dimenſions, the water ſent forward by the piſton cannot flow out in the time of the ſtroke without a greater velocity, and therefore a greater force. Part of it, therefore, goes into the air-veſſel, and increaſes the compreſſion. When the piſton has ended its ſtroke, and no more water comes forward, the compreſſion of the air in the air-veſſel being greater than what was ſufficient to balance the preſſure of the water in the main pipe, now forces out ſome of the water which is lying below it. This cannot return towards the pump, becauſe the valve S is now ſhut. It therefore goes forward along the main, and produces an efflux during the time of the piſton's riſing in order to make another ſtroke. In order that this efflux may be very equable, the air-veſſel muſt be very large. If it be ſmall, the quantity of water that is diſcharged by it during the return of the piſton makes ſo great a portion of its capacity, that the elaſticity of the confined air is too much diminiſhed by this enlargement of its bulk, and the rate of efflux muſt diminiſh accordingly. The capacity of the air-veſſel ſhould be ſo great that the change of bulk of the compreſſed air during the inaction of the piſton may be inconſiderable. It muſt therefore be very ſtrong.

It is pretty indifferent in what way this air-veſſel is connected with the riſing pipe. It may join it laterally, as in fig. 13. n° 1, and the main pipe go on without interruption; or it may be made to *ſurround* an interruption of the main pipe, as in fig. 13, n° 2. It may alſo be in any part of the main-pipe. If the ſole effect intended by it is to produce an equable jet, as in ornamental water-works, it may be near the end of the main. This will require much leſs ſtrength, becauſe there remains but a ſhort column of water to compreſs the air in it. But it is, on the whole, more advantageous to place it as near the pump as poſſible, that it may produce an equable motion in the whole main-pipe. This is of conſiderable advantage: when a column of water ſeveral hundred feet long is at reſt in the main-pipe, and the piſton at one end of it put at once into motion, even with a moderate velocity, the ſtrain on the pipe would be very great. Indeed if it were poſſible to put the piſton inſtantaneouſly into motion with a finite velocity, the ſtrain on the pipe, tending to burſt it, would be next to infinite. But this ſeems impoſſible in nature; all changes of motion *which we obſerve* are gradual, becauſe all impelling bodies have ſome elaſticity or ſoftneſs by which they yield to compreſſion. And, in the way in which piſtons are commonly moved, *viz.* by cranks, or ſomething analogous to them, the motion is *very ſenſibly* gradual. But ſtill the air-veſſel tends to make the motion along the main-pipe leſs deſultory and therefore diminiſhes thoſe ſtrains which would really take place in the main-pipe. It acts like the ſprings of a travelling carriage, whoſe jolts are incomparably leſs than thoſe of a cart; and by this means really enables a given force to propel a greater quantity of water in the ſame time.

We may here by the way obſerve, that the attempts of mechanicians to correct this unequal motion of the piſton-rod are miſplaced, and if it could be done, would greatly hurt a pump. One of the beſt methods of producing this effect is to make the piſton-rod conſiſt of two parallel bars, having teeth in the ſides which front each other. Let a toothed wheel be placed between them, having only the half of its circumference furniſhed with teeth. It is evident, without any further deſcription, that if this wheel be turned uniformly round its axis, the piſton-rod will be moved uniformly up and down without intermiſſion. This has often been put in practice; but the machine always went by jolts, and ſeldom laſted a few days. Unſkilled mechanicians attributed this to defect in the execution: but the fault is eſſential, and lies in the principle.

The machine could not perform one ſtroke, if the firſt mover did not ſlacken a little, or the different parts of the machine did not yield by bending or by compreſſion; and no ſtrength of materials could withſtand the violence of the ſtrains at every reciprocation of the motion. This is chiefly experienced in great works which are put in motion by a water-wheel, or ſome other equal power exerted on the maſs of matter of which the machine conſiſts. The water-wheel being of great weight, moves with conſiderable ſteadineſs or uniformity; and when an additional reſiſtance is oppoſed to it by the beginning of a new ſtroke of the piſton, its great quantity of motion is but little affected by this addition, and it proceeds very little retarded; and the machine muſt either yield a little by bending and compreſſion, or go to pieces, which is the common event. Cranks are free from this inconvenience, becauſe they accelerate the piſton gradually, and bring it gradually to reſt, while the water-wheel moves round with almoſt perfect uniformity. The only inconvenience (and it may be conſiderable) attending this ſlow motion of the piſton at the beginning of its ſtroke is, that the valves do not ſhut with rapidity, ſo that ſome water gets back through them. But when they are properly formed and loaded, this is but trifling.

We muſt not imagine that becauſe the ſtream produced by the aſſiſtance of an air-barrel is almoſt perfectly equable, and becauſe as much water runs out during the returning of the piſton as during its active ſtroke, it therefore doubles the quantity of water. No more water can run out than what is ſent forward by the piſton during its effective ſtroke. The continued ſtream is produced only by preventing the whole of this water from being diſcharged during this time, and by providing a propelling force to act during the piſton's return. Nor does it enable the moving force of the piſton to produce a double effect: for the compreſſion which is produced in the air-veſſel, more than what is neceſſary for merely balancing the quieſcent column of water, reacts on the piſton, reſiſting its compreſſion juſt as much as the column of water would do which produces a velocity equal to that of the efflux. Thus if the water be made to ſpout with the velocity of eight feet per ſecond, this would require an additional column of one foot high, and this would juſt balance the compreſſion in the air-veſſel, which maintains this velocity during the non-action of the piſton. It is, however, a matter of fact, that a pump furniſhed with an air-veſſel delivers a little more water than it would do without it. But the difference depends on the combination of many very diſſimilar circumſtances, which it is extremely difficult to bring into calculation. Some of theſe will be mentioned afterwards.

To deſcribe, or even to enumerate, the immenſe variety of combinations of theſe three ſimple pumps would fill a volume. We ſhall ſelect a few, which are more deſerving of notice.

I. The common ſucking-pump may, by a ſmall addition, be converted into a lifting pump, fitted for propelling the water to any diſtance, and with any velocity.

Fig. 14. is a ſucking-pump, whoſe working-barrel ACDB has a lateral pipe AEGHF connected with it cloſe to the top. This terminates in a *main* or riſing pipe IK, furniſhed or not with a valve L. The top of the barrel is ſhut up by a ſtrong plate MN, having a hollow neck terminating in a ſmall flanch. The piſton rod QR paſſes through this neck, and is nicely turned and poliſhed. A number of rings of leather are put over the rod, and ſtrongly compreſſed round it by another flanch and ſeveral ſcrewed bolts, as is repreſented at OP. By this contrivance the rod is cloſely graſped by the leathers, but may be eaſily drawn up and down, while all paſſage of air or water is effectually prevented.

The piſton S is perforated, and furniſhed with a valve opening upwards. There is alſo a valve T on the top of the ſuction-pipe YX; and it will be of advantage, though not abſolutely neceſſary, to put a valve L at the bottom of the riſing pipe. Now ſuppoſe the piſton at the bottom of the working barrel. When it is drawn up, it tends to compreſs the air above it, becauſe the valve in the piſton remains ſhut by its own weight. The air therefore is driven through the valve L into the riſing pipe, and eſcapes. In the mean time, the air which occupied the ſmall ſpace between the piſton and the valve T expands into the upper part of the working-barrel; and its elaſticity is ſo much diminiſhed thereby, that the atmoſphere preſſes the water of the ciſtern into the ſuction-pipe, where it will riſe till an equilibrium is again produced. The next downward ſtroke of the piſton allows the air, which had come from the ſuction-pipe into the barrel during the aſcent of the piſton, to get through its valve. Upon drawing up the piſton, this air is alſo drawn off through the riſing pipe. Repeating this proceſs brings the water at laſt into the working barrel, and it is then driven along the riſing pipe by the piſton.

This is one of the beſt forms of a pump. The rarefaction may be very perfect, becauſe the piſton can be brought ſo near to the bottom of the working-barrel: and, for forcing water in oppoſition to great preſſures, it appears preferable to the common forcing-pump; becauſe in that the piſton-rods are compreſſed and expoſed to bending, which greatly hurts the pump by wearing the piſton and barrel on one ſide. This ſoon renders it leſs tight, and much water ſquirts out by the ſides of the piſton. But in this pump the piſton-rod is always drawn or pulled, which keeps it ſtraight; and rods exert a much greater force in oppoſition to a pull than in oppoſition to compreſſion. The collar of leather round the piſton-rods is found by experience to need very little repairs, and is very impervious to water. The whole is very acceſſible for repairs; and in this reſpect much preferable to the common pump in deep mines, where every fault of the piſton obliges us to draw up ſome hundred feet of piſton-rods. By this addition, too, any common pump for the ſervice of a houſe is converted into an engine for extinguiſhing fire, or may be made to convey the water to every part of the houſe; and this without hurting or obſtructing its common uſes. All that is neceſſary is to have a large cock on the upper part of the working barrel oppoſite to the lateral pipe in this figure. The cock ſerves for a ſpout when the pump is uſed for common purpoſes; and the merely ſhutting this cock converts the whole into an engine for extinguiſhing fire or for ſupplying diſtant places with water. It is ſcarcely neceſſary to add, that for theſe ſervices it will be proper to connect an air-veſſel with ſome convenient part of the riſing pipe, in order that the current of the water may be continual.

We have frequently ſpoken of the advantages of a continued current in the main pipe. In all great works a conſiderable degree of uniformity is produced by the manner of diſpoſing the actions of the different pumps; for it is very rarely that a machine works but one pump. In order to maintain ſome uniformity in the reſiſtance, that it may not all be oppoſed at once to the moving power, with intervals of total inaction, which would produce a very hobbling motion, it is uſual to diſtribute the work into portions, which ſucceed alternately; and thus both diminiſh the ſtrain, and give greater uniformity of action, and frequently enable a natural power which we can command, to perform a piece of work which would be impoſſible, if the whole reſiſtance were oppoſed at once. In all pump machines therefore we are obviouſly directed to conſtruct them ſo that they may give motion to at leaſt two pumps, which work alternately. By this means a much greater uniformity of current is produced in the main pipe. It will be rendered ſtill more uniform if four are employed, ſucceeding each other at the interval of one quarter of the time of a complete ſtroke.

But ingenious men have attempted the ſame thing with a ſingle pump, and many different conſtructions for this purpoſe have been propoſed and executed. The thing is not of much importance, nor of great reſearch. We ſhall content ourſelves therefore with the deſcription of one that appears to us the moſt perfect, both in reſpect of ſimplicity and effect.

II. It conſiſts of a working-barrel AB (fig. 15.) cloſe at both ends. The piſton C is ſolid, and the rod OP paſſes through a collar of leathers in the plate, which cloſes the upper end of the working-barrel. This barrel communicates laterally with two pipes H, K; the communications *m* and *n* being as near to the top and bottom of the barrel as poſſible. Adjoining to the paſſage *m* are two valves F and G opening upwards. Similar valves accompany the paſſage *n*. The two pipes H and K unite in a larger riſing pipe L. They are all repreſented as in the ſame plane; but the upper ends muſt be bent backwards, to give room for the motion of the piſton-rod OP.

Suppoſe the piſton cloſe to the entry of the lateral pipe *n*, and that it is drawn up: it compreſſes the air above it, and drives it through the valve G, where it eſcapes along the riſing pipe; at the ſame time it rarefies the air in the ſpace below it. Therefore the weight of the atmoſphere ſhuts the valve E, and cauſes the water of the ciſtern to riſe through the valve D, and fill the lower part of the pump. When the piſton is puſhed down again, this water is firſt driven through the valve E, becauſe D immediately ſhuts; and then moſt of the air which was in this part of the pump at the beginning goes up through it, ſome of the water coming back in its ſtead. In the mean time, the air which remained in the upper part of the pump after the aſcent of the piſton is rarefied by its deſcent; becauſe the valve G ſhuts as ſoon as the piſton begins to deſcend, the valve F opens, the air in this ſuction-pipe F *f* expands into the barrel, and the water riſes into the pipes by the preſſure of the atmoſphere. The next riſe of the piſton muſt bring more water into the lower part of the barrel, and muſt drive a little more air through the valve G, namely, part of that which had come out of the ſuction-pipe F *f*; and the next deſcent of the piſton muſt drive more water into the riſing pipe H, and along with it moſt if not all of the air which remained below the piſton, and muſt rarefy ſtill more the air remaining above the piſton; and more water will come in through the pipe F *f*, and get into the barrel. It is evident that a few repetitions will at laſt fill the barrel on both ſides of the piſton with water. When this is accompliſhed, there is no difficulty in perceiving how, at every riſe of the piſton, the water of the ciſtern will come in by the valve D, and the water in the upper part of the barrel will be driven through the valve G; and, in every deſcent of the piſton, the water of the ciſtern will come into the barrel by the valve F, and the water below the piſton will be driven through the valve E: and thus there will be a continual influx into the barrel through the valves D and F, and a continual diſcharge along the riſing pipe L through the valves E and G.

This machine is, to be ſure, equivalent to two forcing pumps, although it has but one barrel and one piſton; but it has no ſort of ſuperiority. It is not even more economical in moſt caſes; becauſe we apprehend that the additional workmanſhip will fully compenſate for the barrel and piſton that is ſaved. There is indeed a ſaving in the reſt of the machinery, becauſe one lever produces both motions. We cannot therefore ſay that it is inferior to two pumps; and we acknowledge that there is ſome ingenuity in the contrivance.

We recommend to our readers the peruſal of Belidor's *Architecture Hydraulique*, where is to be found a great variety of combinations and forms of the ſimple pumps; but we muſt caution them with reſpect to his theories, which in this article are extremely defective. Alſo in Leupold's *Theatrum Machinarum Hydraulicarum*, there is a prodigious variety of all kinds of pumps, many of them very ſingular and ingenious, and many which have particular advantages, which may ſuit local circumſtances, and give them a preference. But it would be improper to ſwell a work of this kind with ſo many peculiarities; and a perſon who makes himſelf maſter of the principles delivered here in ſufficient detail, can be at no loſs to ſuit a pump to his particular views, or to judge of the merit of ſuch as may be propoſed to him.

We muſt now take notice of ſome very conſiderable and important varieties in the form and contrivance of the eſſential parts of a pump.

III. The forcing pump is ſometimes of a very different form from that already deſcribed. Inſtead of a piſton, which applies itſelf to the inſide of the barrel, and ſlides up and down in it, there is a long cylinder POQ (fig. 16.) nicely turned and poliſhed on the outſide, and of a diameter ſomewhat leſs than the inſide of the barrel. This cylinder (called a PLUNGER) ſlides through a collar of leathers on the top of the working-barrel, and is conſtructed as follows: The top of the barrel terminates in a ſlanch *a b*, pierced with four holes for receiving ſcrew-bolts. There are two rings of metal, *c d*, *e f*, of the ſame diameter, and having holes correſponding to thoſe in the flanch. Four rings of ſoft leather, of the ſame ſize, and ſimilarly pierced with holes, are well ſoaked in a mixture of oil, tallow, and a little roſin. Two of theſe leather rings are laid on the pump-flanch, and one of the metal rings above them. The plunger is then thruſt down through them, by which it turns their inner edges downwards. The other two rings are then ſlipped on at the top of the plunger, and the ſecond metal ring is put over them, and then the whole are ſlid down to the metal ring. By this the inner edges of the laſt leather rings are turned upwards. The three metal rings are now forced together by the ſcrewed bolts; and thus the leathern rings are ſtrongly compreſſed between them, and made to graſp the plunger ſo cloſely that no preſſure can force the water through between. The upper metal ring juſt allows the plunger to paſs through it, but without any play; ſo that the turned up edges of the leathern rings do not come up between the plunger and the upper metal ring, but are lodged in a little conical taper, which is given to the inner edge of the upper plate, its hole being wider below than above. It is on this trifling circumſtance that the great tightneſs of the collar depends. To prevent the leathers from ſhrinking by drought, there is uſually a little ciſtern formed round the head of the pump, and kept full of water. The plunger is either forced by a rod from a working beam, or by a ſet of metal weights laid on it, as is repreſented in the figure.

It is hardly neceſſary to be particular in explaining the operation of the pump. When the plunger is at the bottom of the barrel, touching the fixed valve M with its lower extremity, it almoſt completely fills it. That it may do it completely, there is ſometimes a ſmall pipe RSZ branching out from the top of the barrel, and fitted with a cock at S. Water is admitted till the barrel is completely filled, and the cock is then ſhut. Now when the plunger is drawn up, the valve N in the riſing pipe muſt remain ſhut by the preſſure of the atmoſphere, and a void muſt be made in the barrel. Therefore the valve M on the top of the ſuction-pipe muſt be opened by the elaſticity of the air in this pipe, and the air muſt expand into the barrel; and, being no longer a balance for the atmoſphere, the water in the ciſtern muſt be forced into the ſuction-pipe, and riſe in it to a certain height. When the plunger deſcends, it muſt drive the water through the valve N (for the valve M will immediately ſhut), and along with it moſt of the air which had come into the barrel. And as this air occupied the upper part of the barrel, part of it will remain when the plunger has reached the bottom; but a ſtroke or two will expel it all, and then every ſucceeding ſtroke of the deſcending piſton will drive the water along the riſing pipe, and every aſcent of the plunger will be followed by the water from the ciſtern.

The advantage propoſed by this form of piſton is, that it may be more accurately made and poliſhed than the inſide of a working-barrel, and it is of much eaſier repair. Yet we do not find that it is much uſed, although an invention of laſt century (we think by Sir Samuel Morland), and much praiſed by the writers on theſe ſubjects.

It is eaſy to ſee that the ſucking-pump may be varied in the ſame way. Suppoſe this plunger to be open both at top and bottom, but the bottom filled with a valve opening upward. When this is puſhed to the bottom of the barrel, the air which it tends to compreſs lifts the valve (the lateral pipe FIK being taken away and the paſſage ſhut up), and eſcapes through the plunger. When it is drawn up, it makes the ſame rarefaction as the ſolid plunger, becauſe the valve at O ſhuts, and the water will come up from the ciſtern as in the former caſe. If the plunger be now thruſt down again, the valve M ſhuts, the valve O is forced open, and the plunger is filled with water. This will be lifted by it during its next aſcent; and when it is puſhed down again, the water which filled it muſt now be puſhed out, and will flow over its ſides into the ciſtern at the head of the barrel. Inſtead of making the valve at the bottom of the piſton, it may be made at the top; but this diſpoſition is much inferior, becauſe it cannot rarefy the air in the barrel one half. This is evident; for the capacity of the barrel and plunger together cannot be twice the capacity of the barrel.

IV. It may be made after a ſtill different form, as repreſented in plate 30. fig. 17. Here the ſuction-pipe CO comes up through a ciſtern KMNL deeper or longer than the intended ſtroke of the piſton, and has a valve C at top. The piſton, or what acts in lieu of it, is a tube AHGB, open at both ends, and of a diameter ſomewhat larger than that of the ſuction-pipe. The interval between them is filled up at HG by a ring or belt of ſoft leather, which is faſtened to the *outer* tube, and moves up and down with it, ſliding along the ſmoothly poliſhed ſurface of the ſuction-pipe with very little friction. There is a valve I on the top of this piſton, opening upwards. Water is poured into the outer ciſtern.

The outer cylinder or piſton being drawn up from the bottom, there is a great rarefaction of the air which was between them, and the atmoſphere preſſes the water up through the ſuction-pipe to a certain height; for the valve I keeps ſhut by the preſſure of the atmoſphere and its own weight. Puſhing down the piſton cauſes the air, which had expanded from the ſuction-pipe into the piſton, to eſcape through the valve I drawing it up a ſecond time, allows the atmoſphere to preſs more water into the ſuction-pipe, to fill it, and alſo part of the piſton. When this is puſhed down again, the water which had come through the valve C is now forced out through the valve I into the ciſtern KMNL, and now the whole is full of water. When, therefore, the piſton is drawn up, the water follows, and fills it, if not 33 feet above the water in the ciſtern; and when it is puſhed down again, the water which filled the piſton is all thrown out into the ciſtern; and after this it delivers its full contents of water every ſtroke. The water in the ciſtern KMNL effectually prevents the entry of any air between the two pipes; ſo that a very moderate compreſſion of the belt of ſoft leather at the mouth of the piſton cylinder is ſufficient to make all perfectly tight.

It might be made differently. The ring of leather might be faſtened round the top of the inner cylinder at DE, and ſlide on the inſide of the piſton cylinder: but the firſt form is moſt eaſily executed. Muſchenbroeck has given a figure of this pump in his large ſyſtem of natural philoſophy, and ſpeaks very highly of its performance. But we do not ſee any advantage which it poſſeſſes over the common ſucking-pump. He indeed ſays that it is without friction, and makes no mention of the ring of leather between the two cylinders. Such a pump will raiſe water extremely well to a ſmall height, and it ſeems to have been a model only which he had examined: but if the ſuction-pipe be long, it will by no means do without the leather; for on drawing up the piſton, the water of the upper ciſtern will riſe between the pipes, and fill the piſton, and none will come up through the ſuction-pipe.

We may take this opportunity of obſerving, that the many ingenious contrivances of pumps without friction are of little importance in great works; becauſe the friction which is completely ſufficient to prevent all eſcape of water in a well-conſtructed pump is but a very trifling part of the whole force. In the great pumps which are uſed in mines, and are worked by a ſteam-engine, it is very uſual to make the piſtons and valves without any leather whatever. The working barrel is bored truly cylindrical, and the piſton is made of metal of a ſize that will juſt paſs along it without ſticking. When this is drawn up with the velocity competent to a properly loaded machine, the quantity of water which eſcapes round the piſton is inſignificant. The piſton is made without leathers, not to avoid friction, which is alſo inſignificant in ſuch works; but to avoid the neceſſity of frequently drawing it up for repairs through ſuch a length of pipes.

V. If a pump abſolutely without friction is wanted, the following ſeems preferable for ſimplicity and performance to any we have ſeen, when made uſe of in proper ſituations. Let NO (fig. 18.) be the ſurface of the water in the pit, and K the place of delivery. The pit muſt be as deep in water as from K to NO. ABCD is a wooden trunk, round or ſquare, open at both ends, and having a valve P at the bottom. The top of this trunk muſt be on a level with K, and has a ſmall ciſtern EADF. It alſo communicates laterally with a riſing pipe GHK, furniſhed with a valve at H opening upwards. LM is a beam of timber ſo fitted to the trunk as to fill it without ſticking, and is of at leaſt equal length. It hangs by a chain from a working beam, and is loaded on the top with weights exceeding that of the column of water which it diſplaces. Now ſuppoſe this beam allowed to deſcend from the poſition in which it is drawn in the figure; the water muſt riſe all around it, in the crevice which is between it and the trunk, and alſo in the riſing pipe; becauſe the valve P ſhuts, and H opens; ſo that when the plunger has got to the bottom, the water will ſtand at the level of K. When the plunger is again drawn up to the top by the action of the moving power, the water ſinks again in the trunk, but not in the riſing pipe, becauſe it is ſtopped by the valve H. Then allowing the plunger to deſcend again, the water muſt again riſe in the trunk to the level of K, and it muſt now flow out at K; and the quantity diſcharged will be equal to the part of the beam below the ſurface of the pit-water, deducting the quantity which fills the ſmall ſpace between the beam and the trunk. This quantity may be reduced almoſt to nothing; for if the inſide of the trunk and the outſide of the beam be made tapering, the beam may be let down till they exactly fit; and as this may be done in ſquare work, a good workman can make it exceedingly accurate. But in this caſe, the lower half of the beam and trunk muſt not taper; and this part of the trunk muſt be of ſufficient width round the beam to allow free paſſage into the riſing pipe. Or, which is better, the riſing pipe muſt branch off from the bottom of the trunk. A diſcharge may be made from the ciſtern EADF, ſo that as little water as poſſible may deſcend along the trunk when the piſton is raiſed.

One great excellence of this pump is, that it is perfectly free from all the deficiencies which in common pumps reſult from want of being air-tight. Another is, that the quantity of water raiſed is preciſely equal to the power expended; for any want of accuracy in the work, while it occaſions a diminution of the quantity of water diſcharged, makes an equal diminution in the weight which is neceſſary for puſhing down the plunger. We have ſeen a machine conſiſting of two ſuch pumps ſuſpended from the arms of a long beam, the upper ſide of which was formed into a walk with a rail on each ſide. A man ſtood on one end till it got to the bottom, and then walked ſoberly up to the other end, the inclination being about twenty-five degrees at firſt, but gradually diminiſhed as he went along, and changed the load of the beam. By this means he made the other end go to the bottom, and ſo on alternately, with the eaſieſt of all exertions, and what we are moſt fitted for by our ſtructure. With this machine, a very feeble old man, weighing 110 pounds, raiſed 7 cubic feet of water 11^{1} feet high in a minute, and continued working 8 or 10 hours every day. A ſtout young man, weighing nearly 135 pounds, raiſed $8\frac{1}{3}$ to the ſame height; and when he carried 30 pounds, conveniently ſlung about him, he raiſed $9\frac{1}{2}$ feet to this height, working 10 hours a-day without fatiguing himſelf. This exceeds Deſagulier's maximum of a hogſhead of water 10 feet high in a minute, in the proportion of 9 to 7 nearly. It is limited to very moderate heights; but in ſuch ſituations it is very effectual. It was the contrivance of an untaught labouring man, poſſeſſed of uncommon mechanical genius. We ſhall have occaſion to mention, with reſpect, ſome other contrivances of the ſame perſon in the article WATER-*Works*.

VI. The moſt ingenious contrivance of a pump without friction is that of Mr. Haſkins, deſcribed by Deſaguliers, and called by him the QUICKSILVER PUMP. Its conſtruction and mode of operation are pretty complicated; but the following preliminary obſervations will, we hope, render it abundantly plain.

Let *i l m k* (fig. 19.) be a cylindrical iron pipe, about ſix feet long, open at top. Let *e g h f* be another cylinder, connected with it at bottom, and of ſmaller diameter. It may either be ſolid, or, if hollow, it muſt be cloſe at top. Let *a c d b* be a third iron cylinder, of an intermediate diameter, ſo that it may move up and down between the other two without touching either, but with as little interval as poſſible. Let this middle cylinder communicate by means of the pipe AB, with the upright pipe FE, having valves C and D (both opening upwards) adjoining to the pipe of communication. Suppoſe the outer cylinder ſuſpended by chains from the end of a working beam, and let mercury be poured into the interval between the three cylinders till it fills the ſpace to *o p*, about three-fourths of their height. Alſo ſuppoſe that the lower end of the pipe FE is immerſed into a ciſtern of water, and that the valve D is leſs than 33 feet above the ſurface of this water.

Now ſuppoſe a perforation made ſomewhere in the pipe AB, and a communication made with an air-pump. When the air-pump is worked, the air contained in CE, in AB, and in the ſpace between the inner and middle cylinders, is rarefied, and is abſtracted by the air-pump; for the valve D immediately ſhuts. The preſſure of the atmoſphere will cauſe the water to riſe in the pipe CE, and will cauſe the mercury to riſe between the inner and middle cylinders, and ſink between the outer and middle cylinders. Let us ſuppoſe mercury 12 times heavier than water: then for every foot that the water riſes in EC, the level between the outſide and inſide mercury will vary an inch; and if we ſuppoſe DE to be 30 feet, then if we can rarefy the air ſo as to raiſe the water to D, the outſide mercury will be depreſſed to *q*, *r*, and the inſide mercury will have riſen to *s*, *t*, *s q* and *t r* being about 30 inches. In this ſtate of things, the water will run over by the pipe BA, and every thing will remain nearly in this poſition. The columns of water and mercury balance each other, and balance the preſſure of the atmoſphere.

While things are in this ſtate of equilibrium, if we allow the cylinders to deſcend a little, the water will riſe in the pipe FE, which we may now conſider as a ſuction-pipe; for by this motion the capacity of the whole is enlarged, and therefore the preſſure of the atmoſphere will ſtill keep it full, and the ſituation of the mercury will again be ſuch that all ſhall be in equilibrio. It will be a little lower in the inſide ſpace and higher in the outſide.

Taking this view of things, we ſee clearly how the water is ſupported by the atmoſphere at a very conſiderable height. The apparatus is analogous to a ſyphon which has one leg filled with water and the other with mercury. But it was not neceſſary to employ an air-pump to fill it. Suppoſe it again empty, and all the valves ſhut by their own weight. Let the cylinders deſcend a little. The capacity of the ſpaces below the valve D is enlarged, and therefore the included air is rarefied, and ſome of the air in the pipe CE muſt diffuſe itſelf into the ſpace quitted by the inner cylinder. Therefore the atmoſphere will preſs ſome water up the pipe FE, and ſome mercury into the inner ſpace between the cylinders. When the cylinders are raiſed again, the air which came from the pipe CE would return into it again, but is prevented by the valve C.—Raiſing the cylinders to their former height would compreſs this air; it thererefore lifts the valve D, and eſcapes. Another depreſſion of the cylinders will have a ſimilar effect. The water will riſe higher in FC, and the mercury in the inner ſpace; and then, after repeated ſtrokes the water will paſs the valve C, and fill the whole aparatus, as the air-pump had cauſed it to do before.—The poſition of the cylinders, when things are in this ſituation, is repreſented in fig. 20. the outer and inner cylinders in their loweſt poſition having deſcended about 30 inches. The mercury in the outer ſpace ſtands at *q*, *r*, a little above the middle of the cylinders, and the mercury in the inner ſpace is near the top *t s* of the inner cylinder. Now let the cylinders be drawn up. The water above the mercury cannot get back again through the valve C, which ſhuts by its own weight. We therefore attempt to compreſs it; but the mercury yields, and deſcends in the inner ſpace, and riſes in the outer till both are quickly on a level, about the height *v v*. If we continue to raiſe the cylinders, the compreſſion forces out more mercury, and it now ſtands lower in the inner than in the outer ſpace. But that there may be ſomething to balance this inequality of the mercurial columns, the water goes through the valve D, and the equilibrium is reſtored when the height of the water in the pipe ED above the ſurface of the internal mercury is 12 times the difference of the mercurial columns (on the former ſuppoſition of ſpecific gravity). If the quantity of water be ſuch as to riſe two feet in the pipe ED, the mercury in the outer ſpace will be two inches higher than that in the inner ſpace. Another depreſſion of the cylinders will again enlarge the ſpace within the apparatus, the mercury will take the poſition of fig. 19. and more water will come in. Raiſing the cylinders will ſend this water four feet up the pipe ED, and the mercury will be four inches higher in the inner than in the outer ſpace. Repeating this operation, the water will be raiſed ſtill higher in DE; and this will go on till the mercury in the outer ſpace reaches the top of the cylinder; and this is the limit of the performance. The dimenſions with which we ſet out will enable the machine to raiſe the water about 30 feet in the pipe, ED; which, added to the 30 feet of CF, makes the whole height above the pit-water 60 feet. By making the cylinders longer, we increaſe the height of FD. This machine muſt be worked with great attention, and but ſlowly; for at the beginning of the forcing ſtroke the mercury very rapidly ſinks in the inner ſpace and riſes in the outer, and will daſh out and be loſt. To prevent this as much as poſſible, the outer cylinder terminates in a ſort of cup or diſh, and the inner cylinder ſhould be tapered atop.

The machine is exceedingly ingenious and refined; and there is no doubt but that its performance will exceed that of any other pump which raiſes the water to the ſame height, becauſe friction is completely avoided, and there can be no want of tightneſs of the piſton. But this is all its advantage; and from what has been obſerved, it is but trifling. The expenſe would be enormous; for with whatever care the cylinders are made, the interval between the inner and outer cylinders muſt contain a very great quantity of mercury. The middle cylinder muſt be made of iron plate, and muſt be without a ſeam, for the mercury would diſſolve every ſolder. For ſuch reaſons, it has never come into general uſe. But it would have been unpardonable to have omitted the deſcription of an invention which is ſo original and ingenious ; and there are ſome occaſions where it may be of great uſe, as in nice experiments for illuſtrating the theory of hydraulics, it would give the fineſt piſtons for meaſuring the preſſures of water, in pipes, &c. It is on preciſely the ſame principle that the cylinder bellows, deſcribed in the article Pneumatics, are conſtructed.

We beg leave to conclude this part of the ſubject with the deſcription of a pump without friction, which may be conſtructed in a variety of ways by any common carpenter, without the aſſiſtance of the pump-maker, or plumber, and will be very effective for raiſing a great quantity of water to ſmall heights, as in draining marſhes, marle pits, quarries, &c. or even for the ſervice of a houſe.

VII. ABCD (pl. 30. fig. 21.) is a ſquare trunk of carpenter's work open at both ends, and having a little ciſtern and ſpout at top. Near the bottom there is a partition made of board, perforated with a hole E, and covered with a clack. *ffff* repreſents a long cylindrical bag or pudding, made of leather or of double canvas, with a fold of thin leather ſuch as ſheepſkin between the canvas bags. This is firmly nailed to the board E with ſoft leather between. The upper end of this bag is fixed on a round board having a hole and valve F. This board may be turned in the lathe with a groove round its edge, and the bag faſtened to it by a cord bound tight round it. The fork of the piſton-rod FG is firmly fixed into this board ; the bag is kept diſtended by a number of wooden hoops or rings of ſtrong wire *ff, ff, ff,* &c. put into it at a few inches diſtance from each other. It will be proper to connect theſe hoops before putting them in, by three or four cords from top to bottom, which will keep them at their proper diſtances. Thus will the bag have the form of a barber's bellows powder-puff. The diſtance between the hoops ſhould be about twice the breadth of the rim of the wooden ring to which the upper valve and piſton-rod are fixed.

Now let this trunk be immerſed in the water. It is evident that if the bag be ſtretched from the compreſſed form which its own weight will give it by drawing up the piſton-rod, its capacity will be enlarged, the valve F will be ſhut by its own weight, the air in the bag will be rarefied, and the atmoſphere will preſs the water into the bag. When the rod is thruſt down again, this water will come out by the valve F, and fill part of the trunk. A repetition of the operation will have a ſimilar effect; the trunk will be filled, and the water will at laſt be diſcharged by the ſpout.

Here is a pump without friction, and perfectly tight. For the leather between the folds of canvas renders the bag impervious both to air and water. And the canvas has very conſiderable ſtrength. We know from experience that a bag of ſix inches diameter, made of ſail-cloth No. 3. with a ſheepſkin between, will bear a column of 15 feet of water, and ſtand ſix hours work *per* day for a month without failure, and that the pump is conſiderably ſuperior in effect to a common pump of the ſame dimenſions. We muſt only obſerve, that the length of the bag muſt be three times the intended length of the ſtroke ; ſo that when the piſton-rod is in its higheſt poſition, the angles or ridges of the bag may be pretty acute. If the bag be more ſtretched than this, the force which muſt be exerted by the labourer becomes much greater than the weight of the column of water which he is raiſing. If the pump be laid aſlope, which is very uſual in theſe occaſional and haſty drawings, it is neceſſary to make a guide for the piſton-rod within the trunk, that the bag may play up and down without rubbing on the ſides, which would quickly wear it out.

The experienced reader will ſee that this pump is very like that of Goſſet and De la Deuille, deſcribed by Belidor vol. ii. p. 120, and moſt writers on hydraulics. It would be ſtill more like it, if the bag were on the under ſide of the partition E, and a valve placed further down the trunk. But we think that our form is greatly preferable in point of ſtrength. When in the other ſituation, the column of water lifted by the piſton tends to *burſt* the bag, and this with a great force, as the intelligent reader well knows. But in the form recommended here, the bag is *compreſſed*, and the ſtrain on each part may be made much leſs than that which tends to burſt a bag of ſix inches diameter. The nearer the rings are placed to each other the ſmaller will the ſtrain be.

The ſame bag piſton may be employed for a forcing pump, by placing it below the partition, and inverting the valve ; and it will then be equally ſtrong, becauſe the reſiſtance in this caſe too will act by compreſſion.

We now come naturally to the conſideration of the different forms which may be given to the piſtons and valves of a pump. A good deal of what we have been deſcribing already is reducible to this head ; but, having a more general appearance, changing as it were the whole form and ſtructure of the pump, it was not improper to keep theſe things together.

The great deſideratum in a piſton is, that it be as tight as poſſible, and have as little friction as is conſiſtent with this indiſpenſable quality. We have already ſaid, that the common form, when carefully executed, has theſe properties in an eminent degree. And accordingly this form has kept its ground amidſt all the improvements which ingenious artiſts have made. Mr. Belidor, an author of the firſt reputation, has given the deſcription of a piſton which he highly extols, and is undoubtedly a very good one, conſtructed from principle, and extremely well compoſed.

It conſiſts of a hollow cylinder of metal *g h* (fig. 22.) pierced with a number of holes, and having at top a flanch AB, whoſe diameter is nearly equal to that of the working-barrel of the pump. This flanch has a groove round it. There is another flanch IK below, by which this hollow cylinder is faſtened with bolts to the lower end of the piſton, repreſented in fig. 23. This conſiſts of a plate CD, with a grooved edge ſimilar to AB, and an intermediate plate which forms the ſeat of the valve. The compoſition of this part is better underſtood by inſpecting the figure than by any deſcription. The piſton-rod HL is fixed to the upper plate by bolts through its different branches at G, G. This metal body is then covered with a cylindrical bag of leather, faſtened on it by cords bound round it, filling up the grooves in the upper and lower plates. The operation of the piſton is as follows.

A little water is poured into the pump, which gets paſt the ſides of the piſton, and lodges below in the fixed valve. The piſton being puſhed down dips into this water, and it gets into it by the valve. But as the piſton in deſcending compreſſes the air below it, this compreſſed air alſo gets into the inſide of the piſton, ſwells out the bag which ſurrounds it, and compreſſes it to the ſides of the working-barrel. When the piſton is drawn up again, it muſt remain tight, becauſe the valve will ſhut and keep in the air in its moſt compreſſed ſtate ; therefore the piſton muſt perform well during the ſuction. It muſt act equally well when puſhed down again, and acting as a forcer ; for, however great the reſiſtance may be, it will affect the air within the piſton to the ſame degree, and keep the leather cloſe applied to the barrel. There can be no doubt therefore of the piſton's performing both its offices completely ; but we imagine that the adheſion to the barrel will be greater than is neceſſary : it will extend over the whole ſurface of the piſton, and be equally great in every part of its ſurface ; and we ſuſpect that the friction will therefore be very great. We have very high authority for ſuppoſing that the adheſion of a piſton of the common form, carefully made, will be ſuch as will make it perfectly tight ; and it is evident that the adheſion of Belidor's piſton will be much greater, and it will be productive of worſe conſequences. If the leather bag be worn through in any one place, the air eſcapes, and the piſton ceaſes to be compreſſed altogether; whereas in the common piſton there will very little harm reſult from the leather being worn through in one place, eſpecially if it project a good way beyond the baſe of the cone. We ſtill think the common piſton preferable. Belidor's piſton would do much better inverted as the piſton of a ſucking pump; and in this ſituation it would be equal, but not ſuperior to the common.

Belidor deſcribes another forcing piſton, which he had executed with ſucceſs, and prefers to the common wooden forcer. It conſiſts of a metal cylinder or cone, having a broad flanch united to it at one end, and a ſimilar flanch which is ſcrewed on the other end. Between theſe two plates are a number of rings of leather ſtrongly compreſſed by the two flanches; and then turned in a lathe like a block of wood, till the whole fits tight, when dry, into the barrel. It will ſwell, ſays he, and ſoften with the water, and withſtand the greateſt preſſures. We cannot help thinking this but an indifferent piſton. When it wears, there is nothing to ſqueeze it to the barrel. It may indeed be taken out and another ring or two of leather put in, or the flanches may be more ſtrongly ſcrewed together: but all this may be done with any kind of piſton; and this has therefore no peculiar merit.

The following will, we preſume, appear vaſtly preferable. ABCD (fig. 24.) is the ſolid wooden or metal block of the piſton; EF is a metal plate, which is turned hollow or diſh like below, ſo as to receive within it the ſolid block. The piſton-rod goes through the whole, and has a ſhoulder above the plate EF, and a nut H below. Four ſcrew bolts, ſuch as *i k*, *l m*, alſo go through the whole, having their heads *k*, *m* ſunk into the block, and nuts above at *i*, *l*. The packing or ſtuffing, as it is termed by the workmen, is repreſented at NO. This is made as ſolid as poſſible, and generally conſiſts of ſoft hempen twine well ſoaked in a mixture of oil, tallow, and roſin. The plate EF is gently ſcrewed down, and the whole is then put into the barrel, fitting it as tight as may be thought proper. When it wears looſe, it may be tightened at any time by ſcrewing down the nuts *i l*, which cauſe the edges of the diſh to ſqueeze out the packing, and compreſs it againſt the barrel to any degree.

The greateſt difficulty in the conſtruction of a piſton is to give a ſufficient paſſage through it for the water, and yet allow a firm ſupport for the valve, and fixture for the piſton-rod. We ſhall ſee preſently that it occaſions a conſiderable expenſe of the moving power to force a piſton with a narrow perforation through the water lodged in the working-barrel. When we are raiſing water to a ſmall height, ſuch as 10 or 20 feet, the power ſo expended amounts to a fourth part of the whole, if the water-way in the piſton is leſs than one-half of the ſection of the barrel, and the velocity of the piſton two feet *per* ſecond, which is very moderate. There can be no doubt, therefore, that metal piſtons are preferable, becauſe their greater ſtrength allows much wider apertures.

The following piſton, deſcribed and recommended by Belidor, ſeems as perfect in theſe reſpects as the nature of things will allow. We ſhall therefore deſcribe it in the author's own words as a model, which may be adopted with confidence in the greateſt works.

"The body of the piſton is a truncated metal cone CCXX (fig. 25.), having a ſmall fillet at the greater end. Fig. 26 ſhows the profile, and fig. 27 the plan of its upper baſe; where appears a croſs bar DD, pierced with an oblong mortiſe E for receiving the tail of the piſton-rod. A band of thick and uniform leather AA (fig. 26. and 28.) is put round this cone, and ſecured by a braſs hoop BB firmly driven on its ſmaller end, where it is previouſly made thinner to give room for the hoop.

"This piſton is covered with a leather valve, fortified with metal plates GG (fig. 29.) Theſe plates are wider than the hole of the piſton, ſo as to reſt on its rim. There are ſimilar plates below the leather of a ſmaller ſize, that they may go into the hollow of the piſton; and the leather is firmly held between the metal plates by ſcrews H, H, which go through all. This is repreſented by the dotted circle IK. Thus the preſſure of the incumbent column of water is ſupported by the plates GG, whoſe circular edges reſt on the brim of the water-way, and thus ſtraight edges reſt on the croſs bar DD of fig. 26. and 27. This valve is laid on the top of the conical box in ſuch a manner that its middle FF reſts on the croſs bar. To bind all together, the end of the piſton-rod is formed like a croſs, and the arms MN (fig. 30.) are made to reſt on the diameter FF of the valve, the tail EP going through the hole E in the middle of the leather, and through the mortiſe E of the croſs bar of the box; and alſo through another bar QR (fig. 28 and 29.) which is notched into the lower brim of the box. A key V is then driven into the hole T in the piſton-rod; and this wedges all faſt. The bar QR is made ſtrong; and its extremities project a little, ſo as to ſupport the braſs hoop BB which binds the leather band to the piſton-box. The adjoining ſcale gives the dimenſions of all the parts, as they were executed for a ſteam-engine near Condé, where the piſton gave complete ſatisfaction."

This piſton has every advantage of ſtrength, tightneſs, and large water-way. The form of the valve (which has given it the name of the *butterfly-valve*) is extremely favourable to the paſſage of the water; and as it has but half the motion of a complete circular valve, leſs water goes back while it is ſhutting.

The following piſton is alſo ingenious, and has a good deal of merit. OPPO (pl. 31, fig. 31.) is the box of the piſton, having a perforation Q, covered above with a flat valve K, which reſts in a metal plate that forms the top of the box. ABCBA is a ſtirrup of iron to which the box is fixed by ſcrews *a*, *a*, *a*, *a*, whoſe heads are ſunk in the wood. This ſtirrup is perforated at C, to receive the end of the piſton-rod, and a nut H is ſcrewed on below to keep it faſt. DEFED is another ſtirrup, whoſe lower part at DD forms a hoop like the ſole of a ſtirrup, which embraces a ſmall part of the top of the wooden box. The lower end of the piſton-rod is ſcrewed; and before it is put into the holes of the two ſtirrups (through which holes it ſlides freely) a broad nut G is ſcrewed on it. It is then put into the holes, and the nut H firmly ſcrewed up. The packing RR is then wound about the piſton as tight as poſſible till it completely fills the working-barrel of the pump. When long uſe has rendered it in any degree looſe, it may be tightened again by ſcrewing down the nut G. This cauſes the ring DD to compreſs the packing between it and the projecting ſhoulder of the box at PP; and thus cauſes it to ſwell out, and apply itſelf cloſely to the barrel.

We ſhall add only another form of a perforated piſton; which being on a principle different from all the preceding, will ſuggeſt many others; each of which will have its peculiar advantages. OO in fig. 32. repreſents the box of this piſton, fitted to the working-barrel in any of the preceding ways as may be thought beſt. AB is a croſs bar of four arms, which is fixed to the top of the box. CF is the piſton-rod going through a hole in the middle of AB, and reaching a little way beyond the bottom of the box. It has a ſhoulder D, which prevents its going too far through. On the lower end there is a thick metal plate, turned conical on its upper ſide, ſo as to fit a conical ſeat PP in the bottom of the piſton-box.

When the piſton-rod is puſhed down, the friction on the barrel prevents the box from immediately yielding. The rod therefore ſlips through the hole of the croſs bar AB. The plate E, therefore, detaches itſelf from the box. When the ſhoulder D preſſes on the bar AB, the box muſt yield, and be puſhed down the barrels, and the water gets up through the perforation. When the piſton-rod is drawn up again, the box does not move till the plate E lodged in the ſeat PP, and thus ſhuts the water-way; and then the piſton lifts the water which is above it, and acts as the piſton of a ſucking-pump.

This is a very ſimple and effective conſtruction, and makes a very tight valve. It has been much recommended by engineers of the firſt reputation, and is frequently uſed; and, from its ſimplicity, and the great ſolidity of which it is capable, it ſeems very fit for great works. But it is evident that the water-way is limited to leſs than one-half of the area of the working-barrel. For if the perforation of the piſton be one-half of the area, the diameter of the plate or ball EF muſt be greater; and therefore leſs than half the area will be left for the paſſage of the water by its ſides.

In treating on piſtons and the advantages of particular forms which may be given them, it will be proper here to notice Mr. Lander's new patent apparatus for moving the piſton-rod. See plate 31. the figures of which ſhow part or parts of a wheel or circle, moving a rack or racks by a rotary or continued circular motion, and cauſing the piſton-rod or rods to make a longer ſtroke, and thereby raiſe a greater quantity of water, with the ſame bore, power, and time, than by cranks, or any other mode now in uſe, where it may be applied.

Fig. 1, repreſents a ſemi-circle, whoſe radius ſuppoſe to be four inches, and periphery twelve inches; conſequently the length of the ſtroke of the piſton muſt be twelve inches, being connected with the rack. The power of a winch (if uſed), applied to the centre of motion at A, may be extended in proportion as ſix to one, or two feet to four inches. A, the centre of motion. B, ſemicircular wheel, which alternately acts upon the racks C, C, and moves the piſton up and down perpendicularly, while it continues its own circular motion. D, D, grooved rollers, to guide the rack. Fig. 2, repreſents three quarters of a circle, of the ſame radius as the preceding one; of courſe the arc is eighteen inches, being likewiſe the length of the ſtroke of the piſton: the other quarter of a larger circle, is to depreſs or ſink the piſton-rod. A, the centre of motion. Fig. 3, is more peculiarly adapted to large pumps for mines, being a little more ſimple in its conſtruction, but on the ſame principle, and has the ſame effect, as fig. 1. Figs. 4 and 5, are about three quarters of a circle, for the ſame purpoſe, and have nearly the ſame effect, as fig. 2. Fig. 6, repreſents two ſemi-circles reverſed, (on one axis), and their racks acting alternately, to work two pumps, one piſton riſing while the other is depreſſed; and, though only one pump raiſes the weight, or water, at once, yet both ſtrokes, being made in one revolution, will be equal to twenty-four inches, (the radius of the wheel being four inches, as in fig. 1); each turn or revolution may be made in about the ſame time as a perſon can lift and depreſs the handle of a common pump, which raiſes no more than ſeven or eight inches of water. Fig. 7, is on the ſame conſtruction as fig. 1; but, by the addition of a weight on a beam (as deſcribed in the figure), is made to lift the water with one half the power as at fig. 1, (the dimenſions being the ſame); for example, ſuppoſe the weight to be raiſed be 400lbs. if one of 200lbs. is affixed to the beam at A, it reduces the weight to be raiſed to 200lbs. there will then be 200lbs. on each ſide, and the work will be regular, whereas, in fig. 1. it is lifted only on one ſide. Again, ſuppoſe 400lbs. to be lifted by fig. 6, (which weight will be continued through the whole revolution), by a lever in proportion as ſix to one, the ſame weight may be lifted by fig. 7, by a lever proportioned as three to one, *i. e.* two feet to eight inches, by fixing 200lbs. to the beam; the power being, in this caſe, but one half as much as in the other, and the weight alſo reduced one half, the ſtroke will be twenty-four inches, as in fig. 6.

The different forms delineated in the plate, are principally to ſhow that the form may be varied according to the purpoſe requiring it, or at the option or fancy of any perſon; and they will admit of a ſtill greater variety of conſtruction, without departing from the original principle of the invention.

We come now to conſider the forms which may be given to the valves of a hydraulic engine.

The requiſites of a valve are, that it ſhall be tight, of ſufficient ſtrength to reſiſt the great preſſures to which it is expoſed, that it afford a ſufficient paſſage for the water, and that it do not allow much to go back while it is ſhutting.

We have not much to add to what has been ſaid already on this ſubject. The valves which accompany the pump of fig. 5. are called *clack valves*, and are of all the moſt obvious and common; and the conſtruction deſcribed on that occaſion is as perfect as any. We only add, that as the leather is at laſt deſtroyed at the hinge by ſuch inceſſant motion, and it is troubleſome, eſpecially in deep mines, and under water, to undo the joint of the pump in order to put in a new valve, it is frequently annexed to a box like that of a piſton, made a little conical on the outſide, ſo as to fit a conical ſeat made for it in the pipe, as repreſented in fig. 33. and it has an iron handle like that of a baſket, by which it can be laid hold of by means of a long grappling-hook let down from above. Thus it is drawn up; and being very gently tapered on the ſides, it ſticks very faſt in its place.

The only defect of this valve is, that by opening very wide when puſhed up by the ſtream of water, it allows a good deal to go back during its ſhutting again. In ſome great machines which are worked by a ſlow turning crank, the return of the piſton is ſo very ſlow, that a ſenſible loſs is incurred by this; but it is nothing like what Dr. Deſaguliers ſays, one half of a cylinder whoſe height is equal to the diameter of the valve.—For in ſuch machines, the laſt part of the upward ſtroke is equally ſlow, and the velocity of the water through the valve exceedingly ſmall, ſo that the valve is at this time almoſt ſhut.

The butterfly-valve repreſented in figures 29, &c. is free from moſt of thoſe inconveniences, and ſeems the moſt perfect of the clack valves. Some engineers make their great valves of a pyramidal form, conſiſting of four clacks, whoſe hinges are in the circumference of the water way, and which meets with their points in the middle, and are ſupported by four ribs which riſe up from the ſides, and unite in the middle. This is an excellent form, affording the moſt ſpacious water-way, and ſhutting very readily. It ſeems to be the beſt poſſible for a piſton. The rod of the piſton is branched out on four ſides, and the branches go through the piſton-box, and are faſtened below with ſcrews. Theſe branches form the ſupport for the four clacks. We have ſeen a valve of this form in a pump of ſix feet diameter, which diſcharged 20 hogſheads of water every ſtroke, and made 12 ſtrokes in a minute, raiſing the water above 22 feet.

There is another form of valve, called the *button* or *tail valve*. It conſiſts of a plate of metal AB (fig. 34.) turned conical, ſo as exactly to fit the conical cavity *a b* of its box. A tail CD projects from the under ſide, which paſſes through a croſs bar EF in the bottom of the box, and has a little knob at the end, to hinder the valve from riſing too high.

This valve, when nicely made, is unexceptionable. It has great ſtrength, and is therefore proper for all ſevere ſtrains, and it may be made perfectly tight by grinding. Accordingly it is uſed in all caſes where this is of indiſpenſable conſequence. It is moſt durable, and the only kind that will do for paſſages where ſteam or hot water is to go through. Its only imperfection is a ſmall water-way; which, from what has been ſaid, cannot exceed, nor indeed equal, one-half of the area of the pipe.

If we endeavour to enlarge the water-way, by giving the cone very little taper, the valve frequently ſticks ſo faſt in the ſeat that no force can detach them.—And this ſometimes happens during the working of the machine; and the jolts and blows given to the machine in taking it to pieces, in order to diſcover what has been the reaſon that it has diſcharged no water, frequently detaches the valve, and we find it quite looſe, and cannot tell what has deranged the pump. When this is guarded againſt, and the diminution of the water-way is not of very great conſequence, this is the beſt form of a valve.

Analogous to this is the ſimpleſt of all valves, repreſented in fig. 35. It is nothing more than a ſphere of metal A, to which is fitted a ſeat with a ſmall portion BC of a ſpherical cavity. Nothing can be more effectual than this valve; it always falls into its proper place, and in every poſition fits it exactly. Its only imperfection is the great diminution of the water-way. If the diameter of the ſphere do not conſiderably exceed that of the hole, the touching parts have very little taper, and it is very apt to ſtick faſt. It oppoſes much leſs reſiſtance to the paſſage of the water than the flat under-ſurface of the button-valve. *N. B.* It would be an improvement of that valve to give it a taper ſhape below like a boy's top. The ſpherical valve muſt not be made too light, otherwiſe it will be hurried up by the water, and much may go back while it is returning to its place.

Belidor deſcribes with great minuteneſs (vol. ii. p. 221, &c.) a valve which unites every requiſite. But it is of ſuch nice and delicate conſtruction, and its defects are ſo great when this exactneſs is not attained, or is impaired by uſe, that we think it hazardous to introduce it into a machine in a ſituation where an intelligent and accurate artiſt is not at hand. For this reaſon we have omitted the deſcription, which cannot be given in few words, nor without many figures; and deſire our curious readers to conſult that author, or peruſe Dr. Deſagulier's tranſlation of this paſſage. Its principle is preciſely the ſame with the following rude contrivance, with which we ſhall conclude the deſcriptive part of this article.

Suppoſe ABCD (fig. 36.) to be a ſquare wooden trunk. EF is a piece of oak-board, exactly fitted to the trunk in an oblique poſition, and ſupported by an iron pin which goes through it at I, one-third of its length from its lower extremity E. The two ends of this board are bevelled, ſo as to apply exactly to the ſides of the trunk. It is evident, that if a ſtream of water come in the direction BA, its preſſure on the part IF of this board will be greater than that upon EI. It will therefore force it up and ruſh through, making it ſtand almoſt parallel to the ſides of the trunk. To prevent its riſing ſo far, a pin muſt be put in its way. When this current of water changes its direction, the preſſure on the upper ſide of the board being again greateſt on the portion IF, it is forced back again to its former ſituation; and its two extremities reſting on the oppoſite ſides of the trunk, the paſſage is completely ſtopped. This board therefore performs the office of a valve; and this valve is the moſt perfect that can be, becauſe it offers the freeſt paſſage to the water, and it allows very little to get back while it is ſhutting; for the part IE brings up half as much water as IF allows to go down. It may be made extremely tight, by fixing two thin fillets H and G to the ſides of the trunk, and covering thoſe parts of the board with leather which apply to them; and in this ſtate it perfectly reſembles Belidor's fine valve.

And this conſtruction of the valve ſuggeſts, by the way, a form of an occaſional pump, which may be quickly ſet up by any common carpenter, and will be very effectual in ſmall heights. Let *abcde* (fig. 36.) be a ſquare box made to ſlide along this wooden trunk without ſhake, having two of its ſides projecting upwards, terminating like the gable-ends of a houſe. A piece of wood *e* is mortiſed into theſe two ſides, and to this the piſton-rod is fixed. This box being furniſhed with a valve ſimilar to the one below, will perform the office of a piſton. If this pump be immerſed ſo deep in the water that the piſton ſhall alſo be under water, we ſcruple not to ſay that its performance will be equal to any. The piſton may be made abundantly tight by covering its outſide neatly with ſoft leather. And as no pipe can be bored with greater accuracy than a very ordinary workman can make a ſquare trunk, we preſume that this pump will not be very deficient even for a conſiderable ſuction.

We now proceed to the laſt part of the ſubject, to conſider the motion of water in pumps, in reference to the force which muſt be employed. What we have hitherto ſaid with reſpect to the force which muſt be applied to a piſton, related only to the ſuſtaining the water at a certain height: but in actual ſervice we muſt not only do this, but we muſt diſcharge it at the place of delivery in a certain quantity; and this muſt require a force ſuperadded to what is neceſſary for its mere ſupport at this height.

This is an extremely intricate and difficult ſubject, and very imperfectly underſtood even by profeſſed engineers. The principles on which this knowledge muſt be founded are of a much more abſtruſe nature than the ordinary laws of hydroſtatics; and all the genius of Newton was employed in laying the foundation of this part of phyſical ſcience. It has been much cultivated in the courſe of this century by the firſt mathematicians of Europe. Daniel and John Bernoulli have written very elaborate treatiſes on the ſubject, under the very appoſite name of HYDRODYNAMICS; in which, although they have added little or nothing to the fundamental propoſitions eſtabliſhed in ſome ſort by Newton, and acquieſced in by them, yet they have greatly contributed to our progreſs in it by the *methods* which they have purſued in making application of thoſe fundamental propoſitions to the moſt important caſes. It muſt be acknowledged, however, that both theſe propoſitions, and the extenſions given them by theſe authors, are ſupported by a train of argument that is by no means unexceptionable; and that they proceed on aſſumptions or poſtulates which are but nearly true in any caſe, and in many are inadmiſſible: and it remains to this hour a wonder or puzzle how theſe propoſitions and their reſults correſpond with the phenomena which we obſerve.

But fortunately this correſpondence does obtain to a certain extent. And it ſeems to be this correſpondence chiefly which has given theſe authors, with Newton at their head, the conſiſtence which they place in their reſpective principles and methods: for there are conſiderable differences among them in thoſe reſpects; and each ſeems convinced that the others are in a miſtake. Meſſieurs d'Alembert and De la Grange have greatly corrected the theories of their predeceſſors, and have proceeded on poſtulates which come much nearer to the real ſtate of the caſe. But their inveſtigations involve us in ſuch an inextricable maze of analytical inveſtigation, that even when we are again conducted to the light of day by the clue which they have given us, we can make no uſe of what we there diſcovered.

But this theory, imperfect as it is, is of great ſervice. It generalizes our obſervations and experiments, and enables us to compoſe a *practical doctrine* from a heap of facts which otherwiſe muſt have remained ſolitary and unconnected, and as cumberſome in their application as the characters of the Chineſe writing.

The fundamental propoſition of this practical hydrodynamics is, that water or any fluid contained in an open veſſel of indefinite magnitude, and impelled by its weight only, will flow through a ſmall orifice with the velocity which a heavy body would acquire by falling from the horizontal ſurface of the fluid. Thus, if the orifice be 16 feet under the ſurface of the water, it will iſſue with the velocity of 32 feet in a ſecond.

Its velocity correſponding to any other depth h of the orifice under the ſurface, will be had by this eaſy proportion: "As the ſquare root of 16 is to the ſquare root of h; ſo is 32 feet to the velocity required: or, alternately, $\sqrt{16} : 32 = \sqrt{h} : v$, and $v = \frac{32\sqrt{h}}{\sqrt{16}}, = \frac{32}{4}\sqrt{h}, = 8\sqrt{h}$: that is, multiply the ſquare root of the height in feet by eight, and the product is the required velocity.

On the other hand, it frequently occurs, that we want to diſcover the depth under the ſurface which will produce a known velocity v. Therefore $\sqrt{h} = \frac{v}{8}$, and $h = \frac{v^2}{64}$: that is, divide the ſquare of the velocity by 64, and the quotient is the depth wanted in feet.

This propoſition is ſufficient for all our purpoſes. For ſince water is nearly a perfect fluid, and propagates all impreſſions undiminiſhed, we can, in place of any preſſure of a piſton or other cauſe, ſubſtitute a perpendicular column of water whoſe weight is equal to this preſſure, and will therefore produce the ſame efflux.—Thus, if the ſurface of a piſton be half a ſquare foot, and it be preſſed down with the weight of 500 pounds, and we would wiſh to know with what velocity it would cauſe the water to flow through a ſmall hole, we know that a column of water of this weight, and of half a foot baſe, would be 16 feet high. And this propoſition teaches us, that a veſſel of this depth will have a velocity of efflux equal to 32 feet in a ſecond.

If therefore our preſſing power be of ſuch a kind that it can continue to preſs forward the piſton with the force of 500 pounds, the water will flow with this velocity, whatever be the ſize of the hole. All that remains is, to determine what change of *actual preſſure* on the piſton reſults from the motion of the piſton itſelf, and to change the velocity of efflux in the ſubduplicate ratio of the change of actual preſſure.

But before we can apply this knowledge to the circumſtances which take place in the motion of water in pumps, we muſt take notice of an important modification of the fundamental propoſition, which is but very obſcurely pointed out by any good theory, but is eſtabliſhed on the moſt regular and unexceptionable obſervation.

If the efflux is made through a hole in a thin plate, and the velocity is computed as above, we ſhall diſcover the quantity of water which iſſues in a ſecond by obſerving, that it is a priſm or cylinder of the length indicated by the velocity, and having its tranſverſe ſection equal to that of the orifice. Thus, in the example already given, ſuppoſing the hole to be a ſquare inch, the ſolid contents of this priſm, or the quantity of water iſſuing in a ſecond, is 1 × 32 × 12 cubic inches, or 384 cubic inches. This we can eaſily meaſure by receiving it in a veſſel of known dimenſions. Taking this method, we uniformly find a deficiency of nearly 38 parts in 100; that is, if we ſhould obtain 100 gallons in any number of ſeconds, we ſhall in fact get only 62. This is a moſt regular fact, whether the velocities be great or ſmall, and whatever be the ſize and form of the orifice. The deficiency increaſes indeed in a very minute degree with the velocities. If, for inſtance, the depth of the orifice be one foot, the diſcharge is $\frac{6213}{10000}$; if it be 15 feet, the diſcharge is $\frac{6137}{10000}$.

This deficiency is not owing to a diminution of velocity; for the velocity may be eaſily and accurately meaſured by the diſtance to which the jet will go, if directed horizontally. This is found to correſpond very nearly with the propoſition, making a very ſmall allowance for friction at the border of the hole, and for the reſiſtance of the air. Sir Iſaac Newton aſcribed the deficiency with great juſtice to this, that the lateral columns of water ſurrounding the column which is incumbent on the orifice, preſs towards the orifice, and contribute to the expenſe equally with that column. Theſe lateral filaments, therefore iſſue obliquely, croſſing the motion of the central ſtream, and produce a contraction of the jet; and the whole ſtream does not acquire a parallel motion and its ultimate velocity till it has got to ſome diſtance from the orifice. Careful obſervation ſhowed him that this was really the caſe. But even his genius could not enable him to aſcertain the motion of the lateral filaments by theory, and he was obliged to meaſure every thing as he ſaw it. He found the diameter of the jet at the place of the greateſt contraction to be preciſely ſuch as accounted for the deficiency. His explication has been unanimouſly acquieſced in; and experiments have been multiplied to aſcertain all thoſe circumſtances which our theory cannot determine *à priori*. The moſt complete ſet of experiments are thoſe of Michelotti, made at Turin at the expenſe of the prince of Piedmont. Here jets were made of 1, 2, 3, and 4 inches diameter; and the water received into ciſterns moſt accurately formed of brick, and lined with ſtucco. It is the reſult of theſe experiments which we have taken for a meaſure of the deficiency.

We may therefore conſider the water as flowing through a hole of this contracted dimenſion, or ſubſtitute this for the real orifice in all calculations. For it is evident that if a mouth-piece (ſo to call it) were made, whoſe internal ſhape preciſely tallied with the form which the jet aſſumes; and if this mouth-piece be applied to the orifice, the water will flow out without any obſtruction. The veſſel may therefore be conſidered as really having this mouth-piece.

Nay, from this we derive a very important obſervation, "that if, inſtead of allowing the water to flow through a hole of an inch area made of a thin plate, we make it flow through a hole in a thick plank, ſo formed that the external orifice ſhall have an inch area, but be widened internally agreeably to the ſhape which nature forms, both the velocity and quantity will be that which the fundamental propoſition determines. Michelotti meaſured with great care the form of the great jets of three and four inches diameter, and found that the bounding curve was an elongated trochoid. He then made a mouth-piece of this form for his jet of one inch, and another for his jet of two inches; and he found the diſcharge to be $\frac{983}{1000}$ and $\frac{979}{1000}$; and he, with juſtice, aſcribed the trifling deficiency which ſtill remained, partly to friction and partly to his not having exactly ſuited his mouth-piece to the natural form. We imagine that this laſt circumſtance was the ſole cauſe: for, in the firſt place, the water in his experiments, before getting at his jet-holes, had to paſs along a tube of eight inches diameter. Now a jet of four inches bears too great a proportion to this pipe; and its narrowneſs undoubtedly hindered the lateral columns from contributing to the efflux in their due proportion, and therefore rendered the jet leſs convergent. And, in the next place, there can be no doubt (and the obſervations of Daniel Bernoulli confirm it) but that this convergency begins within the veſſel, and perhaps at a very conſiderable diſtance from the orifice. And we imagine, that if accurate obſervations could be made on the motion of the remote lateral particles within the veſſel, and an internal mouth piece were ſhaped according to the curve which is deſcribed by the remoteſt particle that we can obſerve, the efflux of water would almoſt perfectly tally with the theory. But indeed the coincidence is already ſufficiently near for giving us very valuable information. We learn that the quantity of water which flows through a hole, in conſequence of its own weight, or by the action of any force, may be increaſed one half by properly ſhaping the paſſage to this hole: for we ſee that it may be increaſed from 62 to near 99.

But there is another modification of the efflux, which we confeſs our total incapacity to explain. If the water iſſues through a hole made in a plate whoſe thickneſs is about twice the diameter of the hole; or, to expreſs it better, if it iſſues through a pipe whoſe length is about twice its diameter, the quantity diſcharged is nearly $\frac{82}{100}$ of what reſults from the propoſition. If the pipe be longer than this, the quantity is diminiſhed by friction. which increaſes as the length of the pipe increaſes. If the pipe be ſhorter, the water will not fill it, but detaches itſelf at the very entry of the pipe, and flows with a contracted jet. When the pipe is of this length, and the extremity is ſtopped with the finger, ſo that it begins to flow with a full mouth, no ſubſequent contraction is obſerved; but merely ſtriking on the pipe with a key or the knuckle is generally ſufficient to detach the water in an inſtant from the ſides of the pipe, and reduce the efflux to $\frac{62}{100}$.

This effect is moſt unaccountable. It certainly ariſes from the mutual adheſion or attraction between the water and the ſides of the pipe; but how this, acting at right angles to the motion, ſhould produce an increaſe from 62 to 82, nearly $\frac{1}{3}$, we cannot explain. It ſhows, however, the prodigious force of this attraction, which in the ſpace of two or three inches is able to communicate a great velocity to a very great body of water. Indeed the experiments on capillary tubes ſhow that the mutual attraction of the parts of water is ſome thouſands of times greater than their weight.

We have only further to add, that every increaſe of pipe beyond two diameters is accompanied with a diminution of the diſcharge; but in what ratio this is diminiſhed it is very difficult to determine. We ſhall only obſerve at preſent that the diminution is very great. A pipe of 2 inches diameter and 30 feet long has its diſcharge only $\frac{54}{100}$ of what it would be if only 4 inches long. If its length be 60 feet, its diſcharge will be no more than $\frac{39}{100}$. A pipe of 1 inch diameter would have a diſcharge of $\frac{44}{100}$, and $\frac{31}{100}$, in the ſame ſituation. Hence we may conclude that the diſcharge of a 4-inch pipe of 30 feet long will not exceed $\frac{2}{3}$ of what it would be if only 8 inches long. This will ſuffice for our preſent purpoſes; and the determination of the velocities and diſcharges in long conduits from pump-machines muſt be referred to the article Water-*Works*. At preſent we ſhall confine our attention to the pump itſelf, and to what will contribute to its improvement.

Before we can proceed to apply this fundamental propoſition to our purpoſe, we muſt anticipate in a looſe way a propoſition of continual uſe in the conſtruction of Water-*Works*.

Let water be ſuppoſed ſtagnant in a veſſel EFGH (fig. 37.), and let it be allowed to flow out by a cylindrical pipe HIKL, divided by any number of partitions B, C, D, &c. Whatever be the areas B, C, D, of theſe orifices, the velocity in the intermediate parts of the pipe will be the ſame; for as much paſſes through any one orifice in a ſecond as paſſes through any other in the ſame time, or through any ſection of the intervening pipe. Let this velocity in the pipe be V, and let the area of the pipe be A. The velocity in the orifices B, C, D, muſt be $\frac{VA}{B}$, $\frac{VA}{C}$, $\frac{VA}{D}$, &c. Let g be the velocity acquired in a ſecond by a heavy body. Then, by the general propoſition, the height of water in the veſſel which will produce the velocity $\frac{VA}{B}$ in the firſt orifice alone is $\frac{V^2A^2}{2gB^2}$. After this paſſage the velocity is again reduced to V in the middle of the ſpace between the firſt and ſecond orifices. In the ſecond orifice this velocity is changed to $\frac{VA}{C}$. This alone would have required a height of water $\frac{V^2A^2}{2gC^2}$ But the water is already moving with the velocity V, which would have reſulted from a height of water in the veſſel (which we ſhall, in the language of the art, call the HEAD OF WATER) equal to $\frac{V^2}{2g}$. Therefore there is only required a head of water $\frac{V^2A^2}{2gC^2} - \frac{V^2}{2g}$, or $\frac{V^2}{2g} \times \overline{\frac{A^2}{C^2} - 1}$. Therefore the whole height neceſſary for producing the efflux through both orifices, ſo as ſtill to preſerve the velocity V in the intervening pipe, is $\frac{V^2}{2g} \times \overline{\frac{A^2}{B^2} + \frac{A^2}{C^2} - 1}$. In like manner the third orifice D would alone require a head of water $\frac{V^2}{2g} \times \overline{\frac{A^2}{D^2} - 1}$; and all the three would require a head $\frac{V^2}{2g} \times \overline{\frac{A^2}{B^2} + \frac{A^2}{C^2} + \frac{A^2}{D^2} - 2}$. By this induction may eaſily be ſeen what head is neceſſary for producing the efflux through any number of orifices.

Let the expenſe or quantity of water diſcharged in an unit of time (ſuppoſe a ſecond) be expreſſed by the ſymbol Q. This is meaſured by the product of the velocity by the area of the orifice, and is therefore $= VA$; or $\frac{VA}{B} \times B$, or $\frac{VA}{C} \times C$, &c. and $V^2 = \frac{Q^2}{A^2}$. Therefore we may compute the head of water (which we ſhall expreſs by H) in reference to the quantity of water diſcharged, becauſe this is generally the intereſting circumſtance. In this view we have $H = \frac{Q^2}{2gA} \times \overline{\frac{A^2}{B^2} + \frac{A^2}{C^2} + \frac{A^2}{D^2} - 2}$: which ſhows that the head of water neceſſary for producing the diſcharge increaſes in the proportion of the ſquare of the quantity of water which is diſcharged.

Theſe things being premiſed, it is an eaſy matter to determine the motion of water in a pump, and the quantity diſcharged, reſulting from the action of any force on the piſton, or the force which muſt be applied to the piſton in order to produce any required motion or quantity diſcharged. We have only to ſuppoſe that the force employed is the preſſure of a column of water of the diameter of the working barrel: and this is over and above the force which is neceſſary for merely ſupporting the water at the height of the place of delivery. The motion of the water will be the ſame in both caſes.

Let us, firſt of all, conſider a ſucking-pump. The motion here depends on the preſſure of the air, and will be the ſame as if the pump were lying horizontally, and communicated with a reſervoir, in which is a head of water ſufficient to overcome all the obſtructions to the motion, and produce a velocity of efflux ſuch as we deſire. And here it muſt be noted that there is a limit. No velocity of the piſton can make the water riſe in the ſuction pipe with a greater velocity than what would be produced by the preſſure of a column of water 33 feet high; that is, about 46 feet per ſecond.

Let the velocity of the piſton be V, and the area of the working barrel be A. Then, if the water fills the barrel as faſt as the piſton is drawn up, the diſcharge during the riſe of the piſton, or the number of cubic feet of water per ſecond, muſt be $= V \times A$. This is always ſuppoſed, and we have already aſcertained the circumſtances which enſure this to happen. If, therefore, the water arrived with perfect freedom to the piſton, the force neceſſary for giving it this velocity, or for diſcharging the quantity V × A in a ſecond, would be equal to the weight of the pillar of water whoſe height is $\frac{V^2}{2g}$, and baſe A.

It does not appear at firſt ſight that the force neceſſary for producing this diſcharge has any thing to do with the obſtructions to the aſcent of the water into the pump, becauſe this is produced by the preſſure of the atmoſphere, and it is the action of this preſſure which is meaſured by the head of water neceſſary for producing the internal motion in the pump. But we muſt always recollect that the piſton, before bringing up any water, and ſupporting it at a certain height, was preſſed on both ſides by the atmoſphere. While the air ſupports the column below the piſton, all the preſſure expended in this ſupport is abſtracted from its preſſure on the under part of the piſton, while its upper part ſtill ſupports the whole preſſure. The atmoſphere continues to preſs on the under ſurface of the piſton, through the intermedium of the water in the ſuction-pipe, with the difference of theſe two forces. Now while the piſton is drawn up with the velocity V, more of the atmoſpheric preſſure muſt be expended in cauſing the water to follow the piſton; and it is only with the remainder of its whole preſſure that it continues to preſs on the under ſurface of the piſton. Therefore, in order that the piſton may be raiſed with the velocity V, a force muſt be applied to it, over and above the force neceſſary for merely ſupporting the column of water, equal to that part of the atmoſpheric preſſure thus employed; that is, equal to the weight of the head of water neceſſary for forcing the water up through the ſuction-pipe, and producing the velocity V in the working barrel.

Therefore let B be the area of the mouth of the ſuction-pipe, and C the area of the fixed valve, and let the ſuction-pipe be of equal diameter with the working-barrel. The head neceſſary for producing the velocity V on the working-barrel is $\frac{V^2}{2g}\left(\frac{A^2}{B^2}+\frac{A^2}{C^2}-1\right)$. If d expreſs the denſity of water; that is, if d be the number of pounds in a cubic foot of water, then $dA\frac{V^2}{2g}$ will expreſs the weight of a column whoſe baſe is A, and height $\frac{V^2}{2g}$, all being reckoned in feet. Therefore the force which muſt be applied, when eſtimated in pounds, will be $p=\frac{dAV^2}{2g}\left(\frac{A^2}{B^2}+\frac{A^2}{C^2}-1.\right)$

The firſt general obſervation to be made on what has been ſaid is, that the power which muſt be employed to produce the neceſſary motion, in oppoſition to all the obſtacles, is in the proportion of the ſquare of the velocity which we would produce, or the ſquare of the quantity of water we would diſcharge.

We have hitherto proceeded on the ſuppoſition, that there is no contraction of the jet in paſſing through theſe two orifices. This we know would be very far from the truth. We muſt therefore accommodate things to theſe circumſtances, by diminiſhing B and C in the ratio of the contraction, and calling the diminiſhed areas b and c; then we have $p=\frac{AdV^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-1\right)$.

What this diminution may be, depends on the form of the parts. If the fixed valve, and the entry into the pump, are ſimply holes in thin plates, then $b=\frac{62}{100}$ B and $c=\frac{62}{100}$ C. The entry is commonly widened or trumpet-ſhaped, which diminiſhes greatly the contraction: but there are other obſtacles in the way, ariſing from the ſtrainer uſually put round it to keep out filth. The valve may have its contraction greatly diminiſhed alſo by its box being made bell-ſhaped internally; nay, even giving it a cylindrical box, in the manner of fig. 33. is better than no box at all, as in fig. 5.; for ſuch a cylindrical box will have the unaccountable effect of the ſhort tube, and make $b=\frac{82}{100}$ B, inſtead of $\frac{62}{100}$ B. Thus we ſee that circumſtances ſeemingly very trifling may produce great effects in the performance of a pump. We ſhould have obſerved that the valve itſelf preſents an obſtacle which diminiſhes the motion, and requires an increaſe of power; and it would ſeem that in this reſpect the clack or butterfly-valve is preferable to the button valve.

Example. Suppoſe the velocity of the piſton to be 2 feet, or 24 inches per ſecond, and that the two contracted areas are each $\frac{1}{5}$ of the area of the pump, which is not much leſs than what obtains in ordinary pumps. We have $\frac{V^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-1\right)=\frac{576}{768}(25+25-1)=36{,}75$ inches, and the force which we muſt add to what will merely ſupport the column is the weight of a pillar of water incumbent on the piſton, and ſomething more than three feet high. This would be a ſenſible portion of the whole force in raiſing water to ſmall heights.

We have ſuppoſed the ſuction-pipe to be of the ſame diameter with the working barrel; but it is uſual to make it of ſmaller diameter, generally equal to the water-way of the fixed valve. This makes a conſiderable change in the force neceſſary to be applied to the piſton. Let a be the area of the ſuction-pipe, the area of the entry being ſtill B; and the equivalent entry without contraction being ſtill b, we have the velocity at the entrance $=\frac{AV}{b}$, and the producing head of water $=\frac{A^2V^2}{2gb^2}$. After this the velocity is changed to $\frac{AV}{a}$ in the ſuction-pipe, with which the water arrives at the valve, where it is again changed to $\frac{AV}{c}$, and requires for this change a head of water $=\frac{A^2V^2}{2gc^2}$. But the velocity retained in the ſuction-pipe is equivalent to the effect of a head of water $\frac{A^2V^2}{2ga^2}$. Therefore the head neceſſary for producing ſuch a current through the fixed valve, that the water may follow the piſton with the velocity V, is $\frac{A^2V^2}{2gb^2}+\frac{A^2V^2}{2gc^2}-\frac{A^2V^2}{2ga^2}$, or $=\frac{V^2}{2g}\left(\frac{A^2}{b^2}+\frac{A^2}{c^2}-\frac{A^2}{a^2}\right)$. This is evidently leſs than before, becauſe a is leſs than A, and therefore $\frac{A^2}{a^2}$ is greater than unity, which was the laſt term of the former formula. There is ſome advantage, therefore, derived from making the diameter of the ſuction-pipe leſs than that of the working-barrel: but this is only becauſe the paſſage of the fixed valve is ſmaller, and the inſpection of the formula plainly points out that the area of the ſuction-pipe ſhould be equal to that of the fixed valve. When it is larger, the water muſt be accelerated in its paſſage through the valve; which is an uſeleſs expenſe of force, becauſe this velocity is to be immediately reduced to V in the working barrel. If the foregoing example be computed with a equal to $\frac{1}{4}$ of A, we ſhall find the head H equal to 29 inches inſtead of 37.

But this advantage of a ſmaller ſuction-pipe is in all caſes very moderate; and the pump is always inferior to one of uniform dimenſions throughout, having the orifice at the fixed valve of the ſame area. And if theſe orifices are conſiderably diminiſhed in any proportion, the head neceſſary for overcoming the obſtacles, ſo that the required velocity V may ſtill be produced in the working barrel, is greatly increaſed. If we ſuppoſe the area a $\frac{1}{9}$ of A, which is frequently done in houſe pumps, where the diameter of the ſuction-pipe does ſeldom exceed $\frac{1}{3}$ of that of the working-barrel; and ſuppoſe every thing made in proportion to this, which is alſo uſual, becauſe the unſkilled pump-makers ſtudy a ſymmetry which ſatisfies the eye; we ſhall find that the pump taken as an example will require a head of water = 13 feet and upwards. Beſides, it muſt be obſerved that the friction of the ſuction-pipe itſelf has not been taken into the account. This alone is greater, in moſt caſes, than all the obſtructions we have been ſpeaking of; for if this pipe is three inches diameter, and that of the working barrel is ſix, which is reckoned a liberal allowance for a ſuction-pipe, and if the fixed valve is 25 feet above the ſurface of the pit-water; the friction of this pipe will amount to one-third of the whole propelling force.

Thus we have enabled the reader to aſcertain the force neceſſary for producing any required diſcharge of water from a pump of known dimenſions: and the converſe of this determination gives us the diſcharge which will be produced by any given force. For making $\frac{A^2}{b^2}+\frac{A^2}{c^2}-\frac{A^2}{a^2}$, (which is a known quantity, reſulting from the dimenſions of the pump) = M, we have $H=\frac{V^2}{2g}M$, and $V^2=\frac{2gH}{M}$, and $V=\sqrt{\frac{2gH}{M}}$. Now H is that part of the natural power which we have at command which exceeds what is neceſſary for merely ſupporting the column of water. Thus, if we have a pump whoſe piſton has an area of $\frac{1}{4}$ of a ſquare foot, its diameter being $6\frac{3}{4}$ inches; and we have to raiſe the water 32 feet, and can apply a power of 525 pounds to the piſton; we wiſh to know at what rate the piſton will be moved, and the quantity of water diſcharged? Merely to ſupport the column of water of this height and diameter, requires 500 pounds. Therefore the remaining power, which is to produce the motion, is 25 pounds. This is the weight of a column 1 foot 4 inches high, and H = 1,333 feet. Let us ſuppoſe the diameter of the ſuction-pipe $\frac{1}{2}$ of that of the working-barrel, ſo that $\frac{A}{B}=4$. We may ſuppoſe it executed in the beſt manner, having its lower extremity trumpet-ſhaped, formed by the revolution of the proper trochoid. The contraction at the entry may therefore be conſidered as nothing, and $\frac{A}{b}=4$, and $\frac{A^2}{b^2}=16$. We may alſo ſuppoſe the orifice of the fixed valve equal to the area of the ſuction-pipe, ſo that $\frac{A^2}{C^2}$ is alſo = 16, and there is no contraction here: and therefore $\frac{A^2}{c^2}$ is alſo 16. And laſtly, $\frac{A^2}{a^2}$ is alſo 16. Therefore $\frac{A^2}{b^2}+\frac{A^2}{c^2}-\frac{A^2}{a^2}$ or M, $= 16 + 16 - 16, = 16$. We have alſo $2g=64$. Now $V=\sqrt{\frac{2gH}{M}}$ $=\sqrt{\frac{64\times 1{,}333}{16}}, = 2{,}309$ feet, and the piſton will move with the velocity of 2 feet 4 inches nearly. Its velocity will be leſs than this, on account both of the friction of the piſton and the friction of the water in the ſuction-pipe. Theſe two circumſtances will probably reduce it to one foot eight inches; and it can hardly be leſs than this.

We have taken no notice of the friction of the water in the working-barrel, or in the ſpace above the piſton; becauſe it is in all caſes quite inſignificant. The longeſt pipes employed in our deep mines do not require more than a few inches of head to overcome it.

But there is another circumſtance which muſt not be omitted. This is the reſiſtance given to the piſton in its deſcent. The piſtons of an engine for drawing water from deep mines muſt deſcend again by their own weight in order to repeat their ſtroke. This muſt require a preponderance on that end of the working beam to which they are attached, and this muſt be overcome by the moving power during the effective ſtroke. It makes, therefore, part of the whole work to be done, and muſt be added to the weight of the column of water which muſt be raiſed.

This is very eaſily aſcertained. Let the velocity of the piſton in its deſcent be V, the area of the pump-barrel A, and the area of the piſton-valve a. It is evident, that while the piſton deſcends with the velocity V, the water which is diſplaced by the piſton in a ſecond is $(A-a)$ V. This muſt paſs through the hole of the piſton, in order to occupy the ſpace above, which is left by the piſton. If there were no contraction, the water would go through with the velocity $\frac{A-a}{a}V$; but as there will always be ſome contraction, let the diminiſhed area of the hole (to be diſcovered by experiment) be b; the velocity therefore will be $V\frac{A-a}{b}$. This requires for its production a head of water $\frac{V^2}{2g}\left(\frac{A-a}{b}\right)^2$. This is the height of a column of water whoſe baſe is not A but $A-a$. Calling the denſity of water d, we have for the weight of this column, and the force p is $d\times\overline{A-a}\times\left(\frac{A-a}{b}\right)^2\times\frac{V^2}{2g}=\frac{dV^2(A-a)^3}{2gb^2}$. This we ſee again is proportional to the ſquare of the velocity of the piſton in its deſcent, and has no relation to the height to which the water is raiſed.

If the piſton has a button valve, its ſurface is at leaſt equal to a; and therefore the preſſure is exerted on the water by the whole ſurface of the piſton. In this caſe we ſhall have $p=\frac{dV^2A^3}{2gb^2}$ conſiderably greater than before. We cannot aſcertain this value with great preciſion, becauſe it is extremely difficult, if poſſible, to determine the reſiſtance in ſo complicated a caſe. But the formula is exact, if b can be given exactly; and we know within very moderate limits what it may amount to. In a pump of the very beſt conſtruction, with a button valve, b cannot exceed one half of A; and therefore $\frac{A^3}{b^2}$ cannot be leſs than 8. In this caſe. $\frac{V^2A^3}{2gb^2}$ will be $\frac{V^2}{8}$. In a good ſteam-engine pump V is about three feet per ſecond, and $\frac{V^2}{8}$ is about $1\frac{1}{8}$ feet, which is but a ſmall matter.

We have hitherto been conſidering the ſucking pump alone: but the forcing pump is of more importance, and apparently more difficult of inveſtigation.—Here we have to overcome the obſtructions in long pipes, with many bends, contractions, and other obſtructions. But the conſideration of what relates merely to the pump is abundantly ſimple. In moſt caſes we have only to force the water into an air-veſſel, in oppoſition to the claſticity of the air compreſſed in it, and to ſend it thither with a certain velocity, regulated by the quantity of water diſcharged in a given time. The elaſticity of the air in the air-veſſel propels it along the *Main*. We are not now ſpeaking of the force neceſſary for counterbalancing this preſſure of the air in the air-veſſel, *which is equivalent to all the ſubſequent obſtructions*, but only of the force neceſſary for propelling the water out of the pump with the proper velocity.

We have in a manner determined this already. The piſton is ſolid, and the water which it forces has to paſs through a valve in the lateral pipe, and then to move in the direction of the Main. The change of direction requires an addition of force to what is neceſſary for merely impelling the water through the valve. Its quantity is not eaſily determined by any theory, and it varies according to the abruptneſs of the turn. It appears from experiment, that when a pipe is bent to a right angle, without any curvature or rounding, the velocity is diminiſhed about $\frac{1}{18}$. This would augment the head of water about $\frac{1}{9}$. This may be added to the contraction of the valve-hole. Let *c* be its natural area, and whatever is the contraction competent to its form increaſe it $\frac{1}{18}$, and call the contracted area *c*. Then this will require a head of water $= \frac{V^2 A^2}{2 g c^2}$. This muſt be added to the head $\frac{V^2}{2 g}$, neceſſary for merely giving the velocity V to the water. Therefore the whole is $\frac{V^2}{2 g}\left(\frac{A^2}{c^2} + 1\right)$; and the power *p* neceſſary for this purpoſe is $\frac{d V^2}{2 g}\left(\frac{A^2}{c^2} + 1\right)$.

It cannot eſcape the obſervation of the reader, that in all theſe formulæ, expreſſing the height of the column of water which would produce the velocity V in the working-barrel of the pump, the quantity which multiplies the conſtant factor $\frac{d A V^2}{2 g}$ depends on the contracted paſſages which are in different parts of the pump, and increaſes in the duplicate proportion of the ſum of thoſe contractions. It is therefore of the utmoſt conſequence to avoid all ſuch, and to make the Main which leads from the forcing-pump equal to the working-barrel. If it be only of half the diameter, it has but one-fourth of the area, the velocity in the Main is four times greater than that of the piſton, and the force neceſſary for diſcharging the ſame quantity of water is 16 times greater.

It is not, however, poſſible to avoid theſe contractions altogether, without making the main pipe wider than the barrel. For if only ſo wide, with an entry of the ſame ſize, the valve makes a conſiderable obſtruction. Unſkilful engineers endeavour to obviate this by making an enlargement in that part of the Main which contains the valve. This is ſeen in fig. 14. at the valve L. If this be not done with great judgment it will increaſe the obſtructions. For if this enlargement is full of water, the water muſt move in the direction of its axis with a diminiſhed velocity; and when it comes into the main, it muſt again be accelerated. In ſhort, any abrupt enlargement which is to be afterwards contracted, does as much harm as a contraction, unleſs it be ſo ſhort that the water in the axis keeps its velocity till it reaches the contraction. Nothing would do more ſervice to an artiſt, who is not well founded in the theory of hydrodynamics, than to make a few ſimple and cheap experiments with a veſſel like that of fig. 17. Let the horizontal pipe be about three inches diameter, and made in joints which can be added to each other. Let the joints be about ſix inches long, and the holes from one-fourth to a whole inch in diameter. Fill the veſſel with water, and obſerve the time of its ſinking three or four inches. Each joint ſhould have a ſmall hole in its upper ſide to let out the air; and when the water runs out by it, let it be ſtopped by a peg. He will ſee that the larger the pipe is in proportion to the orifices made in the partitions, the efflux is *more diminiſhed*. We believe that no perſon would ſuſpect this who has not conſidered the ſubject minutely.

All angular enlargements, all boxes, into which the pipes from different working-barrels, unite their water before it goes into the Main, muſt therefore be avoided by an artiſt who would execute a good machine; and the different contractions which are unavoidable at the ſeats of valves and the perforations of piſtons, &c. ſhould be diminiſhed by giving the parts a trumpet-ſhape.

In the air-veſſels repreſented in fig. 13. this is of very great conſequence. The throat O, through which the water is forced by the expanſion of the confined air, ſhould always be formed in this manner. For it is this which produces the motion during the returning part of the ſtroke in the pump conſtructed like fig. 13. No. 1. and during the whole ſtroke in No. 2. Neglecting this ſeemingly trifling circumſtance will diminiſh the performance at leaſt one-fifth. The conſtruction of No. 1. is the beſt, for it is hardly poſſible to make the paſſage of the other ſo free from the effects of contraction. The motion of the water during the returning ſtroke is very much contorted.

There is one circumſtance that we have not taken any notice of, viz. the gradual acceleration of the motion of water in pumps. When a force is applied to the piſton, it does not in an inſtant communicate all the velocity which it acquires. It acts as gravity acts on heavy bodies; and if the reſiſtances remained the ſame, it would produce, like gravity, an uniformly accelerated motion. But we have ſeen that the reſiſtances (which are always meaſured by the force which juſt overcomes them) increaſe as the ſquare of the velocity increaſes. They, therefore quickly balance the action of the moving power, and the motion becomes uniform, in a time ſo ſhort that we commit no error of any conſequence by ſuppoſing it uniform from the beginning. It would have prodigiouſly embarraſſed our inveſtigations to have introduced this circumſtance; and it is a matter of mere ſpeculative curioſity: for moſt of our moving powers are unequal in their exertions, and theſe exertions are regulated by other laws. The preſſure on a piſton moved by a crank is as variable as its velocity, and in moſt caſes is nearly in the inverſe proportion of its velocity, as any mechanician will readily diſcover. The only caſe in which we could conſider this matter with any degree of comprehenſibility is that of a ſteam-engine, or of a piſton which forces by means of a weight lying on it. In both, the velocity becomes uniform in a very ſmall fraction of a ſecond.

We have been very minute on this ſubject. For although it is the only view of a pump which is of any importance, it is hardly ever underſtood even by profeſſed engineers. And this is not peculiar to hydraulics, but is ſeen in all the branches of practical mechanics. The elementary knowledge to be met with in ſuch books as are generally peruſed by them, goes no further than to ſtate the forces which are in equilibrio by the intervention of a machine, or the proportion of the parts of a machine which will ſet two known forces in equilibrio. But when this equilibrium is deſtroyed by the ſuperiority of one of the forces, the machine muſt move; and the only intereſting queſtion is, *what will be the motion?* Till this is anſwered with ſome preciſion, we have learned nothing of any importance. Few engineers are able to anſwer this queſtion even in the ſimpleſt caſes; and they cannot, from any confident ſcience, ſay what will be the performance of an untried machine. They gueſs at it with a ſucceſs proportioned to the multiplicity of their experience and their own ſagacity. Yet this part of mechanics is as ſuſceptible of accurate computation as the caſes of equilibrium. We therefore thought it our duty to point out the manner of proceeding ſo circumſtantially, that every ſtep ſhould be plain and eaſy, and that conviction ſhould always accompany our progreſs. This we think it has been in our power to do, by the very ſimple method of ſubſtituting a column of water acting by its weight in lieu of any natural power which we may chance to employ.

To ſuch as wiſh to proſecute the ſtudy of this important part of hydraulics in its moſt abſtruſe parts, we recommend the peruſal of the diſſertations of Mr. Pitot and Mr. Boſſut, in the Memoirs of the Academy of Paris; alſo the diſſertations of the Chevalier De la Borda, 1766 and 1767; alſo the *Hydraulique* of the Chevalier De Buat. We ſhall have occaſion to conſider the motion of the water in the mains of forcing or lifting pumps which ſend the water to a diſtance, in the article WATER-*Works*; where the reader will ſee how ſmall is the performance of all hydraulic machines, in compariſon of what the uſual theories, founded on equilibrium only, would make him expect.

PUN, or PUNN, an expreſſion where a word has at once different meanings. The practice of punning is the miſerable refuge of thoſe who wiſh to paſs for wits, without having a grain of wit in their compoſition.—James I. of England delighted in punning; and the taſte of the ſovereign was ſtudied by the courtiers and even by the clergy. Hence the ſermons of that age abound with this ſpecies of falſe wit. It continued to be more or leſs faſhionable till the reign of queen Anne, when Addiſon, Swift, Pope, and Arbuthnot, with the other real wits of that claſſical age, united their efforts to baniſh punning from polite compoſition. It is ſtill admitted ſparingly in converſation; and no one will deny that a happy pun, when it comes unſought, contributes to excite mirth in a company. A profeſſed *punſter*, however, who is always pouring forth his ſenſeleſs quibbles, as Sancho Panca poured forth his proverbs, is ſuch an intolerable nuiſance in ſociety, that we do not wonder at Pope or Swift having written a pamphlet with the title of *God's Revenge againſt Punning*.

PUNCH, an inſtrument of iron or ſteel, uſed in ſeveral arts, for the piercing or ſtamping holes in plates of metals, &c. being ſo contrived as not only to perforate, but to cut out and take away the piece. The punch is a principal inſtrument of the metal button-makers, ſhoe-makers, &c.

PUNCH is alſo a name for a ſort of compound drink, much uſed here, and in many parts abroad, particularly in Jamaica, and ſeveral other parts of the Weſt Indies. Its baſis is ſpring-water; which being rendered cooler, briſker, and more acid, with lemon or lime juice, and ſweetened again to the palate with fine ſugar, makes what they call *ſherbet*; to which a proper quantity of ſpirituous liquor, as brandy, rum, or arrack, being added, the liquor commences punch.

PUNCHEON, PUNCHIN, or *Punchion*, a little block or piece of ſteel, on one end whereof is ſome figure, letter, or mark, engraven either in creux or relievo, impreſſions whereof are taken on metal, or ſome matter, by ſtriking it with a hammer on the end not engraved. There are various kinds of theſe puncheons uſed in the mechanical arts; ſuch, for inſtance, are thoſe of the goldſmiths, cutlers, pewterers, &c. The puncheon in coining, is a piece of iron ſteeled, whereon the engraver has cut in relievo the ſeveral figures, arms, effigy, inſcription, &c. that there are to be in matrices, wherewith the ſpecies are to be marked. Minters diſtinguiſh three kinds of puncheons, according to the three kinds of matrices to be made; that of the effigy, that of the croſs or arms and that of the legend or inſcription. The firſt includes the whole portrait in relievo; the ſecond are ſmall, ſuch only containing a piece of the croſs or arms; for inſtance, a fleur-de-lis, a harp, a coronet, &c. by the aſſemblage of all which the entire matrice is formed. The puncheons of the legend only contain each one letter, and ſerve equally for the legend on the effigy ſide and the croſs ſide. See the article COINAGE. For the puncheons uſed in ſtamping the matrices wherein the types of printing characters are caſt, ſee *Letter*-FOUNDERY.

PUNCHEON is alſo uſed for ſeveral iron tools, of various ſizes and figures, uſed by the engravers en creux on metals. Seal-gravers particularly uſe a great number for the ſeveral pieces of arms, &c. to be engraven, and many ſtamp the whole ſeal from a ſingle puncheon.

PUNCHEON, is alſo a common name for all thoſe iron inſtruments uſed by ſtone-cutters, ſculptors, blackſmiths, &c. for the cutting, inciding, or piercing their ſeveral matters. Thoſe of ſculptors and ſtatuaries ſerve for the repairing of ſtatues when taken out of the moulds. The lockſmiths uſe the greateſt variety of puncheons; ſome for piercing hot, others for piercing cold; ſome flat, ſome ſquare, ſome round, others oval, each to pierce holes of its reſpective figure in the ſeveral parts of locks.

PUNCHEON, in carpentry, is a piece of timber placed upright between two poſts, whoſe bearing is too great; ſerving, together with them, to ſuſtain ſome large weights. This term is alſo uſed for a piece of timber raiſed upright, under the ridge of a building, wherein the legs of a couple, &c. are jointed.

PUNCHEON, is alſo the name of a meaſure for liquids. Rum is brought from the colonies in puncheons, which are large caſks containing about 120 gallons.

PUNCTUATION, in grammar, the art of pointing, or of dividing a diſcourſe into periods, by points expreſſing the pauſes to be made therein. The points uſed are four, viz. the period, colon, ſemi-colon, and comma. See the particular uſe of each under its proper article, COMMA, COLON, PERIOD, and SEMI-COLON.

In the general, we ſhall only here obſerve, that the comma is to diſtinguiſh nouns from nouns, verbs from verbs, and ſuch other parts of a period as are not neceſſarily joined together.—The ſemi-colon ſerves to ſuſpend and ſuſtain the period when too long:—the colon, to add ſome new, ſupernumerary reaſon, or conſequence to what is already ſaid:—and the period, to cloſe the ſenſe and conſtruction, and releaſe the voice.

Punctuation is a modern art. The ancients were entirely unacquainted with the uſe of our commas, colons, &c. and wrote not only without any diſtinction of members and periods, but alſo without diſtinction of words: which cuſtom, Lipſius obſerves, continued till the hundred and fourth Olympiad; during which time the ſenſe alone divided the diſcourſe.

What within our own knowledge at this day puts this beyond diſpute, is the Alexandrian manuſcript, which is at preſent in the king's library at the Britiſh Muſæum. Whoever examines this, will find that the whole is written *continuo ductu*, without diſtinction of words or ſentences. How the ancients read their works written in this manner, it is not eaſy to conceive.

After the practice of joining words together ceaſed, notes of diſtinction were placed at the end of every word. In all the editions of the *Faſti Capitolini* theſe points occur. The ſame are to be ſeen on the *Columna Roſtrata*. For want of theſe we find much confuſion in the *Chronicon Marmoreum*, and the covenant between the Smyrnæans and Magneſians, which are both now at Oxford. In Salmaſius's edition of *Dedicatio ſtatuæ rigillæ Herodis*, the like confuſion occurs, where we find ΔΕΥΡΙΤΕ and Δευρ ιτε.

Of theſe marks of diſtinction, the Walcote inſcription found near Bath, may ſerve for a ſpecimen:

IVLIUSv VITALISv FABRI
CESISv LEGv XXv Vv V
STIPENDIORUMv &c.

After every word here except at the end of a line, we ſee this mark v. There is an inſcription in Mountfaucon, which has

PUMP.

Fig. 1.

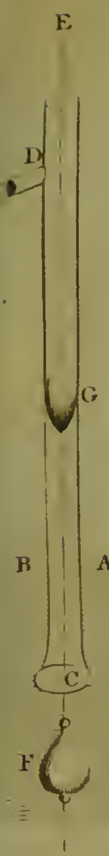


Fig. 2.

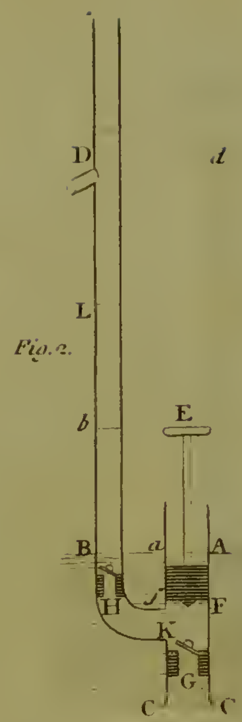


Fig. 3.

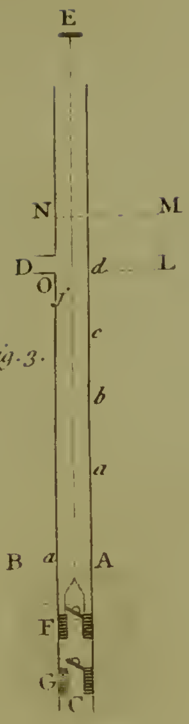
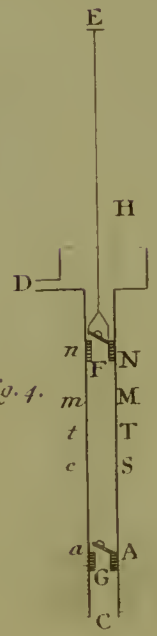


Fig. 4.



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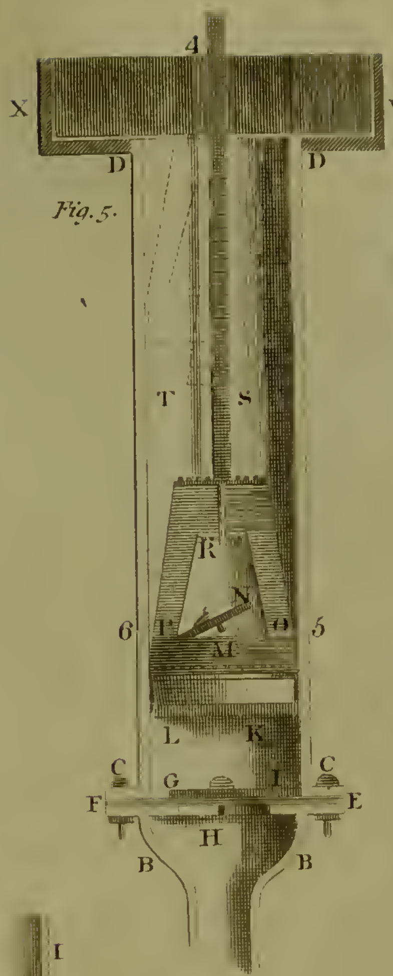

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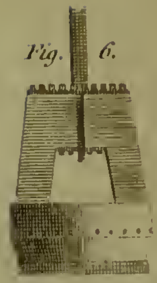

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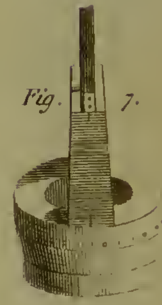

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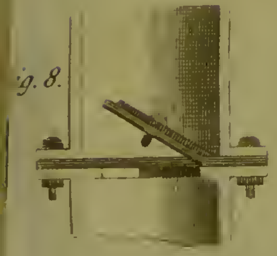

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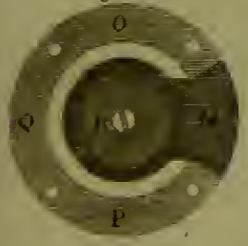

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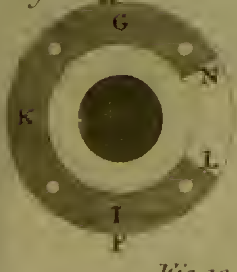

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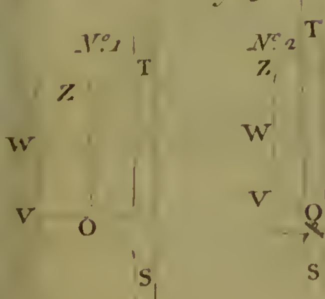


Fig. 11.

Fig. 12.

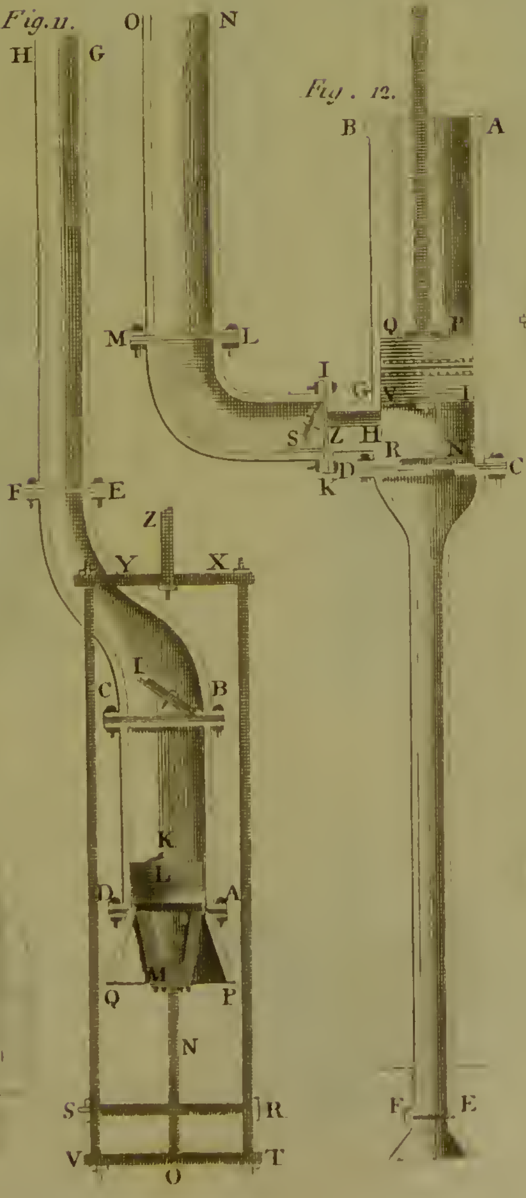
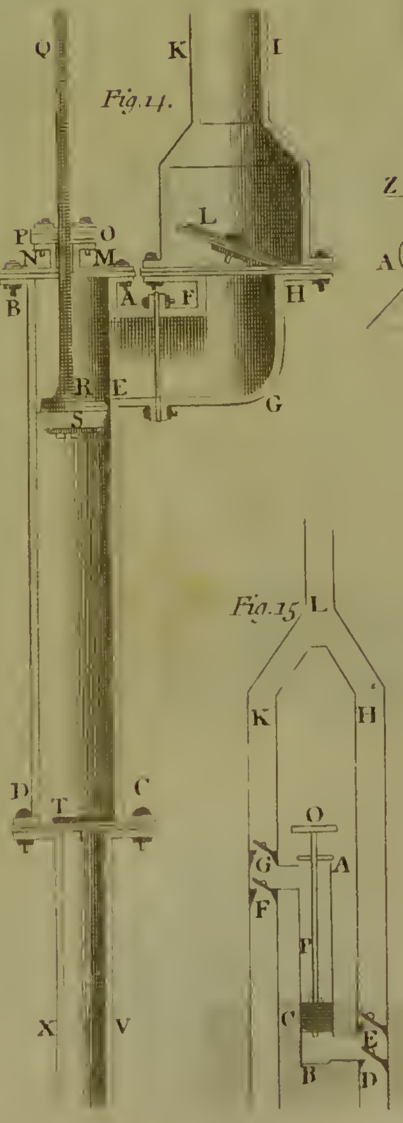
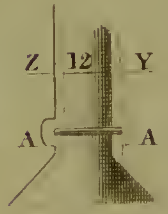


Fig. 14.

Fig. 15





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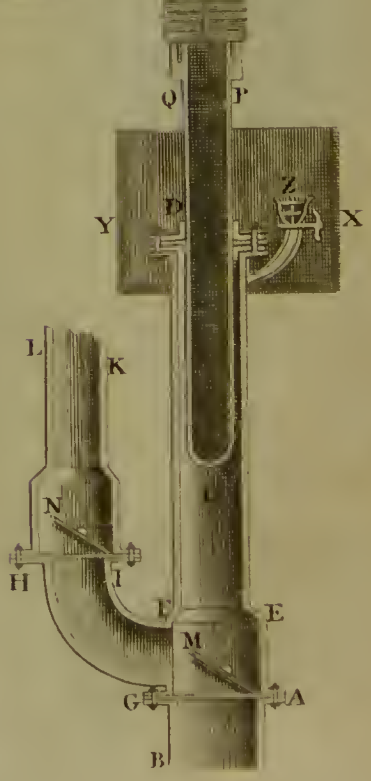
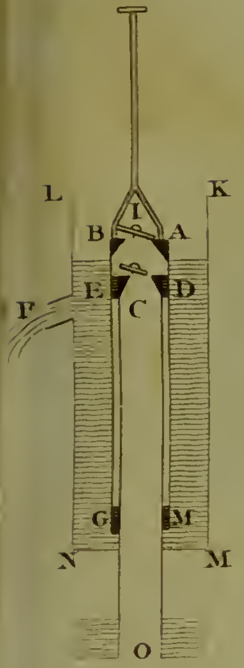


PUMP.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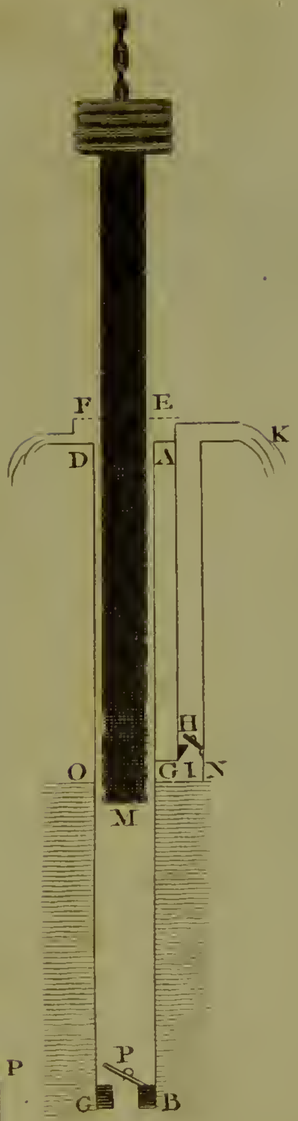
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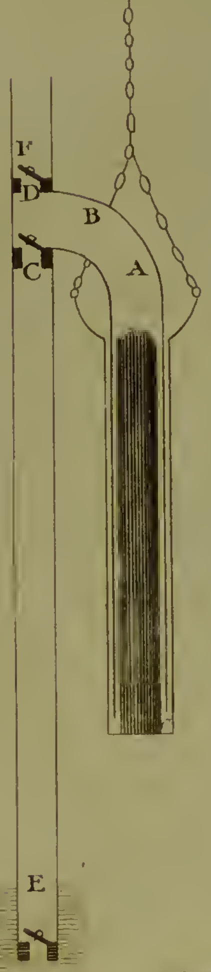
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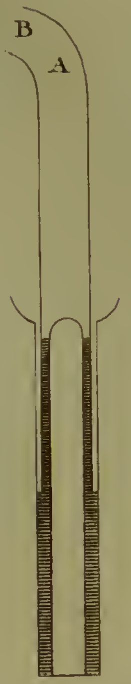
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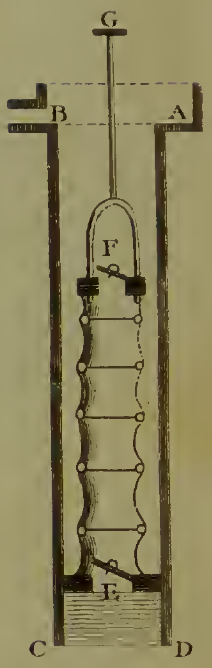
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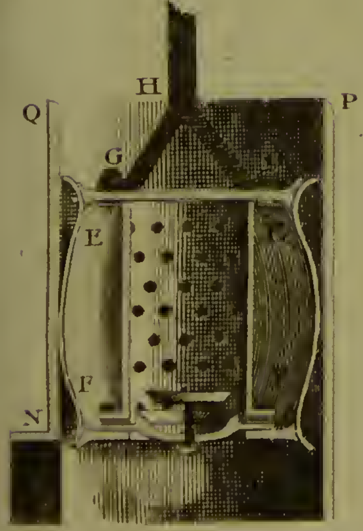
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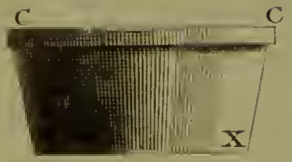
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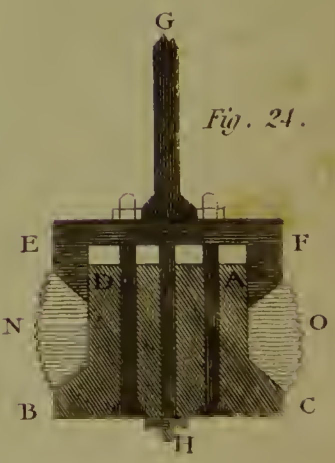
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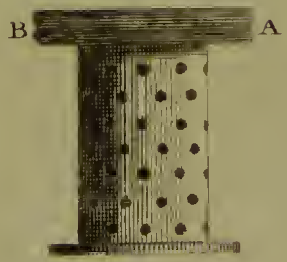
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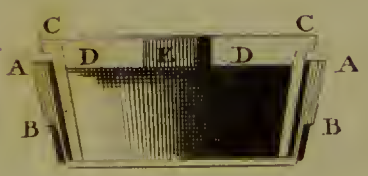
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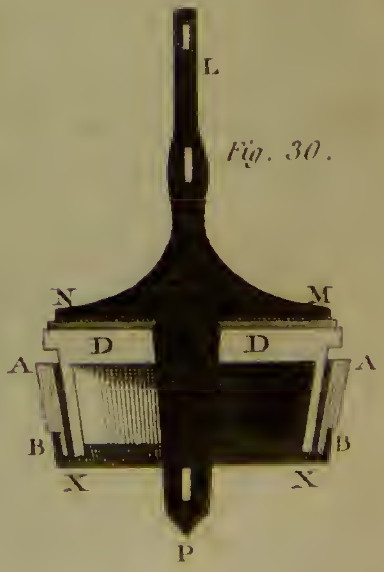
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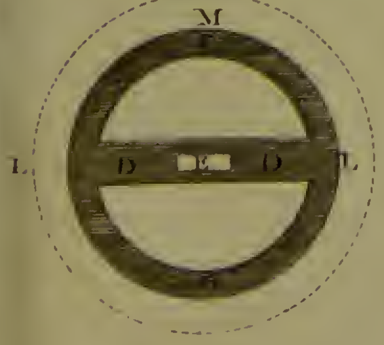
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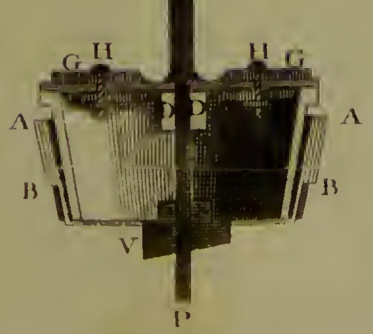
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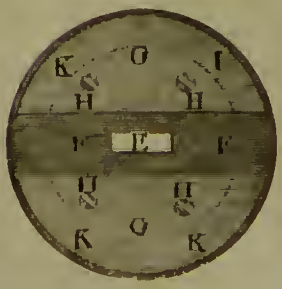
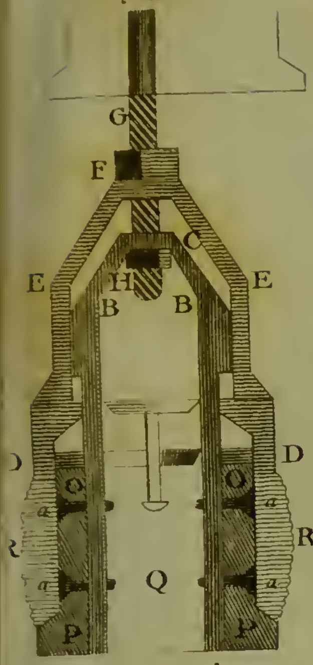


Fig. 29.

PUMP

Fig. 31.



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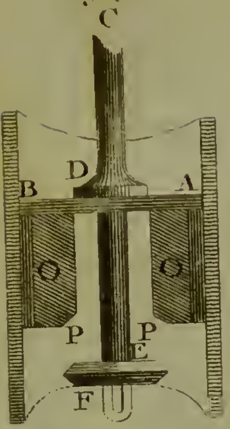

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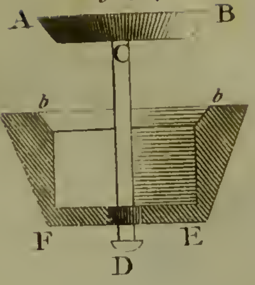

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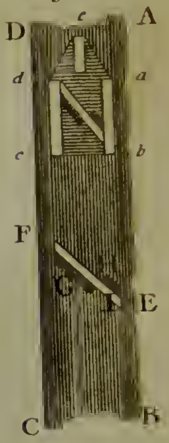

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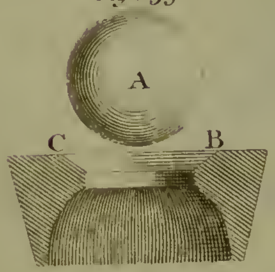

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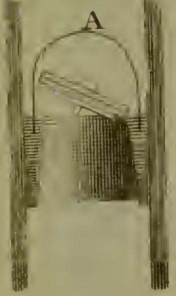

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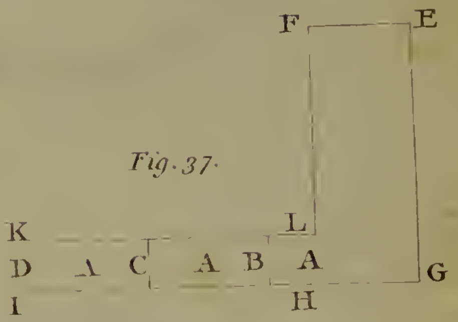

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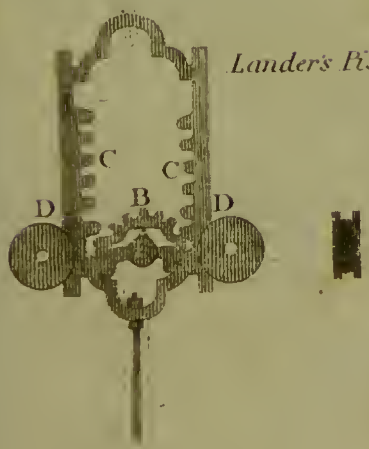


Lander's Piston Rod.

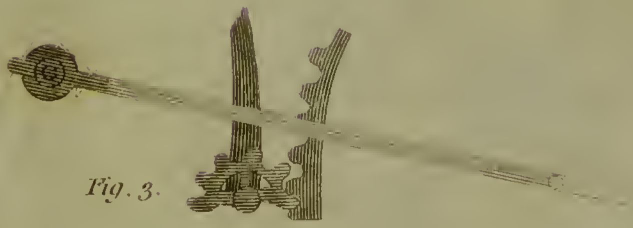
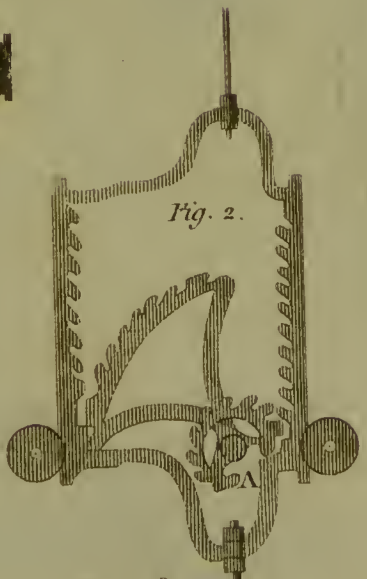


Fig. 3.



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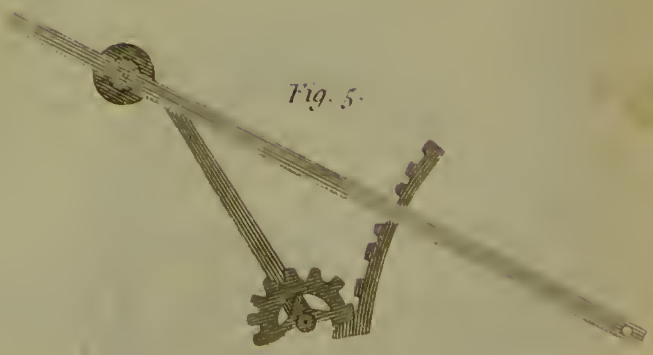

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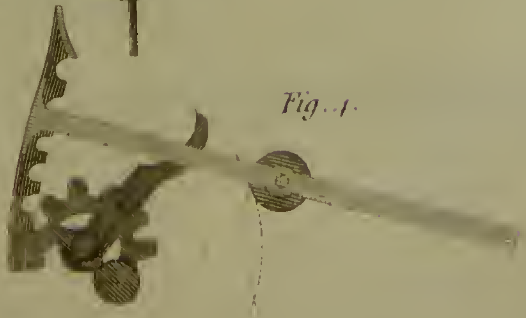
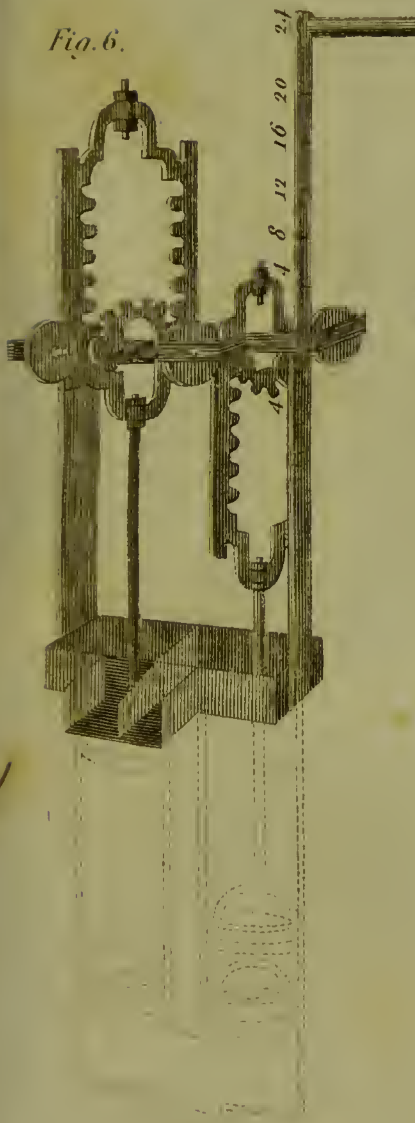


Fig. 4.

PUMP.

Landers Piston Rod.

Fig.6.



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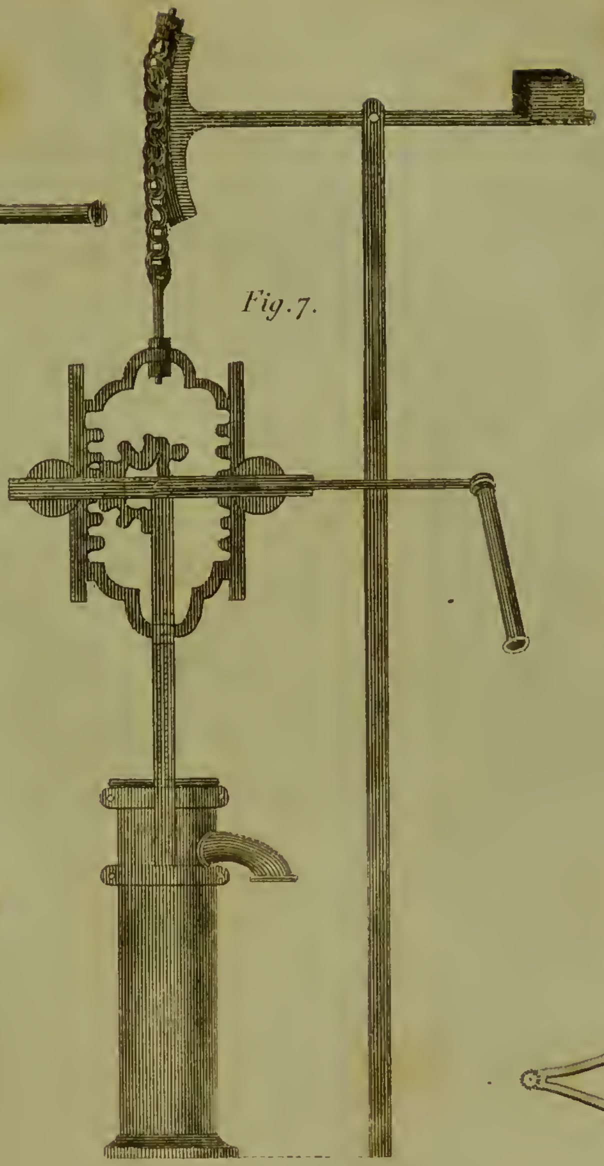


PROTRACTOR.

Fig.2.

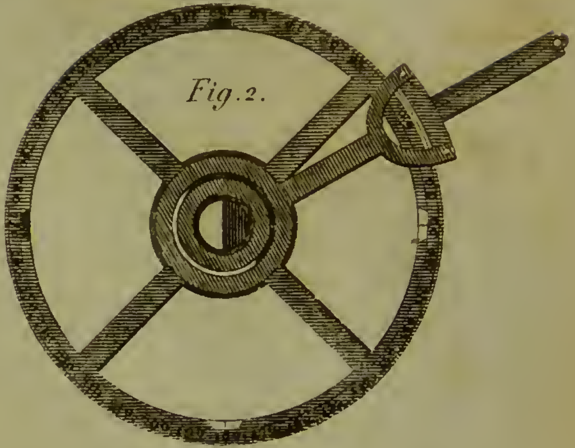


Fig.3.

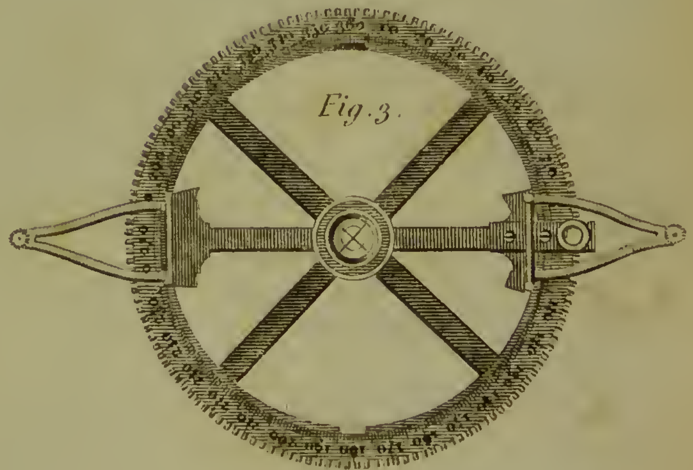
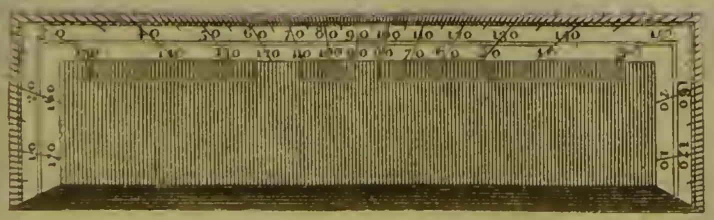


Fig.1.



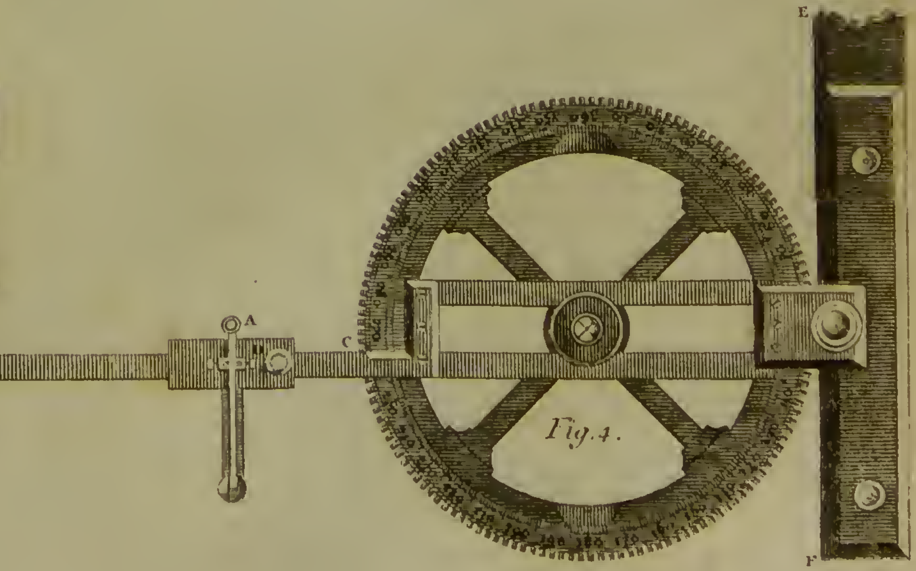


Fig.4.

a capital letter in a horizontal poſition, by way of interſtitial mark, which makes one apt to think that this way of pointing was ſometimes according to the fancy of the graver.

P. FERRARIVS HERMES
CAECINIAE ⊣ DIGNAE
CONIVGI ⊣ KARRISSIMAE
NVMERIAE ⊣ &c.

Here we obſerve after the words a T laid horizontally, but not after each word, which proves this to be of a much later age than the former.

Having now conſidered that the preſent uſage of ſtops was unknown to the ancients, we proceed to aſſign the time in which this uſeful improvement of language begun.

As it appears not to have taken place while manuſcripts and monumental inſcriptions were the only known methods to convey knowledge, we muſt conclude that it was introduced with the art of printing. The 14th century, to which we are indebted for this invention, did not, however, beſtow thoſe appendages we call *ſtops*: whoever will be at the pains to examine the firſt printed books, will diſcover no ſtops of any kind; but arbitrary marks here and there, according to the humour of the printer. In the 15th century, we obſerve their firſt appearance. We find, from the books of this age, that they were not all produced at the ſame time; thoſe we meet with there in uſe, being only the comma, the parentheſis, the interrogation, and the full point. To prove this, we need but look into Bale's Acts of Engliſh Votaries, black-letter, printed 1550. Indeed, in the dedication of this book, which is to Edward VI. we diſcover a colon: but, as this is the only one of the kind throughout the work, it is plain this ſtop was not eſtabliſhed at this time, and ſo warily put in by the printer; or if it was, that it was not in common uſe. Thirty years after this time, in that ſenſible and judicious performance of Sir Thomas Elyot, entitled *The Governour*, imprinted 1580, we ſee the colon as frequently introduced as any other ſtop; but the ſemi-colon and the admiration were ſtill wanting, neither of theſe being viſible in this book. In Hackluyt's voyages, printed 1599, we ſee the firſt inſtance of a ſemi-colon: and, as if the editors did not fully apprehend the propriety of its general admiſſion, it is but ſparingly introduced. The admiration was the laſt ſtop that was invented; and ſeems to have been added to the reſt in a period not ſo far diſtant from our own time.

Thus we ſee, that theſe notes of diſtinction came into uſe as learning gradually advanced and improved; one invention indeed, but enlarged by ſeveral additions.

PUNCTUM SALIENS, in anatomy, the firſt rudiments of the heart in the formation of the fœtus, where a throbbing motion is perceived. This is ſaid to be eaſily obſerved with a microſcope in a brood-egg, wherein, after conception, we ſee a little ſpeck or cloud, in the middle whereof is a ſpot that appears to beat or leap a conſiderable time before the fœtus is formed for hatching. See the article FOETUS.

PUNCTUM *ſtans*, a phraſe by which the ſchoolmen vainly attempted to bring within the reach of human comprehenſion the poſitive eternity of God. Thoſe ſubtile reaſoners ſeem to have diſcovered that nothing which is made up of parts whether continuous or diſcrete, can be abſolutely infinite, and that therefore eternity cannot conſiſt of a boundleſs ſeries of ſucceſſive moments. Yet as if ſuch a ſeries had always exiſted and were commenſurate in duration with the ſupreme Being, they compared his eternity to one of the moments which compoſe the flux of time arreſted in its courſe; and to this eternal moment they gave the name of *punctum ſtans*, becauſe it was ſuppoſed to ſtand ſtill, whilſt the reſt followed each other in ſucceſſion, all vaniſhing as ſoon as they appeared. We need not waſte time or room in expoſing the abſurdity of this conceit, as we have elſewhere endeavoured, in the beſt manner that we can, to aſcertain the meaning of the words *eternity* and *infinity*, and to ſhow that they cannot be predicated of time or ſpace, of points or moments, whether flowing or ſtanding ſtill. See METAPHYSICS.

PUNCTURE, in ſurgery, any wound made by a ſharp-pointed inſtrument.

PUNCTURE, in farriery. See FARRIERY.

PUNDITS, or PENDITS, learned Bramins devoted to the ſtudy of the Shanſcrit language, and to the ancient ſcience, laws, and religion of Hindoſtan. See PHILOSOPHY.

PUNICA, the POMEGRANATE TREE: A genus of the monogynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 39th order, *Pomaceæ*. The calyx is quinqueſid ſuperior; there are five petals; the fruit is a multilocular and polyſpermous apple.

The *Species* are, 1. The *granatum*, or common pomegranate, riſes with a tree ſtem, branching numerouſly all the way from the bottom, growing 18 or 20 feet high; with ſpear-ſhaped, narrow oppoſite leaves; and the branches terminated by moſt beautiful large red flowers, ſucceeded by large roundiſh fruit as big as an orange, having a hard rind filled with ſoft pulp and numerous ſeeds. There is a variety with double flowers, remarkably beautiful; and one with ſtriped flowers. 2. The *nana*, or dwarf American pomegranate, riſes with a ſhrubby ſtem branching four or five feet high, with narrow ſhort leaves and ſmall red flowers, ſucceeded by ſmall fruit; begins flowering in June, and continues till October. Both theſe ſpecies are propagated by layers: the young branches are to be choſen for this purpoſe, and autumn is the proper time for laying them. Thoſe of the common ſort may be trained either as half or full ſtandards, or as dwarfs. But thoſe deſigned for walls muſt be managed as directed for peaches.

The dried flowers of the double-flowered pomegranate are poſſeſſed of an aſtringent quality; for which reaſon they are recommended in diarrhœas, dyſenteries, &c. where aſtringent medicines are proper. The rind of the fruit is alſo a ſtrong aſtringent, and as ſuch is occaſionally made uſe of.

PUNISHMENT, in law, the penalty which a perſon incurs on the commiſſion of a crime. See the article CRIME *and Puniſhment*. The ingenuity of men has been much exerted to torment each other; but the following are the puniſhments that have been uſually adopted in the different countries of the world. The capital puniſhments have been beheading, crucifixion, burning, roaſting, drowning, ſcalping, hanging by the neck, the arm, or the leg, ſtarving, ſawing, expoſing to wild beaſts, rending aſunder by horſes drawing oppoſite ways, burying alive, ſhooting, blowing from the mouth of a cannon, compulſory deprivation of ſleep, rolling in a barrel ſtuck with nails pointed inwards, poiſoning, preſſing ſlowly to death by a weight laid on the breaſt, caſting headlong from a rock, tearing out the bowels, pulling to pieces with red-hot pincers, the rack, the wheel, impaling, ſlaying alive, &c. &c. The puniſhments ſhort of death have been, fine, pillory, impriſonment, compulſory labour at the mines, galleys, highways, or correction-houſe; whipping, baſtonading, mutilation by cutting away the ears, the noſe, the tongue, the breaſts of women, the foot, the hand; ſqueezing the marrow from the bones with ſcrews or wedges, caſtration, putting out the eyes, baniſhment, running the gauntlet, drumming, ſhaving off the hair, burning on the hand or forehead, &c.

PUNNING. See PUN.

PUPIL, in the civil law, a boy or girl not yet arrived at the age of puperty; i. e. the boy under 14 years, the girl under 12.

PUPIL is alſo uſed in univerſities, &c. for a youth under the education or diſcipline of any perſon.

PUPIL, in anatomy, a little aperture in the middle of the uvea and iris of the eye, through which the rays of light paſs to the cryſtalline humour, in order to be painted on the retina, and cauſe viſion. See Anatomy.

PURCELL (Henry), a juſtly celebrated maſter of muſic, began early to diſtinguiſh himſelf. As his genius was original, it wanted but little forming, and he roſe to the height of his profeſſion with more eaſe than others paſs through their rudiments. He was made organiſt to Weſtminſter abbey in the latter end of the reign of Charles II. In that of William, he ſet ſeveral ſongs for Dryden's *Amphytrion*, and his *King Arthur*, which were received with juſt applauſe. His notes in his operas were admirably adapted to his words, and ſo echoed to the ſenſe, that the ſounds alone ſeemed capable of exciting thoſe paſſions which they had never failed to do in conjunction. His muſic was very different from the Italian. It was entirely Engliſh, and perfectly maſculine. His principal works have been publiſhed under the title of *Orpheus Britannicus*. He died in 1695, in the 37th year of his age; and was interred in Weſtminſter abbey, where a monument is erected to his memory.

PURCHAS (Samuel), an Engliſh divine, famous for compiling a valuable collection of voyages, was born in 1577, at Thackſted in Eſſex. After ſtudying at Cambridge, he obtained the vicarage of Eaſtwood in his native county; but leaving that cure to his brother, he ſettled in London, in order to carry on the great work in which he was engaged. He publiſhed the firſt volume in folio in 1613, and the four laſt, 12 years after, under the title of *Purchas his Pilgrimage, or Relations of the world, and the Religions obſerved in all ages and places.* Meanwhile he was collated to the rectory of St. Martin's, Ludgate, in London, and made chaplain to Dr. Abbot, archbiſhop of Canterbury. His *Pilgrimage*, and the learned Hackluyt's *Voyages*, led the way to all the other collections of that kind, and have been juſtly valued and eſteemed. But unhappily, by his publiſhing, he involved himſelf in debt: however, he did not die in priſon, as ſome have aſſerted; but at his own houſe, about the year 1628.

PURCHASE, in law, the buying or acquiring of lands, &c. with money, by deed or agreement, and not by deſcent or right of inheritance.

Purchase, in the ſea-language, is the ſame as *draw in*: thus, when they ſay the capſtan purchaſes a-pace, they only mean, it draws in the cable a-pace.

PURE, ſomething free from any admixture of foreign or heterogeneous matters.

PURFLEW, a term in heraldry, expreſſing ermins, peans, or any of the furs, when they compoſe a bordure round a coat of arms: thus they ſay, He beareth gules, a bordure, purflew, vairy; meaning that the bordure is vairy.

PURGATION, the art of purging, ſcouring, or purifying a thing, by ſeparating, or carrying off any impurities found therein. Thus, in *pharmacy*, purgation is the cleanſing of a medicine by retrenching its ſuperfluities. In chemiſtry, it is uſed for the ſeveral preparations of metals and minerals intended to clear them of their impurities, more uſually called *purification* and *refining*. See Refining. In *medicine*, purgation is an excretory motion ariſing from a quick and orderly contraction of the fleſhy fibres of the ſtomach and inteſtines, whereby the chyle, corrupted humours, and excrements lodged therein, are protruded further and further, and at length quite excluded the body by ſtool. See Materia Medica. For the menſtrual purgation of women, ſee Menses.

Purgation, in law, ſignifies the clearing a perſon's ſelf of a crime of which he is ſuſpected and accuſed before a judge. This purgation is either canonical or vulgar. Canonical purgation is preſcribed by the canon-law, and the form thereof in the ſpiritual court is uſually thus: The perſon ſuſpected takes his oath that he is innocent of the crime charged againſt him; and at the ſame time brings ſome of his neighbours to make oath that they believe he ſwears truly. Vulgar purgation was anciently by fire or water, or elſe by combat, and was practiſed here till aboliſhed by our canons. See Battel *in law*, Ordeal, &c.

PURGATIVE or Purging *Medicines*, medicaments which evacuate the impurities of the body by ſtool, called alſo *cathartics*.

PURGATORY, a place in which the juſt, who depart out of this life, are ſuppoſed to expiate certain offences which do not merit eternal damnation. Broughton has endeavoured to prove that this notion has been held by Pagans, Jews, and Mahometans, as well as by Chriſtians; and that in the days of the Maccabees the Jews believed that ſin might be expiated by ſacrifice after the death of the ſinner, cannot be queſtioned.

Much abuſe has been poured upon the church of Rome for her doctrine of purgatory, and many falſe repreſentations have been made of the doctrine itſelf. The following view of it is taken from a work which is conſidered as a ſtandard by the Britiſh Catholics. 1. Every ſin, how ſlight ſoever, though no more than an idle word, as it is an offence to God, deſerves puniſhment from him, and will be puniſhed by him hereafter, if not cancelled by repentance here. 2. Such ſmall ſins do not deſerve eternal puniſhment. 3. Few depart this life ſo pure as to be totally exempt from ſpots of this nature, and from every kind of debt due to God's juſtice. 4. Therefore few will eſcape without ſuffering ſomething from his juſtice for ſuch debts as they have carried with them out of this world; according to that rule of divine juſtice, by which he treats every ſoul hereafter according to its works, and according to the ſtate in which he finds it in death. From theſe propoſitions, which the Papiſt conſiders as ſo many ſelf-evident truths, he infers that there muſt be ſome third place of puniſhment; for, ſince the infinite goodneſs of God can admit nothing into heaven which is not clean and pure from all ſin both great and ſmall; and his infinite juſtice can permit none to receive the reward of bliſs, who as yet are not out of debt, but have ſomething in juſtice to ſuffer; there muſt of neceſſity be ſome place or ſtate, where ſouls, departing this life, pardoned as to the eternal guilt or pain, yet obnoxious to ſome temporal penalty, or with the guilt of ſome venial faults, are purged and purified before their admittance into heaven. And this is what he is taught concerning purgatory. Which, though he knows not where it is, of what nature the pains are, or how long each ſoul is detained there; yet he believes, that thoſe that are in this place, being the living members of Jeſus Chriſt, are relieved by the prayers of their fellow members here on earth, as alſo by alms and maſſes offered up to God for their ſouls. And as for ſuch as have no relations or friends to pray for them, or give alms, or procure maſſes for their relief; they are not neglected by the church, which makes a general commemoration of all the faithful departed in every maſs, and in every one of the canonical hours of the divine office.

Such is the Popiſh doctrine of purgatory, which is built chiefly upon 2 Macc. xii. 43, 44, 45; St. Matth. xii. 31, 32; and 1 Cor. iii. 15. By Proteſtants the books of Maccabees are not acknowledged to be inſpired ſcripture; but if they were, the texts referred to would rather prove that there is no ſuch place as purgatory, ſince Judas did not expect the ſouls departed to reap any benefit from his ſin-offering till the reſurrection. Our Saviour, in St. Luke, ſpeaks of remiſſion in *this world* and in the world to *come*; but ſurely neither of theſe is purgatory. The world to come is the ſtate after the reſurrection, and the remiſſion ſpoken of is the ſentence of abſolution to be pronounced on the penitent from the ſeat of general judgment. In the obſcure verſe referred to in the epiſtle to the Corinthians, the apoſtle is, by the beſt interpreters, thought to ſpeak of the difficulty with which Chriſtians ſhould be ſaved from the deſtruction of Jeruſalem. Of the ſtate of ſouls departed he cannot well be ſuppoſed to ſpeak, as upon diſembodied ſpirits fire could make no impreſſion. We cannot help. therefore, thinking with the church of England, that "the Romiſh doctrine of purgatory is a fond thing vainly invented, and grounded on no warranty of ſcripture;" but we muſt confeſs, at the ſame time, that it appears to us to be a very harmleſs error, neither hoſtile to virtue nor dangerous to ſociety. See RESURRECTION.

PURIFICATION, in matters of religion, a ceremony which conſiſts in cleanſing any thing from a ſuppoſed pollution or defilement. The Pagans, before they ſacrificed, uſually bathed or waſhed themſelves in water; and they were particularly careful to waſh their hands, becauſe with theſe they were to touch the victims conſecrated to the gods. It was alſo cuſtomary to waſh the veſſel with which they made their libations. The Mahometans alſo uſe purifications previous to the duty of prayer; which are alſo of two kinds, either bathing, or only waſhing the face, hands, and feet. The firſt is required only in extraordinary caſes, as after having lain with a woman, touched a dead body, &c. But leſt ſo neceſſary a preparation for their devotions ſhould be omitted, either where water cannot be had, or when it may be of prejudice to a perſon's health, they are allowed in ſuch caſes to make uſe of fine ſand, or duſt, inſtead of it; and then they perform this duty by clapping their open hands on the ſand, and paſſing them over the parts, in the ſame manner as if they were dipped in water. There were alſo many legal purifications among the Hebrews. When a woman was brought to bed of a male child, ſhe was eſteemed impure for 40 days; and when of a female, for 60; at the end of which time ſhe carried a lamb to the door of the temple to be offered for a burnt-offering, and a young pigeon or turtle for a ſin-offering; and by this ceremony ſhe was cleanſed or purified.

PURIM, or *The* FEAST *of* LOTS, a ſolemn feſtival of the Jews, inſtituted in memory of the deliverance they received by means of Mordecai and Eſther, from Haman's wicked attempt to deſtroy them.

PURITANS, a name formerly given in deriſion to the diſſenters from the church of England, on account of the profeſſion to follow the pure word of God, in oppoſition to all traditions and human conſtitutions. It was likewiſe given in the primitive church to the Novatian ſchiſmatics, becauſe they would never admit to communion any one who from dread of death had apoſtatized from the faith.

PURITY, the freedom of any thing from foreign admixture.

PURITY *of Style*. See ORATORY.

PURLIEU, ſignifies all that ground near any foreſt, which being made foreſt by King Henry II. Richard I. and King John, was afterwards by perambulations and grants of Henry III. ſevered again from the ſame, and made purlieu; that is to ſay, pure and free from the laws of the foreſt.—The word is derived from the French *pur* "pure," and *lieu* "place."

PURLINS, in building, thoſe pieces of timber that lie acroſs the rafters on the inſide to keep them from ſinking in the middle of their length. By the act of parliament for rebuilding London, it is provided, that all purlins from 15 feet 6 inches to 18 feet 6 inches long, be in their ſquare 9 inches and 8 inches; and all in length from 18 feet 6 inches to 21 feet 6 inches, be in their ſquare 12 inches and 9 inches.

PURPLE, a colour compoſed of a mixture of red and blue. See COLOUR-*Making* and DYING.

PURPURA, in natural hiſtory. See MUREX: where we have given an account of the Tyrian method of dying purple with a liquid extracted from the fiſh. It has been affirmed, however, that no ſuch method was ever practiſed. "At Tyre (ſays Mr. Bruce) I engaged two fiſhermen, at the expenſe of their nets, to drag in thoſe places where they ſaid ſhell-fiſh might be caught, in hopes to have brought out one of the famous purple-fiſh. I did not ſucceed: but in this I was, I believe, as lucky as the old fiſhers had ever been. The purple fiſh at Tyre ſeems to have been only a concealment of their knowledge of cochineal; as, had they depended upon the fiſh for their dye, if the whole city of Tyre applied to nothing elſe but fiſhing, they would not have coloured 20 yards of cloth in a year."

PURPURE, in heraldry. The colour ſo called, which ſignifies *purple*, is in engraving repreſented by diagonal lines, from the left to the right. See HERALDRY.

PURPUREUS. See CONVOLVULUS,

PURRE, or PERKIN. See CYDERKIN.

PURSER, an officer aboard a man of war, who receives her victuals from the victualler, ſees that it be well ſtowed, and keeps an account of what he every day delivers to the ſteward. He alſo keeps a liſt of the ſhip's company, and ſets down exactly the day of each man's admiſſion, in order to regulate the quantity of proviſions to be delivered out, and that the paymaſter or treaſurer of the navy may iſſue out the debursements, and pay off the men, according to his book.

PURSLAIN, in botany. See PORTULACA.

PURVIEW, a term uſed by ſome lawyers for the body of an act of parliament, or that part which begins with "Be it enacted &c." as contradiſtinguiſhed from the preamble.

PURULENT, in medicine, ſomething mixed with or partaking of, pus or matter.

PUS, in medicine, a white or yellowiſh matter deſigned by nature for the healing and cementing of wounds and ſores.

The origin and formation of pus is as much unknown as that of any other animal fluid. In an inaugural diſſertation publiſhed at Edinburgh by Dr. Hendy, the author ſuppoſes pus to be a ſecreted fluid. It has been thought by many, that pus is either a ſediment from ſerum when beginning to putrefy, or that it is the ſame fluid inſpiſſated by the heat of the body. But both of theſe opinions are refuted by ſome experiments of our author, which ſhow, that pus is much leſs inclined to putrefaction than ſerum, and the putrefaction of both is haſtened by an addition of ſome of the red part of the blood. Some other experiments were made in order to try whether pus could be artificially produced. A thin piece of lamb's fleſh, applied to an ulcer diſcharging laudable pus, and covered over with lead, did not aſſume the appearance of pus, but became fetid, and was much leſſened. Serum, in its inflammatory and in its ordinary ſtate, and lymph in different ſtates, were applied to the ſame ulcer, which ſtill diſcharged good pus; but none of theſe were converted into pus; on the contrary, they became very putrid.

In oppoſition to theſe arguments of our author, however, it may be alleged, that if pus were a ſecreted fluid, the veſſels by which it was ſecreted would certainly be viſible; but no ſuch thing has ever been obſerved: on the contrary, it is certain that pus cannot be formed unleſs the air be excluded from the wound. Theſe diſputes, however, are of no great conſequence: but in ſome caſes it becomes a matter of real importance to diſtinguiſh pus from mucus; as thus we may be enabled to know whether a cough is conſumptive, or merely catarrhous. See MUCUS. Mr. Home in a diſſertation on the properties of pus, in which he avails himſelf of the experiments of Mr. Hunter, as delivered in his *Phyſiological Lectures*, ſays, "that the characteriſtic of pus is its being compoſed of globules; and he thinks that the preſence of globules ſeems to depend upon the pus being in a perfect ſtate. It differs from the blood in the colour of the globules: in their not being ſoluble in water, which thoſe of the blood are; and from the fluid in which they ſwim being coagulable by a ſolution of ſal ammoniac, which ſerum is not." Reſpecting the formation of pus, our author adopts the idea ſuggeſted by Mr. Hunter, that the veſſels of the part aſſume the nature of a gland, and ſecrete a fluid which becomes pus. Mr. Home aſcertains, by experiment, that pus, at its formation, is not globular, but a tranſparent fluid, of a conſiſtence, in ſome ſort, reſembling jelly; and that the globules are formed while lying upon the ſurface of the ſore: requiring, in ſome inſtances, while the influence of the external air is excluded, fifteen minutes for that purpoſe.

PUSTULE, a pimple, or ſmall eruption on the ſkin full of pus: ſuch as the eruptions of the ſmall-pox.

PUTAMINEÆ, (from *putamen* "a ſhell,") the name of the 25th order of Linnæus's fragments of a natural method; conſiſting of a few genera of plants allied in habit, whoſe fleſhy ſeed-veſſels or fruit are frequently covered with a hard woody ſhell. See Botany, p. 462.

PUTEOLI, (Livy, Strabo): a town of Campania; ſo called either from its wells, there being many hot and cold ſprings thereabouts; or from its ſtench, *putor*, cauſed by ſulphureous exhalations (Varro, Strabo). It is now called *Puzzuoli*, and is pleaſantly and advantageouſly ſituated for trade. In a very remote age, the Cumeans made it their arſenal and dockyard; and to this naval eſtabliſhment gave the ſublime appellation of *Dicæarchia* or *Juſt Power*.

The Romans were well aware of the utility of this port, and took great pains to improve its natural advantages. Nothing remains of their works but a line of piers, built to break the force of a rolling ſea: they are vulgarly called the *bridge of Caligula*, becauſe that madman is ſaid to have marched in triumph from Puzzuoli to Baia on a bridge; but his was a bridge of boats.

The ruins of its ancient edifices are widely ſpread along the adjacent hills and ſhores. An amphitheatre ſtill exiſts entire in moſt of its parts, and the temple of Serapis offers many curious ſubjects of obſervation; half of its buildings are ſtill buried under the earth thrown upon it by volcanical commotions, or accumulated by the crumblings of the hill; the incloſure is ſquare, environed with buildings for prieſts and baths for votaries; in the centre remains a circular platform, with four flights of ſteps up to it, vaſes for fire, a centrical altar, rings for victims, and other appendages of ſacrifice, entire and not diſplaced; but the columns that held its roof have been removed to the new palace of Caſerta (ſee Caserta). Behind this round place of worſhip ſtand three pillars without capitals, part of the pronaos of a large temple; they are of cipolline marble, and at the middle of their height are full of holes eaten in them by the file-fiſh.

The preſent city contains near 10,000 inhabitants, and occupies a ſmall peninſula; the cathedral was a pagan temple, dedicated to the divinities that preſided over commerce and navigation. E. lon. 14. 40. N. lat. 41. 15.

In the neighbourhood of Puteoli are many relics of ancient grandeur, of which none deſerves more attention than the Campanian way paved with lava, and lined on each ſide with venerable towers, the repoſitories of the dead, which are richly adorned with ſtucco in the inſide. This road was made in a moſt ſolid expenſive manner by order of Domitian, and is frequently the ſubject of encomium in the poems of Statius.

PUTI caraja, in botany, is a genus of Indian plants, of which the characters, as given by Sir William Jones in the Aſiatic Reſearches, vol. ii. p. 351. are theſe: The calyx is five-cleft, the corolla has five equal petals, the pericarpium a thorny legumen and two ſeeds, the leaves oval and pinnated, and the ſtem armed. "The ſeeds (ſays the learned preſident) are very bitter, and perhaps tonic; ſince one of them, bruiſed and given in two dozes, will, as the Hindoos aſſert, cure an intermittent fever."

PUTORIUS, in zoology. See Mustela.

PUTREFACTION, one of the natural proceſſes, directly oppoſite to the life of animals and vegetables, by which organized bodies are diſſolved, and reduced to what may be called their *original elements*.

Putrefaction differs from chemical ſolution; becauſe, in the latter, the diſſolved bodies are kept in their ſtate of ſolution by being combined with a certain agent from which they cannot eaſily be ſeparated; but in putrefaction, the agent which diſſolves the body appears not to combine with it in any manner of way, but merely to ſeparate the parts from each other. It differs alſo from the reſolution of bodies by diſtillation with violent fire; becauſe in diſtillation new and permanent compounds are formed, but by putrefaction every thing ſeems to be reſolved into ſubſtances much more ſimple and indeſtructible than thoſe which are the reſult of any chemical proceſs.

The bodies moſt liable to putrefaction are thoſe of animals and vegetables, eſpecially when full of juices. Stones, though by the action of the weather they will moulder into duſt, yet ſeem not to be ſubject to any thing like a real putrefaction, as they are not reſolved into any other ſubſtance than ſand, or ſmall duſt, which ſtill preſerves its lapideous nature. In like manner, vegetables of any kind, when deprived of their juices by drying, may be preſerved for many ages without being ſubjected to any thing like a putrefactive proceſs. The ſame holds good with reſpect to animals; the parts of which, by ſimple drying, may be preſerved in a ſound ſtate for a much longer time than they could be without the previous exhalation of their juices.

Putrefaction is generally allowed to be a kind of fermentation, or rather to be the laſt ſtage of that proceſs; which, beginning with the vinous fermentation, goes on through the acetous, to the ſtage of putridity, where it ſtops. It is argued, however, and ſeemingly not without a great deal of reaſon, that if putrefaction be a fermentation, it muſt neceſſarily be a kind diſtinct from either the vinous or acetous; ſince we frequently obſerve that it takes place where neither the vinous nor the acetous ſtages have gone before; of conſequence, it muſt be, in ſome caſes at leaſt, entirely independent of and unconnected with them. In ſeveral other reſpects it differs ſo much from theſe proceſſes, that it ſeems in ſome degree doubtful whether it can with propriety be called a *fermentation* or not. Both the vinous and acetous fermentations are attended with a conſiderable degree of heat; but in the putrefaction of animal matters eſpecially, the heat is for the moſt part ſo ſmall, that we cannot be certain whether there is any degree of it or not produced by the proceſs. In caſes, indeed, where the quantity of corrupting animal matter is very great, ſome heat may be perceived: and accordingly Dr. Munro tells us, that he was ſenſible of heat on thruſting his hand into the fleſh of a dead and corrupting whale. But the moſt remarkable difference between the putrefactive fermentation and that of the vinous and acetous kinds is, that the end of both theſe proceſſes is to produce a new and permanent compound; but that of the putrefactive proceſs is not to produce any new form, but to deſtroy, and reſolve one which already exiſts into the original principles from which all things ſeem to proceed. Thus, the vinous fermentation produces ardent ſpirits; the acetous, vinegar: but putrefaction produces nothing but earth and ſome effluvia, which, though moſt diſagreeable, and even poiſonous to the human body, yet, being imbibed by the earth and vegetable creation, give life to a new race of beings. It is commonly ſuppoſed, indeed, that volatile alkali is a production of the putrefactive proceſs: but this ſeems liable to diſpute. The vapour of pure volatile alkali is not hurtful to the human frame, but that of putrefying ſubſtances is exceedingly ſo; and, excepting in the caſe of urine, the generation of volatile alkali in putrid ſubſtances is very equivocal. This ſubſtance, which produces more alkali than any other, is much leſs offenſive by its putrid fetor than others; and all animal ſubſtances produce a volatile alkali on being expoſed to the action of fire, of quicklime, or of alkaline ſalts. In theſe caſes the volatile alkali is not ſuppoſed to be produced by the quicklime or fixed ſalt, but only to be extricated from a kind of ammoniacal ſalt pre-exiſting in the animal matters; the probability is the ſame in the other caſe, viz. that volatile alkali is not produced, but only extricated, from theſe ſubſtances by putrefaction.

The only thing in which the putrefactive fermentation agrees with the other kinds is, that in all the three there is an extrication of fixed air. In the putrefactive proceſs, it has been thought that this eſcape of the fixed air deprives the body of its coheſion: and Dr. Macbride has written a treatiſe, in which he endeavours to prove, that fixed air is the very power of coheſion itſelf, and that all bodies when deprived of their fixed air entirely loſe their coheſion. According to this hypotheſis, the cauſe of putrefaction is the eſcape of fixed air: but it is impoſſible to give a reaſon why fixed air, after having ſo long remained in a body, and preſerved its coheſion, ſhould of a ſudden begin to fly off without being acted upon by ſomething elſe. To a ſimilar objection the hypotheſis of thoſe is liable, who ſuppoſe putrefaction to be occaſioned by the eſcape of phlogiſton; for phlogiſton is now known to be a chimæra: and though it were a reality, it would not fly off without ſomething to carry it off, any more than fixed air. Animalcules have been thought to be the cauſe of putrefaction: but if animal ſubſtances are covered ſo as to exclude the acceſs of flies or other inſects, no ſuch animalcules are to be diſcovered though putrefaction has taken place; and indeed it requires little proof to convince us, that animals are produced in corrupted bodies only becauſe ſuch ſubſtances prove a proper nidus for the eggs of the parent inſects.

To underſtand the true cauſe of putrefaction, we muſt take notice of the circumſtances in which the proceſs goes on moſt rapidly. Theſe are heat, a little moiſture, and confined air. Extreme cold prevents putrefaction, as well as perfect dryneſs; and a free circulation of air carries off the putrid effluvia; a ſtagnation of which ſeems to be neceſſary for carrying on the proceſs. It ſeems alſo to hold pretty generally, that putrefying bodies ſwell and become ſpecifically lighter; for which reaſon the carcaſes of dead animals, after having ſunk in water, riſe to the top and float. This laſt phenomenon, as has been obſerved under the article Blood, ſhows that theſe bodies have received a certain quantity of an elaſtic principle from the air, which thus ſwells them up to ſuch a ſize. It may be ſaid indeed, that this increaſe of ſize in putrefying bodies is owing only to the extrication of air within themſelves: but this amounts to the ſame thing; for the air which exiſts internally in the body of any animal, is entirely diveſted of elaſticity while it remains there, and only ſhows its elaſtic properties upon being extricated. The elaſtic principle which combines with the air fixed in the animal ſubſtance, therefore, muſt come from the external atmoſphere; and conſequently the agent in putrefaction muſt be the elaſtic principle of the atmoſphere itſelf, probably the ſame with elementary fire.

But, granting this to be true, it is difficult to ſhow why putrefaction ſhould not take place in a living body as well as in a dead one; ſeeing the one is as much expoſed to the action of the air as the other. This difficulty, however, is not peculiar to the preſent hypotheſis; but will equally occur whatever we may ſuppoſe the cauſe of putrefaction to be. The difficulty ſeems to be a little cleared up by Dr. Prieſtley, who ſhows, that, by means of reſpiration, the body is freed from many noxious effluvia which would undoubtedly deſtroy it; and by the retention of which, he thinks, a living body would putrefy as ſoon as a dead one. The way in which reſpiration prevents the putrefaction of the body, is evidently the ſame with that in which the wind prevents fiſh or fleſh hung up in it from becoming putrid The conſtant inſpiration of the air is like a ſtream of that element continually blown upon the body, and that not only upon its ſurface, but into it; by which means putrefaction is prevented in thoſe parts that are moſt liable to become putrid. On the other hand, the elaſtic principle received from the air by the blood, (ſee Blood) by invigorating the powers of life, quickening the circulation, and increaſing perſpiration, enables the body to expel noxious particles from other parts of the body which cannot conveniently be expelled by the lungs.

This leads us to conſider the reaſon why a free expoſure to the air prevents the coming on of putrefaction, or why the confining of the putrid effluvia ſhould be ſo neceſſary to this proceſs. Here it will be proper to recollect, that putrefaction is a ſimple reſolution of the body into earth, air, &c. of which it ſeems originally to have been compoſed. This reſolution is evidently performed by an expanſive power ſeemingly ſituated in every particle of the body. In conſequence of this principle, the body firſt ſwells, then burſts, flies off in vapour, and its particles fall aſunder from each other. The action of the putrefactive proceſs, then, is analogous to that of fire, ſince theſe are the very properties of fire, and the very effects which follow the action of fire upon any combuſtible body. It is therefore exceedingly probable, that the agent in the air, which we have all along conſidered as the cauſe of putrefaction, is no other than fire itſelf: that is, the ethereal fluid expanding itſelf everywhere, as from a centre to a circumference. The force of the fluid, indeed, is much leſs in putrefaction than in actual ignition; and therefore the effects alſo take place in a much ſmaller degree, and require a much longer time: nevertheleſs, the ſame circumſtances that are neceſſary for keeping up the action of fire, are alſo neceſſary for keeping up the putrefactive proceſs. One of theſe is a free acceſs of air, yet without too violent a blaſt; for as fire cannot burn without air, neither can it endure too much of it: thus a candle goes out if put under a receiver, and the air exhauſted; and it will do the ſame if you blow violently upon it. In like manner, putrefaction requires a certain quantity of air, much leſs indeed than fire: and as it requires leſs to ſupport it, ſo it can alſo endure much leſs air than fire; for a ſtream of air which would not put out a fire, will effectually prevent putrefaction. The cauſe of this in both is the ſame. Fire cannot burn becauſe the vapour is carried off too faſt; and thus the latent heat, which ought to ſupport the flame, (ſee the article Flame) is entirely diſſipated. In like manner putrefaction is as certainly attended with an emiſſion of azotic gas as fire is with an emiſſion of flame. Theſe gaſes contain a great quantity of latent heat, or of the expanſive principle already mentioned; and if theſe be carried off with greater rapidity than the heat of the atmoſphere can produce them, the conſequence muſt be, that an oppoſite principle to that which produces putrefaction, namely, a principle of cold, or condenſation, inſtead of expanſion, muſt take place, and the body cannot putrify. That this muſt be the caſe, is evident from the property which all evaporations have of producing cold; (ſee Evaporation) and it is well known that a briſk current of air promotes evaporation to a great degree. Hence alſo the reaſon is evident why bodies are preſerved uncorrupted by cold; for thus the action of the expanſive principle is totally overcome and ſuſpended, ſo that none of its effects can be perceived.

Thus we may ſee, that one reaſon why an animal body does not putrefy while alive, is its ventilation, as we may call it, by reſpiration ; and another is, the continual acceſſion of new particles, leſs diſpoſed to putrefy than itſelf, by the food and drink which is conſtantly taken in. But if either of theſe ways of preventing the commencement of this proceſs are omitted, then putrefaction will take place as well in a living as in a dead body. Of the truth of this laſt fact we have innumerable inſtances. When air is infected with the putrid effluvia of marſhes, and thus the natural effluvia are not carried off from the human body, but, on the contrary, ſome enter into it which are not natural to it, the moſt putrid diſeaſes are produced. The ſame thing happens from the putrid effluvia of dead bodies. Of this we have a remarkable inſtance in the fever which took place in Germany in the war of 1755 : one reaſon of which is ſaid to have been an infection of the air by the vaſt numbers of people killed in battle, to which was added a calm in the atmoſphere for a long time ; the putrid effluvia being by this prevented from flying off. When Mr. Holwell, with 145 others were impriſoned in the black-hole at Calcutta, after paſſing a night in that diſmal habitation, he found himſelf in a high putrid fever. When ſailors in long voyages are obliged to feed upon putrid aliments ; when, through ſtormy weather, they are much expoſed to wet ; in the one caſe the putreſcent effluvia being kept from flying off, and in the other a greater quantity being thrown into the body than what it naturally contains, the ſcurvy, malignant fevers, &c. make their appearance. Neither can theſe diſeaſes be removed without removing every one of the cauſes juſt now mentioned : for, as putrid diſeaſes will be the conſequence of confined air, naſtineſs, &c. though the proviſions be ever ſo good ; ſo, on the other hand, if the proviſions be bad, the beſt air, and moſt exact cleanlineſs, nay, the beſt medicines in the world, will be of no ſervice ; as hath been often obſerved in the ſcurvy.

From this account of the nature, cauſe, and method of preventing putrefaction by means of a current of air, we may eaſily ſee the reaſon why it does not take place in ſome other caſes alſo. Bodies will not putrefy *in vacuo*, becauſe there the atmoſphere has not acceſs to impart its elaſtic principle ; and though in the vacuum itſelf the principle we ſpeak of does undoubtedly exiſt, yet its action there is by far too weak to decompoſe the ſtructure of an animal body. In extreme cold, the reaſon why putrefaction does not take place has been already ſhown. If the heat be extremely great, the proceſs of ignition or burning takes place inſtead of putrefaction. If the body be very dry putrefaction cannot take place, becauſe the texture is too firm to be decompoſed by the weak action of the elaſtic principle. Putrefaction may alſo be prevented by the addition of certain ſubſtances ; but they are all of them ſuch as either harden the texture of the body, and thus render it proof againſt the action of the elaſtic fluid, or, by diſſolving its texture entirely, bring it into a ſtate ſimilar to what it would be brought by the utmoſt power of putrefaction, ſo that the proceſs cannot then take place. Thus various kinds of ſalts and acids harden the texture of animal ſubſtances, and thus are ſucceſsfully uſed as antiſeptics. The ſame thing may be ſaid of ardent ſpirits ; while oils and gums of various kinds prove antiſeptic by a total excluſion of air, which is neceſſary in ſome degree for carrying on the proceſs of putrefaction. Many vegetables, by the aſtringent qualities they poſſeſs, harden the texture of animal ſubſtances, and thus prove powerfully antiſeptic ; while, on the other hand, fixed alkaline ſalts, quicklime, and cauſtic volatile alkali, though they prevent putrefaction, yet they do it by diſſolving the ſubſtances in ſuch a manner that putrefaction could do no more though it had exerted its utmoſt force. There is only one other antiſeptic ſubſtance whoſe effects deſerve to be conſidered, and that is ſugar. This, though neither acid nor alkaline, is yet one of the moſt effectual means of preventing putrefaction : and this ſeems to be owing to its great tendency to run into the vinous fermentation, which is totally inconſiſtent with that of putrefaction ; and this tendency is ſo great, that it can ſcarce be counteracted by the tendency of animal ſubſtances to putrefy in any circumſtances whatever.

Some kinds of air are remarkably antiſeptic, though this ſubject has not been ſo fully inquired into as could be wiſhed. The moſt powerful of them in this reſpect is the nitrous air ; next to it, is fixed air ; but the powers of the other airs are not ſo well known. It is probable that the antiſeptic properties of fixed and nitrous air, are owing to their quality of extinguiſhing fire, or at leaſt that the principle is the ſame ; but, till the nature of theſe two kinds of air be better known, little can be ſaid with certainty on the ſubject.

Sir John Pringle has made experiments to determine the powers of certain ſubſtances to promote or to prevent putrefaction. From theſe experiments he has formed the following table, ſhowing the relative antiſeptic powers of the ſaline ſubſtances mentioned. Having found that two drams of beef put in a phial with two ounces of water, and placed in a heat equal to 90° of Fahrenheit's thermometer, became putrid in 14 hours, and that 60 grains of ſea-ſalt preſerved a ſimilar mixture of beef and water more than 30 hours, he made the antiſeptic power of the ſea-ſalt a ſtandard, to which he compared the powers of the other ſalts. The algebraic character + ſignifies that the ſubſtance to which it is annexed had a greater antiſeptic power than is expreſſed by the numbers ;

Sea-ſalt, or the ſtandard	1
Sal gem	1 +
Vitriolated tartar	2
Spiritus Mindereri	2
Soluble tartar	2
Sal diureticus	2 +
Crude ſal ammoniac	3
Saline mixture	3
Nitre	4 +
Salt of hartſhorn	4 +
Salt of wormwood	4 +
Borax	12
Salt of amber	20
Alum	30

N. B. The quantities of ſpiritus Mindereri and of the ſaline mixture were ſuch, that each of them contained as much alkaline ſalt as the other neutral ſalts.

Myrrh, aloes, aſafœtida, and terra Japonica, were found to have an antiſeptic power 30 times greater than the ſtandard. Gum ammoniacum and ſagapenum ſhowed little antiſeptic power.

Of all reſinous ſubſtances, camphor was found to reſiſt putrefaction moſt powerfully. Sir John Pringle believes that its antiſeptic power is 300 times greater than that of ſea-ſalt.

Chamomile flowers, Virginian ſnake-root, pepper, ginger, ſaffron, contrayerva-root, and galls, were found to be 12 times more antiſeptic than ſea-ſalt.

Infuſions of large quantities of mint, angelica, ground-ivy, green tea, red roſes, common wormwood, muſtard, and horſeradiſh, and alſo decoctions of poppy-heads, were more antiſeptic than ſea-ſalt.

Decoctions of wheat, barley, and other farinaceous grains, checked the putrefaction by becoming ſour.

Chalk, and other abſorbent powders, accelerated the putrefaction, and reſolved meat into a perfect mucus. The ſame powders prevented an infuſion of farinaceous grains from becoming mucilaginous and ſour.

One dram of ſea ſalt was found to preſerve two drams of freſh beef in two ounces of water, above 30 hours, uncorrupted, in a heat equal to that of the human body, or above 20 hours longer than meat is preſerved in water without ſalt: but half a dram of ſalt did not preſerve it more than two hours longer than pure water. Twenty-five grains of ſalt had little or no antiſeptic quality. Twenty grains, 15 grains, but eſpecially 10 grains only of ſea-ſalt, were found to accelerate and heighten the putrefaction of two drams of fleſh. Theſe ſmall quantities of ſea-ſalt did alſo ſoften the fleſh more than pure water.

The ſame learned and ingenious phyſician made experiments to diſcover the effects of mixing vegetable with animal matters.

Two drams of raw beef, as much bread, and an ounce of water, being beaten to the conſiſtence of pap, and expoſed to 90° of heat according to Fahrenheit's thermometer, began to ferment in a few hours, and continued in fermentation during two days. When it began to ferment and ſwell, the putrefaction had begun; and in a few hours afterwards, the ſmell was offenſive. Next day the putrid ſmell ceaſed, and an acid taſte and ſmell ſucceeded. Freſh alimentary vegetables, as ſpinach, aſparagus, ſcurvy-graſs, produced ſimilar effects as bread on fleſh, but in a weaker degree. From ſeveral other experiments he found, that animal ſubſtances excite the fermentation of vegetable ſubſtances, and that the latter ſubſtances correct the putreſcency of the former.

By adding ſaliva to a ſimilar mixture of fleſh, bread, and water, the fermentation was retarded, moderated, but rendered of twice the uſual duration, and the acid produced at laſt was weaker than when no ſaliva was uſed.

By adding an oily ſubſtance to the common mixture of fleſh, bread, and water, a ſtronger fermentation was produced, which could not be moderated by the quantity of ſaliva uſed in the former experiment, till ſome fixed alkaline ſalt was added; which ſalt was found, without ſaliva, to ſtop ſuddenly very high fermentations.

He did not find that ſmall quantities of the following ſalts, ſal ammoniac, nitre, vitriolated tartar, ſal diureticus, ſalt of hartſhorn, ſalt of wormwood, were ſeptic, as ſmall quantities of ſea ſalt were.

Sugar was found to reſiſt putrefaction at firſt, as other ſalts do, and alſo to check the putrefaction after it had begun by its own fermentative quality, like bread and other fermentative vegetables.

Lime-water made ſome ſmall reſiſtance to putrefaction.

Port-wine, ſmall-beer, infuſions of bitter vegetables, of bark, and the juice of antiſcorbutic plants, retarded the fermentation of mixtures of fleſh and bread. But an unſtrained decoction of bark conſiderably increaſed that fermentation.

Crabs-eyes accelerated and increaſed the fermentation of a mixture of fleſh and bread.

Lime-water neither retarded nor haſtened the fermentation of ſuch a mixture: but, when the fermentation ceaſed, the liquor was neither putrid nor acid, but ſmelt agreeably.

Fleſh pounded in a mortar was found to ferment ſooner than that which had not been bruiſed.

The tough inflammatory cruſt of blood was found to be moſt putreſcent: next to which the craſſamentum, or red coagulated maſs; and laſtly the ſerum.

Dr. Macbride's experiments confirm many of thoſe above related, eſpecially thoſe which ſhow that the fermentation of vegetable ſubſtances is increaſed by a mixture of animal or putreſcent matter; that the putreſcency of the latter is corrected by the fermentative quality of the former; and that the putrefaction and fermentation of mixtures of animal and vegetable ſubſtances were accelerated by additions of abſorbent earths and of Peruvian bark. He alſo found, that although unburnt calcareous earths were ſeptic, quicklime and lime-water prevented putrefaction, but that they deſtroyed or diſſolved the texture of fleſh.

The experiments of the author of the *Eſſai pour ſervir à l'Hiſtoire de la Putrefaction*, ſhow that metallic ſalts, reſinous powders, extracts of bark, and opium, are very powerfully antiſeptic, and that ſalts with earthy baſes are leſs antiſeptic than any other ſalts.

PUTTOCK-SHROUDS, See *Puttock*-SHROUDS.

PUTTY, in its popular ſenſe, is a kind of paſte compounded of whiting and linſeed oil, beaten together to the conſiſtence of a thick dough. It is uſed by glaziers for the faſtening in the ſquares of glaſs in ſaſh-windows, and by painters for ſtopping up the crevices and clefts in timber and wainſcots, &c.

PUTTY ſometimes alſo denotes the powder of calcined tin, uſed in poliſhing and giving the laſt gloſs to works of iron and ſteel.

TERRA PUZZULANA, or POZZOLANA, is a grayiſh kind of earth uſed in Italy for building under water. The beſt is found about Puteoli, Baiæ, and Cumæ, in the kingdom of Naples, from the firſt of which places it derives its name. It is a volcanic product, compoſed of heterogeneous ſubſtances, thrown out from the burning mouths of volcanoes in the form of aſhes; ſometimes in ſuch large quantities, and with ſo great violence, that whole provinces have been covered with it at a conſiderable diſtance. In the year 79 of the common æra, the cities of Herculaneum, Pompeia, and Stabia, although at the diſtance of many miles from Veſuvius, were, neverthelеſs, buried under the matters of theſe dreadful eruptions; as Bergman relates in his *Treatiſe of the Volcanic Products*. This volcanic earth is of a gray, brown, or blackiſh colour; of a looſe, granular, or duſty and rough, porous or ſpongy texture, reſembling a clay hardened by fire, and then reduced to a groſs powder. It contains various heterogeneous ſubſtances mixed with it. Its ſpecific gravity is from 2500 to 2800; and it is, in ſome degree, magnetic: it ſcarcely effervеſces with acids, though partially ſoluble in them. It eaſily melts *per ſe*; but its moſt diſtinguiſhing property is, that it hardens very ſuddenly when mixed with $\frac{1}{3}$ of its weight of lime and water; and forms a cement which is more durable in water than any other.

According to Bergman's Analyſis, 100 parts of it contain from 55 to 60 of ſiliceous earth, 20 of argillaceous, five or ſix of calcareous, and from 15 to 20 of iron. Its effects, however, in cement may perhaps depend only on the iron which has been reduced into a particular ſubſtance by means of ſubterraneous fires; evident ſigns of which are obſervable in the places where it is obtained. If the ſlate in Henneberg, or Kennekulle in the province of Weſtergottland, ſhould happen to get fire, the uppermoſt ſtratum, which now conſiſts of a mixture of iron and different kinds of rocks, called *graberg* in the account given of them, they might perhaps be changed partly into ſlag and partly into *terra puzzolana*.

It is evidently a martial argillaceous marl, that has ſuffered a moderate heat. Its hardening power ariſes from the dry ſtate of the half-baked argillaceous particles, which makes them imbibe water very rapidly, and thus accelerates the deſiccation of the calcareous part; and alſo from the quantity and ſemi-phlogiſticated ſtate of the iron contained in it. It is found not only in Italy but in France, in the provinces of Auvergne and Limoges; and alſo in England and elſewhere.

PUZZUOLI. See PUTEOLI.

PYANEPSIA, in antiquity, an Athenian feſtival celebrated on the ſeventh day of the month *Pyanepſion*; which, according to the generality of critics, was the ſame with our September.

Plutarch refers the inſtitution of this feaſt to Theſeus, who, after the funeral of his father, on this day paid his vows to Apollo, becauſe the youths who returned with him ſafe from Crete then made their entry into the city. On this occaſion, theſe young men putting all that was left of their proviſions into one kettle, feaſted together on it, and made great rejoicing. Hence was derived the cuſtom of boiling pulſe on this feſtival. The Athenians likewiſe carried about an olive branch, bound about with wool, and crowned with all ſorts of firſt-fruits, to ſignify that ſcarcity and barreneſs were ceaſed, ſinging in proceſſion a ſong. And when the ſolemnity was over, it was uſual to erect the olive-branch before their doors, as a preſervative againſt ſcarcity and want.

PYCNOSTYLE, in the ancient architecture, is a building where the columns ſtand very cloſe to each other; only one diameter and a half of the column being allowed for the intercolumniations. According to Mr. Evelyn, the pycnoſtyle chiefly belonged to the compoſite order, and was uſed in the moſt magnificent buildings; as at preſent in the periſtyle at St. Peter's at Rome, which conſiſts of near 300 columns; and in ſuch as yet remain of the ancients, among the ruins of Palmyra.

PYGARGUS, in ornithology, a ſpecies of Falco.

PYGMALION, in fabulous hiſtory, a king of Cyprus, who, being diſguſted at the diſſolute lives of the women of his iſland, reſolved to live in perpetual celibacy; but, making a ſtatue of ivory, he fell ſo paſſionately in love with it, that, the high feſtival of Venus being come, he fell down before the altar of that goddeſs, and beſought her to give him a wife like the ſtatue he loved. At his return home, he embraced, as uſual, his ivory form, when he perceived that it became ſenſible by degrees, and was at laſt a living maid, who found herſelf in her lovers arms the moment ſhe ſaw the light. Venus bleſſed their union; and, at the end of nine months, ſhe was delivered of a boy, who was named *Paphos*.

PYGMY, a perſon not exceeding a cubit in height. This appellation was given by the ancients to a fabulous nation inhabiting Thrace; who brought forth young at five years of age, and were old at eight: theſe were famous for the bloody war they waged with the cranes. As to this ſtory, and for the natural hiſtory of the true pygmy, ſee Simia.

PYKAR, a broker in India, inferior to thoſe called *dallals*, who tranſacts the buſineſs at firſt hand with the manufacturer, and ſometimes carries goods about for ſale.

PYKE, a watchman in India, employed as a guard at night. Likewiſe a footman or runner on buſineſs. They are generally armed with a ſpear.

PYLADES, a ſon of Strophius, king of Phocis, by one of the ſiſters of Agamemnon. He was educated together with his couſin Oreſtes, with whom he formed the moſt inviolable friendſhip, and whom he aſſiſted to revenge the murder of Agamemnon, by aſſaſſinating Clytemneſtra and Ægyſthus. He alſo accompanied him in Taurica Cherſoneſus; and for his ſervices Oreſtes rewarded him, by giving him his ſiſter Electra in marriage. Pylades had by her two ſons, Medon and Strophius. The friendſhip of Oreſtes and Pylades became proverbial.

PYLORUS, in anatomy the under orifice of the ſtomach. See Anatomy.

PYLUS (anc. geog.), a town of Elis; its ruins to be ſeen on the road from Olympia to Elis (Pauſanias); ſituated between the mouths of the Peneus and Sellees, near Mount Scollis (Strabo). Built by Pylas of Megara, and deſtroyed by Hercules (Pauſanias).—Another Pylus in Triphylia (Strabo); by which the Alpheus runs (Pauſanias); on the confines of Arcadia, and not in Arcadia itſelf (id.)—A third in Meſſenia (Strabo, Ptolemy); ſituated at the foot of Mount Ægaleus on the ſea-coaſt, over againſt the iſland Sphagea or Sphacteria: built by Pylas, and ſettled by a colony of Leleges from Megara; but thence expelled by Neleus and the Pelaſgi, and therefore called *Nelea* (Homer). A ſandy territory. The royal reſidence of Neleus, and of Neſtor his ſon: the more ancient and more excellent Pylus; whence the proverb *Pylus ante Pylum* (Ariſtophanes, Plutarch), uſed when we want to repreſs the arrogance and pride of any one: ſaid to be afterwards called *Coryphaſium*. It made a figure in the Peloponneſian war; for, being rebuilt by the Athenians, it proved of great benefit to them for the ſpace of 15 years, and of much annoyance to the Lacedemonians (Thucydides). All the three *Pyli* were ſubject to Neſtor (Strabo.)

PYRAMID, in geometry, a ſolid ſtanding on a triangular, ſquare, or polygonal baſis, and terminating in a point at the top; or, according to Euclid, it is a ſolid figure, conſiſting of ſeveral triangles, whoſe baſes are all in the ſame plane, and have one common vertex.

Pyramids are ſometimes uſed to preſerve the memory of ſingular events, and ſometimes to tranſmit to poſterity the glory and magnificence of princes. But as they are eſteemed a ſymbol of immortality, they are moſt commonly uſed as funeral monuments and temples to the gods. Such is that of Ceſtius at Rome; the pyramids of Daſhur drawn by Pococke; and thoſe other celebrated ones of Egypt, as famous for the enormity of their ſizes as their antiquity. Of theſe the largeſt are the pyramids of *Geeza*, ſo called from a village of that name on the banks of the Nile, diſtant from them about 11 miles. The three which moſt attract the attention of travellers ſtand near one another on the weſt ſide of the river, almoſt oppoſite to Grand Cairo, and not far from the place where the ancient Memphis ſtood. They were viſited by M. Savary, of whoſe deſcription of them we ſhall here give an abſtract.

He took his journey in the night-time, in order to get up to the top of the great one by ſunriſe. Having got within ſight of the two great ones, while the full moon ſhone upon them, he informs us, that they appeared, at the diſtance of three leagues, like two points of rock crowned by the clouds.

It is in the rich territory which ſurrounds them that fable has placed the Elyſian fields. The canals which interſect them are the Styx and Lethe.

The aſpects of the pyramids varied according to the circuits he made in the plain, and the poſition of the clouds diſplayed themſelves more and more to view. "At half paſt three in the morning we arrived (ſays he) at the foot of the greateſt. We left our clothes at the gate of the paſſage which leads to the inſide, and deſcended, carrying each of us a flambeau in his hand. Towards the bottom you muſt creep like ſerpents to get into the interior paſſage, which correſponds with the former. We mounted it on our knees, ſupporting ourſelves with our hands againſt the ſides. Without this precaution one runs the riſk of ſlipping on the inclined plane, where the ſlight notches are inſufficient to ſtop the foot, and one might fall to the bottom. Towards the middle we fired a piſtol, the frightful noiſe of which, repeated in the cavities of this immenſe edifice, continued a long time, and awakened thouſands of bats, which flying round us, ſtruck againſt our hands and faces, and extinguiſhed ſeveral of our wax candles. They are much larger than the European bats. Arrived above, we entered a great hall, the gate of which is very low. It is an oblong ſquare, wholly compoſed of granite. Seven enormous ſtones extend from one wall to the other, and form the roof. A ſarcophagus, made of a ſingle block of marble lies at one end of it. It is empty; and the lid of it has been wrenched off. Some pieces of earthen vaſes lie around it. Under this beautiful hall is a chamber not ſo large, where you find the entrance to a conduit filled with rubbiſh. After examining theſe caves, where daylight never penetrated, we deſcended the ſame way, taking care not to fall into a well, which is on the left, and goes to the very foundations of the pyramid. Pliny makes mention of this well, and ſays it is 26 cubits deep. The internal air of this edifice never being renewed, is ſo hot and mephitic that one is almoſt ſuffocated. When we came out of it, we were dropping with ſweat, and pale as death. After refreſhing ourſelves with the external air, we loſt no time in aſcending the pyramid. It is compoſed of more than 200 layers of ſtone. They overlap each other in proportion to their elevation, which is from two to four feet. It is neceſſary to climb up all theſe enormous ſteps to reach the top. We undertook it at the north-eaſt angle, which is the leaſt damaged. It took us, however, half an hour with great pains and many efforts to effect it.

" The ſun was riſing, and we enjoyed a pure air, with a moſt delicious coolneſs. After admiring the proſpect around us, and engraving our names on the ſummit of the pyramid, we deſcended cautiouſly, for we had the abyſs before us. A piece of ſtone detaching itſelf under our feet or hands might have ſent us to the bottom.

" Arrived at the foot of the pyramid, we made the tour of it, contemplating it with a ſort of horror. When viewed cloſe, it ſeems to be made of maſſes of rocks; but at a hundred paces diſtance, the largeneſs of the ſtones is loſt in the immenſity of the whole, and they appear very ſmall.

" To determine its dimenſions is ſtill a problem. From the time of Herodotus to our days it has been meaſured by a great number of travellers and learned men, and their different calculations, far from clearing up doubts, have only increaſed the uncertainty. The following table will ſerve at leaſt to prove how difficult it is to come at the truth.

Height of the great Pyramid.		*Width of one of its ſides.*
Ancients.		French Feet.
Herodotus	800	800
Strabo	625	600
Diodorus Siculus	600 and a fraction.	700
Pliny	-	708
Moderns.		
Le Bruyn	616	704
Proſper Alpinus	625	750
Thevenot	520	682
Niebuhr	440	710
Greaves	444	648

Number of layers of ſtone which form it.

Greaves	207	layers.
Maillet	208	
Albert Liewenſtein	260	
Pococke	212	
Belon	250	
Thevenot	208	

" It appears that Meſſrs. Greaves and Niebuhr have prodigiouſly deceived themſelves in meaſuring the perpendicular height of the great pyramid. All the travellers allow that it has at leaſt 200 layers of ſtone. Theſe layers are from two to four feet high. According to Pococke, they are from four feet and a half to four feet high, being not ſo high at the top as at the baſe. Proſper Alpinus informs us, that the elevation of the firſt layer is five feet, but it diminiſhes inſenſibly in proportion as one mounts. Thevenot mentions 208 ſteps of large ſtones, the thickneſs of which makes the height of them about two feet and a half one with another: He meaſured ſome of them more than three feet high. I have meaſured ſeveral of them which were more than three feet high, and I found none leſs than two; the leaſt height of them we can take as a medium therefore is two feet and a half; which, even according to Mr. Greaves's calculation, who reckons 207 layers, would make 517 feet 6 inches perpendicular height. Meſſrs. Greaves, Maillet, Thevenot, and Pococke, who only differ in the number of the layers from 207 to 212, all mounted by the north-eaſt angle, as the leaſt injured. I followed the ſame route, and counted only 208 ſteps. But if we reflect that the pyramid has been open on the ſide next the deſert, that the ſtones on that ſide have been thrown down, that the ſand which covers them has formed a conſiderable hill, we ſhall not be aſtoniſhed that Albert Liewenſtein, Belon, and Proſper Alpinus, who muſt have mounted by the ſouth eaſt or ſouth-weſt angle, which are leſs expoſed to the ſands of Lybia, ſhould have found a greater number of ſteps: ſo that the calculation of theſe travellers, agreeing with that of Diodorus Siculus and Strabo, appears to be neareſt the true height of the pyramid taken at its natural baſe; whence we may conclude with reaſon that it is at leaſt 600 feet high. Indeed this is authenticated by a paſſage of Strabo. Theſe are his words: ' Towards the middle of the height of one of the ſides is a ſtone that may be raiſed up. It ſhuts an oblique paſſage which leads to a coffin placed in the centre of the pyramid.' This paſſage, open in our days, and which in the time of Strabo was towards the middle of one face of the pyramid, is at preſent only 100 feet from the baſe. So that the ruins of the covering of the pyramid, and of the ſtones brought from within, buried by the ſand, have formed a hill in this place 200 feet high. Pliny confirms this opinion. The great ſphynx was in his time upwards of 62 feet above the ſurface of the ground. Its whole body is at preſent buried under the ſand. Nothing more appears of it than the neck and head, which are 27 feet high. If even the ſphynx, though defended by the pyramids againſt the northerly winds, which bring torrents of ſand from Libya, be covered as high as 38 feet, what an immenſe quantity muſt have been heaped up to the northward of an edifice whoſe baſe is upwards of 700 feet long? It is to this we muſt attribute the prodigious difference between the accounts of the hiſtorians who have meaſured the great pyramid at diſtant periods, and at oppoſite angles. Herodotus, who ſaw it in the age neareſt to its foundation, when its true baſe was ſtill uncovered, makes it 800 feet ſquare. This opinion appears very probable. Pliny alſo ſays, that it covered the ſpace of eight acres.

" Meſſrs Shaw, Thevenot, and the other travellers who pretend that this pyramid was never finiſhed, becauſe it is open and without coating, are in an error. It is only neceſſary to obſerve the remains of the mortar, with the ſplinters of white marble which are to be found in many parts of the ſteps, to ſee that it has been coated. After reading attentively the deſcription given of it by the ancients, every doubt vaniſhes, and the truth is as clear as day-light. Herodotus tells us, ' The great pyramid was covered with poliſhed ſtones, perfectly well jointed, the ſmalleſt of which was 30 feet long. It was built in the form of ſteps, on each of which were placed wooden machines to raiſe the ſtones from one to another.' According to Diodorus, ' The great pyramid is built of ſtones, very difficult of workmanſhip, but of an eternal duration. It is preſerved to our days (towards the middle of the Auguſtan age) without being in the leaſt injured. The marble was brought from the quarries of Arabia.' This hiſtorian thought that the whole building was compoſed of ſtones, ſimilar to thoſe of the coating, which were of very hard marble. Had there been ſome pieces torn off, he would have perceived under that covering a calcareous ſtone rather ſoft. Pliny ſays that it ' is formed of ſtones brought from the quarries of Arabia. It is not far from the village of Buſiris (which ſtill exiſts under the name of *Bouſir*), where thoſe perſons reſide who are ſo ſkilful as to climb up to the top.'

" This paſſage ſhows that Pliny, deceived by the appearance, was in the ſame error with Diodorus Siculus. It demonſtrates alſo that it was covered; for what difficulty would there have been for the inhabitants of Buſiris to ſcale a building raiſed by ſteps? but it was really a prodigy for them to get up it when it formed a mountain, the four inclined planes of which preſented a ſurface covered with poliſhed marble. It is indeed an inconteſtable fact, that the great pyramid was coated. It is as certain too that it has been ſhut, as Strabo gives us to underſtand; and that by removing a ſtone placed in the middle of one of the ſides, one found a paſſage which led to the tomb of the king. But I ſhall leave Mr. Maillet, who viſited it 40 times with all imaginable attention, the honour of relating the means employed to open it. I have examined the inſide of it in two different journeys: twice I have mounted it: and cannot help admiring the ſagacity with which that author has developed the mechaniſm of that aſtoniſhing edifice."

Our author next proceeds to give a particular deſcription of the methods by which it was moſt probable that the pyramids were cloſed, and the immenſe labour requiſite to open them; but as this deſcription affords nothing very intereſting we ſhall not inſert it. Only we muſt remark, that the final outlet to the workmen he ſuppoſes to have been the well at the entrance formerly mentioned. This well deſcends towards the bottom of the pyramid by a line not quite perpendicular to the horizon, but ſlanting a little, in ſuch a manner as to reſemble the figure of the Hebrew letter Lamed. About 60 feet from the aperture there is a ſquare window in this paſſage, from whence we enter a ſmall grotto hewn out of the mountain; which in this place is not a ſolid ſtone, but a kind of gravel concreted together. The grotto extends about 15 feet from eaſt to weſt, where there is another groove hollowed likewiſe, but almoſt perpendicular. It is two feet four inches wide by two and a half in height. It deſcends through a ſpace of 123 feet, after which we meet with nothing but ſand and ſtones. M. Savary is convinced that the only uſe of this paſſage was to ſerve as a retreat for the labourers who conſtructed the pyramid; and of this he looks upon the ſlope of the conduit, its winding road, its ſmallneſs, and its depth to be certain proofs. The way out of it he ſuppoſes to have been formed by a paſſage over which hung a row of ſtones, which they had diſcovered the ſecret of ſuſpending, and which falling down into the paſſage by the means of ſome ſpring they ſet in motion, ſhut up the entrance for ever, as ſoon as the workmen were withdrawn from the pyramid.

It ſeems to be an unqueſtionable fact, that this pyramid was a mauſoleum of one of the kings of Egypt, and it is very probable that all the reſt anſwered ſimilar purpoſes. We do not, however, think that this was their primary uſe or the original deſign of their builders. Mr. Bryant is of opinion that they were temples erected in honour of the Deity; and a very ingenious writer in the Gentleman's Magazine for June 1794 has done much to prove that they were altars dedicated to the ſun, the firſt and greateſt god in every pagan kalendar.

"Our Engliſh word pyramid (ſays he) is directly derived from the Latin *pyramis*, and mediately from the Greek ϖυραμις; all denoting the ſame mathematical figure. The original of the whole ſeems to be the Egyptian word *pyramoua*, which, we are told by Oriental ſcholars, ſignifies light, or a ray of light. From this Coptic vocable the word ϖυρ in Greek, ſignifying fire, is probably deſcended; as the flames of fire aſſume that conical or pyramidal form which the ſolar rays commonly diſplay; and as it is natural for the mind to diſtinguiſh its objects rather by their external qualities, and thoſe obvious and intereſting appearances which they exhibit to the ſenſes, than by their conſtituent and inſeparable properties.

"The ancient Egyptians ſeem to have penetrated very far into the myſteries of nature; and although their ſuperſtition appears at firſt ſight to be extremely groſs and abſurd, yet it is very probable that their deities were only emblematical perſonages, repreſenting by ſenſible images the grand effects or preſiding principles which they ſuppoſed to exiſt in the univerſe. Thus the moon was called *Iſis*, and the ſun *Oſiris*; and to the honour of this laſt deity, from whoſe viſible influence and creative energy all things ſeem to ſpring into exiſtence, it is not improbable that the Egyptians erected thoſe ſtupendous monuments, and dedicated them to him as temples or altars. It was natural to build them in that ſhape which the rays of the ſun diſplay when diſcovered to the eye, and which they obſerved to be the ſame in terreſtrial flame, becauſe this circumſtance was combined in their imaginations with the attribute which they adored. If they were temples dedicated to the ſun, it ſeems a natural conſequence that they ſhould likewiſe be places of ſepulture for kings and illuſtrious men, as the ſpace which they covered would be conſidered as conſecrated ground. This hypotheſis is common, and is not contradicted by the preſent reaſoning. But, conſidering them as altars, and as moſt travellers agree that they were never finiſhed, but terminate in a ſquare horizontal ſurface, it would not be refining too much to venture an aſſertion that, in great and ſolemn acts of adoration, the Egyptians conſtructed fires, the flames of which ſhould terminate in the vertex of the pyramid, and ſo complete that emanation of their deity which they admired and adored. As far, therefore, as we are juſtified in forming any concluſion on ſo dark a ſubject, we may venture to ſay, that the Egyptian pyramids were temples or altars dedicated to the ſun; as the material repreſentative of that inviſible power which creates, governs, and pervades, the whole ſyſtem of nature."

This reaſoning has great force; and it certainly receives additional ſtrength from the undoubted fact, that the firſt ſtatues for idolatrous worſhip were erected on the tops of mountains, and of a pyramidal or conical form. (See POLYTHEISM.) It is likewiſe corroborated by other circumſtances diſcovered by the members of the Aſiatic Society. In the ſecond volume of their tranſactions we have an account of ſeveral large ſtatues of the gods SEEVA and MCHEDEO, all of a conical or pyramidal figure; but it has been ſhown in the article already referred to, that the idolatry of Hindoſtan was probably of Egyptian original.

It is not known in Europe when the pyramids were built; but we have reaſon to expect a hiſtory of them ſoon from Shanſcrit records examined by Mr. Wilford, lieutenant of engineers. It is as little known at what time, or from what motive, the great pyramid was opened. Some think it was done by one of the khalifs about the beginning of the eighth century, in expectation of finding a great treaſure; but all he met with was the king's body, with ſome golden idols which had been buried along with it.—By others it is ſuppoſed to have been done by the celebrated Harun Al Baſakid khalif of Bagdad; but all are agreed that this pyramid was opened in the time of the Arabs. The ſecond pyramid has likewiſe been opened; and an attempt was made not long ago upon the third by one of the Beys of Cairo: but, after removing a number of ſtones at a conſiderable expenſe, he thought proper to deſiſt from the enterprize.—Mr. Bryant is of opinion that the pyramids, at leaſt the three great ones, are not artificial ſtructures of ſtone and mortar, but ſolid rocks cut into a pyramidal ſhape, and afterwards caſed with ſtone; and to this we find that Mr. Bruce likewiſe aſſents. The reaſon given for this opinion is, that the paſſages within it ſeem rather to anſwer to the natural cavities and rents in rocks than to the artificial ones in buildings. The opinion, however, we think ſufficiently confuted by Savary and Maillet: and, as an acute critic obſerves, it is in itſelf as improbable as that the caverns inhabited by the *Troglodytes* were dug by the hands of man. See TROGLODYTES.

On the eaſt ſide of the ſecond pyramid is the ſphynx, an enormous maſs of one ſolid ſtone, but ſo buried in the ſand that only the top of the back is viſible, which is 100 feet long. Its head riſes, as we have ſeen, 27 feet above the ſand; and its face has been disfigured by the Arabs, who hold all repreſentations of men and living animals in deteſtation. Other travellers ſay that this ſphynx is a huge miſhapen rock, by no means worthy of the attention which has been beſtowed upon it.

In the deſert of Saccara there are a great number of pyramids, which, in Mr. Bruce's opinion, are compoſed of clay. They terminate in what the inhabitans call a *dagiour*, or *falſe pyramid*, about two miles from the Nile, between Suf and Woodan. This is no other than a hill cut in the ſhape of a pyramid, or naturally ſo formed, for a conſiderable height; on the top of which is a pyramidal building of brick terminating in a point, and having its baſis ſo exactly adapted to the top of the hill, that at a diſtance the difference cannot be perceived; eſpecially as the face of the ſtone reſembles very nearly the clay of which the pyramids of the Saccara are compoſed.

PYRAMIDALES, in anatomy, one of the muſcles of the abdomen. See ANATOMY, *Table of the Muſcles*.

PYRENEAN MOUNTAINS, or PYRENEES, are the mountains which divide France from Spain, and are the moſt celebrated in Europe, except the Alps. They reach from the Mediterranean Sea as far as the ocean, and are about 212 miles in length. They have different names, according to the different places wherein they ſtand. Some think they are as high as the Alps; but the paſſages over them are not ſo difficult, whatever ſome travellers may think who have not croſſed the former.

BANKSIA PYRIFORMIS, in botany, is a ſpecies of BANKSIA, which ſee. It was unknown to Linnæus; and Gaertner, who has mentioned it, gives no ſpecific character of it. It has ſolitary flowers, ovate downy capſules, and lance-ſhaped entire ſmooth leaves. The capſules larger than in any other known ſpecies. See *White's Journal of a Voyage to New South Wales*, p. 221—225.

PYRITES, a genus of inflammable ſubſtances compoſed of ſulphur, which has diſſolved or ſaturated itſelf with metals. Thus there are many kinds of pyrites; as of gold, arſenic, iron, &c. It is alſo the principal ore of ſulphur; particularly that called *martial pyrites*, *copperas-ſtone*, or *marcaſite*. This is very common, containing a quantity of ſulphur in proportion to the iron; and, when thoroughly inflamed, burns by itſelf. It is either of a compact texture, ſteel-grained, coarſe-grained, or cryſtalliſed. In this laſt form, it ſhoots moſtly into cube and octohedral figures, though it is met with alſo in innumerable other forms. The liver-coloured marcaſite has an appearance between that of the preceding and the blue copper-ore. The iron predominates in this kind, ſo that it is leſs fit than the other for extracting ſulphur from it, or for the ſmelting of copper-ores. It is formed of a compact texture, coarſe-grained, and ſteel-grained. See CHEMISTRY, MINERALOGY, and METALLURGY.

PYRMONT, a town of Lippe in Germany, in the circle of Weſtphalia, and capital of a country of the ſame name. It has a caſtle, kept by a governor, who is under the counts of Waldeck. At a ſmall diſtance from hence there are mineral waters, which are much eſteemed. The Proteſtants have here the free exerciſe of their religion. It is ſeated on the confines of the duchy of Brunſwick, 40 miles ſouth-weſt of Hanover. E. lon. 9. 0. N. lat. 52. 0.

PYROLA, in botany: A genus of the monogynia order, belonging to the decandria claſs of plants; and in the natural method ranking under the 18th order, *Bicornes*. The calyx is quinquepartite; there are five petals; the capſule is quinquelocular, opening at the angles.

PYROMANCY, a kind of divination by means of fire. See DIVINATION.

PYROMETER, an inſtrument for meaſuring the expanſion of bodies by heat. Muſchenbroeck, who was the original inventor of this machine, has given a table of the expanſion of the different metals in the ſame degree of heat. Having prepared cylindric rods of iron, ſteel, copper, braſs, tin, and lead, he expoſed them firſt to a pyrometer with one flame in the middle; then with two flames; and ſucceſſively to one with three, four, and five flames. But previous to this trial, he took care to cool them equally, by expoſing them ſome time upon the ſame ſtone, when it began to freeze, and Fahrenheit's thermometer was at 32 degrees. The effects of which experiment are digeſted in the following table, where the degrees of expanſion are marked in parts equal to the $\frac{1}{12500}$ part of an inch.

Expanſion of	Iron	Steel	Copper	Braſs	Tin	Lead
By one flame.	80	85	89	110	153	155
By two flames placed cloſe together.	117	123	115	220		274
By two flames 2½ inches diſtant.	109	94	92	141	219	263
By three flames placed cloſe together.	142	168	193	275		
By four flames placed cloſe together.	211	270	270	361		
By five flames.	230	310	310	377		

It is to be obſerved of tin, that it will eaſily melt when heated by two flames placed together. Lead commonly melts with three flames placed together, eſpecially if they burn long.

From theſe experiments, it appears at firſt view that iron is the leaſt rarefied of any of theſe metals, whether it be heated by one or more flames; and therefore is moſt proper for making machines or inſtruments which we would have free from any alterations by heat or cold, as the rods of pendulums for clocks, &c. So likewiſe the meaſures of yards or feet ſhould be made of iron, that their length may be as nearly as poſſible the ſame, ſummer and winter.

The expanſion of lead and tin, by only one flame, is nearly the ſame; that is, almoſt double of the expanſion of iron. It is likewiſe obſervable, that the flames placed together, cauſe a greater rarefaction than when they have a ſenſible interval between them; iron in the former caſe, being expanded 117 degrees, and only 109 in the latter; the reaſon of which difference is obvious.

By comparing the expanſions of the ſame metal produced by one, two, three, or more flames, it appears that two flames do not cauſe double the expanſion of one, nor three flames three times that expanſion, but always leſs; and theſe expanſions differ ſo much the more from the ratio of the number of flames as there are more flames acting at the ſame time.

It is alſo obſervable, that metals are not expanded equally at the time of their melting, but ſome more ſome leſs. Thus tin began to run when rarefied 219 degrees; whereas braſs was expanded 377 degrees, and yet was far from melting.

Mr. Ellicot found, upon a medium, that the expanſion of bars of different metals, as nearly of the ſame dimenſions as poſſible, by the ſame degree of heat, were as follow:

Gold,	Silver,	Braſs,	Copper,	Iron,	Steel,	Lead,
73	103	95	89	60	56	149

The great difference between the expanſions of iron and braſs has been applied with good ſucceſs to remedy the irregularities in pendulums ariſing from heat. See PENDULUM.

Mr. Graham uſed to meaſure the minute alterations, in length, of metal bars, by advancing the point of a micrometer-ſcrew, till it ſenſibly ſtopped againſt the end of the bar to be meaſured. This ſcrew, being ſmall and very lightly hung, was capable of agreement within the three or four thouſandth part of an inch. On this general principle Mr. Smeaton contrived his pyrometer, in which the meaſures are determined by the contact of a piece of metal with the point of a micrometer-ſcrew.

The following table ſhows how much a foot in length of each metal grows longer by an increaſe of heat, correſponding to 180° of Fahrenheit's thermometer, or to the difference between freezing and boiling water, expreſſed in ſuch parts of which the unit is equal to the 10,000th part of an inch.

1.	White-glaſs barometer tube,	100
2.	Martial regulus of antimony,	130
3.	Bliſtered ſteel,	138
4.	Hard ſteel,	147
5.	Iron,	151
6.	Biſmuth,	167
7.	Copper hammered,	204
8.	Copper eight parts, with tin one,	218
9	Caſt braſs,	225
10.	Braſs ſixteen parts, with tin one,	229
11.	Braſs wire,	232
12.	Speculum metal,	232
13.	Spelter ſolder, viz. braſs two parts, zinc one,	247
14.	Fine pewter,	274
15.	Grain tin,	298
16.	Soft ſolder, viz lead two, tin one,	301
17.	Zinc eight parts, with tin one, a little hammered,	323
18.	Lead,	344
19.	Zinc or ſpelter,	353
20.	Zinc hammered half an inch per foot,	373

We ſhall cloſe this article with a brief deſcription of a pyrometer lately invented by M. De Luc, in conſequence of a hint ſuggeſted to him by Mr. Ramſden. The baſis of this inſtrument is a rectangular piece of deal board two feet and a half long, 15 inches broad, and one inch and a half thick; and to this all the other parts are fixed. This is mounted in the manner of a table, with four deal legs, each a foot long and an inch and a half ſquare, well fitted near its four angles, and kept together at the other ends by four firm croſs-pieces. This ſmall table is ſuſpended by a hook to a ſtand; the board being in a vertical ſituation in the direction of its grain, and bearing its legs forward in ſuch a manner as that the croſs-pieces which join them may form a frame, placed vertically facing the obſerver. This frame ſuſtains a microſcope, which is firmly fixed in another frame that moves in the former by means of grooves, but with a very conſiderable degree of tightneſs; the friction of which may be increaſed by the preſſure of four ſcrews. The inner ſliding frame, which is likewiſe of deal, keeps the tube of the microſcope in a horizontal poſition, and in great part without the frame, inſomuch that the end which carries the lens is but little within the ſpace between the frame and the board. This microſcope is conſtructed in ſuch a manner as that the object obſerved may be an inch diſtant from the lens; and it has a wire which is ſituated in the focus of the glaſſes, in which the objects appear reverſed. At the top of the apparatus there is a piece of deal, an inch and a half thick and two inches broad, laid in a horizontal direction from the board to the top of the frame. To this piece the rods of the different ſubſtances, whoſe expanſion by heat is to be meaſured, are ſuſpended: one end of it ſlides into a ſocket, which is cut in the thickneſs of the board; and the other end, which reſts upon the frame, meets there with a ſcrew, which makes the piece move backward and forward, to bring the objects to the focus of the microſcope. There is a cork very ſtrongly driven through a hole bored vertically through this piece; and in another vertical hole made through the cork, the rods are fixed at the top; ſo that they hang only, and their dilatation is not counteracted by any preſſure. In order to heat the rods, a cylindrical bottle of thin glaſs, about 21 inches high, and four inches in diameter, is placed in the inſide of the machine, upon a ſtand independent of the reſt of the apparatus. In this bottle the rods are ſuſpended at a little leſs than an inch diſtance from one of the inſides, in order to have them near the microſcope. Into this bottle is poured water of different degrees of heat, which muſt be ſtirred about, by moving upwards and downwards, at one of the ſides of the bottle, a little piece of wood, faſtened horizontally at the end of a ſtick: in this water is hung a thermometer, the ball of which reaches to the middle of the height of the rods. During theſe operations the water riſes to the cork, which thus determines the length of the heated part; the bottle is covered, to prevent the water from cooling too rapidly at the ſurface; and a thin caſe of braſs prevents the vapour from fixing upon the piece of deal to which the rods are fixed.

PYROPHORUS, formed of ϖυρ, *fire*, and φερω, *I bear*, in chemiſtry, the name uſually given to that ſubſtance called by ſome black phoſphorus; a chemical preparation poſſeſſing the ſingular property of kindling ſpontaneouſly when expoſed to the air. This ſubſtance was accidentally diſcovered by M. Homberg, who prepared it of alum and human fæces. See PHOSPHORUS. It was apprehended, for a conſiderable time after the diſcovery, that human fæces were eſſential to the operation, till the youngeſt ſon of the great Lemeri found that honey, ſugar, flour, and indeed any animal or vegetable matter, might be ſubſtituted inſtead of the human fæces; and, ſince that time M. De Sauvigny has ſhown that moſt vitriolic ſalts may be ſubſtituted for the alum; having added to the aluminous pyrophorus of Homberg two other claſſes of ſubſtances of this kind, viz. the metallic, or thoſe made with the three vitriols of iron, copper, and zinc; and the neutral, or thoſe compoſed of vitriolated tartar and Glauber's ſalt.

Mr. Bewly prepares his pyrophorus in the following manner. "I fill (ſays he) half or three-fourths of the bowl of a tobacco-pipe with a mixture, conſiſting of two parts of alum, previouſly calcined in a red-heat, and of powdered charcoal and ſalt of tartar each one part; preſſing the matter down ſlightly, and filling the remainder of the bowl with fine ſand. As ſoon as the powder becomes hot, the ſand lying over it is put into a ſtate of ebullition, which generally continues ſeveral minutes. This appearance ſeems to proceed partly from the vitriolic acid in the alum leaving its earth, and expelling fixed air from the alkali; while another part of it is poſſibly converted into vitriolic acid air. This phenomenon is ſucceeded by the appearance of a blue ſulphureous flame, proceeding from the combination of the ſame acid with what was formerly called the *phlogiſton of the coal*, and which continues about ten minutes or a quarter of an hour. After it ceaſes, no other remarkable appearance preſents itſelf. The matter is now to be kept in a red heat 20 minutes or half an hour; or it may continue there two hours longer, if the operator pleaſes, without any injury to the pyrophorus. The pipe being taken out of the fire, the matter is knocked out of it as ſoon as it becomes cool, and generally pretty ſoon afterwards takes fire ſpontaneouſly."

In another experiment, having added ſucceſſively various and increaſing quantities of fixed alkali to the ſalt heated as above, till the vitriolic acid contained in the mixture might be conſidered merely as an evaneſcent quantity, a pyrophorus was ſtill produced on calcining it with charcoal as before." He alſo mixed equal parts of ſalt of tartar and vegetable or animal coal, or ſometimes three parts of the former with two of the latter, and calcined them in the uſual manner: and this compoſition, on being expoſed to the air, generally kindled in half a minute or a minute; though, as it contained no ſulphur, it did not burn with ſo much vivacity as the vitriolic pyrophori. This, which Mr. Bewly calls the *alkaline pyrophorus*, differs in no circumſtance from M. De Sauvigny's neutral pyrophori, except in its not containing that principle to which he aſcribes their accenſion. However, leſt it might be ſuſpected that the ſalt of tartar which he employed might accidentally contain vitriolated tartar, or vitriolic acid, he repeated the experiment with tartar calcined by himſelf, as well as with nitre fixed or alkaliſed by deflagration with charcoal, and with iron filings; and in all theſe caſes with the ſame reſult. By diverſifying in a like manner M. De Sauvigny's experiments on the metallic pyrophori, Mr. Bewly found that none of the three vitriols, heated with charcoal alone, in his uſual method, could produce a pyrophorus. And thus he found that the addition of an alkaline ſalt to the compoſition, which was a part of M. De Sauvigny's proceſs, was eſſential to its ſucceſs.

Treating in the uſual manner equal parts of calcined green vitriol and charcoal, the powder, which contained no ſulphur nor hepar ſulphuris, did not acquire any of the properties of a pyrophorus. The vitriolic acid ſeemed to have been entirely diſſipated, having no baſe to detain it, when diſlodged from the metallic earth. The charcoal and calx of iron left in this proceſs were calcined again, together with ſome ſalt of tartar: and a pyrophorus was produced, which exhibited indications of its containing a ſcarcely perceptible portion of hepar ſulphuris. Thirty grains of crocus martis aſtringens were calcined with 15 grains of charcoal, and the ſame quantity of ſalt of tartar; and the mixture burnt ſpontaneouſly, though it contained no hepar ſulphuris or vitriolic acid. Having by theſe experiments evinced that metallic pyrophori may be prepared without vitriolic acid, Mr. Bewly proceeded to form an aluminous pyrophorus of the ſame kind. For this purpoſe he procured the earth of alum by a long and violent calcination; and examining a part of it, he found, by the uſual teſts, that it neither contained any ſulphur, hepar ſulphuris, nor alum undecompounded. This he conſidered as perfectly pure, though he afterwards found that it contained a ſmall quantity of vitriolated tartar; and yet it repeatedly furniſhed a pyrophorus, as active as when alum itſelf is employed. From theſe and ſimilar experiments, he infers, that the ſeveral kinds of pyrophori are not kindled by moiſture, attracted by the vitriolic acid, as M. De Sauvigny has maintained: and his concluſion is further confirmed by ſome experiments of Dr. Prieſtley; from which it appears, that they are kindled in dry, nitrous, and what he calls dephlogiſticated air.

M. Prouſt, cited by Mr. Bewly, deſcribes a variety of new pyrophori, which neither contain vitriolic acid, nor ſeem likely to owe their accenſion to the attraction of humidity from the air. Theſe principally conſiſt of a coaly matter ſimply divided by metallic or other earths; ſuch are the ſediment left on the filter in preparing Goulard's extract, various combinations of tartar or its acid, or the acetous acid, with metals, calcareous earth, &c.

Mr. Bewly, having evinced the inſufficiency of M. De Sauvigny's theory, and diſcovered that the pyrophori are not kindled by moiſture, attracted (merely) by the vitriolic acid, directed his attention to the nitrous acid, which Dr. Prieſtly has ſhown to be a conſtituent part of atmoſpherical air, as the probable agent in the production of this phenomenon. The ſtrong affinity which this acid has with phlogiſton, and the heat, and even flame, which it is known to produce with certain inflammable matters, manifeſted that it was equal to the effect; and having excluded the vitriolic acid from having any eſſential concern in this operation, he ſuggeſts, either that the pyrophorus is kindled by moiſture attracted by ſome of the other ingredients which compoſe it; or that it has the power of decompounding atmoſpherical air, by ſuddenly attracting its nitrous acid, and thereby generating a heat ſufficient to kindle the phlogiſtic matter contained in it. This idea appeared plauſible, when he further conſidered that Dr. Prieſtley produced the pureſt reſpirable air with this ſame acid combined with other principles; and that this as well as common air is diminiſhed, and probably in part decompounded, in a variety of phlogiſtic proceſſes. This ingenious writer concludes, upon the whole, from the experiments he has made, that the pyrophorus ſeems to owe its ſingular property to its being a combination of earth or alkali with phlogiſton; the vitriolic acid, when preſent, only occaſionally increaſing or diminiſhing the effect, according to circumſtances. In the proceſs of calcination, the earth or alkaline principle is not merely mixed, but actually, though looſely, combined with the phlogiſtic principle of the coal; ſo that the pyrophorus, conſidering it in its moſt ſimple ſtate, is only a perfectly dry phlogiſticated alkali or earth. On theſe data the phenomena may be explained in the two following methods; with reſpect particularly to the influence of moiſture and heat upon the pyrophorus. Suppoſing either the alkaline or earthy principle to have a greater affinity to water than to the phlogiſton with which either of them is united, they may, on being expoſed to a moiſt atmoſphere, attract the humidity, and thereby ſet the phlogiſtic principle at liberty; which may, in its turn, attract, and be ignited by, the ſuppoſed aerial acid; its ſtrong affinity to which is well known:—or, if this hypotheſis be rejected, the inflammable matter may be kindled, merely in conſequence of the heat produced by the combination of the alkali, &c. with moiſture.

Mr. Keir gives the following deſcription of a proceſs for preparing a new pyrophorus which he has lately diſcovered: "I filled about five-ſixths of the contents of a copper cylindrical box, which had a lid fitted to it, and which was three inches in diameter and two inches in depth, with ſaw-duſt, which I preſſed down; and I laid upon the ſaw-duſt as much well waſhed *plumbum corneum* as entirely filled the box, which I then covered with its lid. I placed the box on the coals of a chamber fire, ſo that its bottom only ſhould be in contact with the fuel, and I kept it on the fire till no more vapour ſeemed to iſſue at the joining of the lid. I then removed it from the fire; and, while it was hot, I cloſed up the joining of the lid with ſealing-wax, by which means the external air was excluded. After it had ſtood in the cold about ten hours, I opened the box; and the corneous lead, which was very white before the operation, was now rendered black by the vapour which had ariſen from the ſaw-duſt, and which was obliged to paſs through the lead before it could eſcape. This black metallic maſs was no ſooner expoſed to the air, than ignited ſparks appeared, which ſpread more and more, while the lead was ſeen to revive in the form of minute globules, and the part which did not revive was changed into a yellow powder, or calx of lead. It is to be obſerved, that before I opened the box, I placed it at the ſide of the fire, in order to melt the ſealing-wax, to enable me to ſeparate the lid. It is poſſible that this ſmall degree of heat may be neceſſary, or conducive, to the accenſion. I ought alſo to acquaint you, that the preparation of this pyrophorus requires nicer attention than that of any with which I am acquainted. For a ſmall exceſs of heat will revive the lead, which will ſpoil the experiment. Alſo, if any air be admitted through the joints of the veſſels employed, the kindling property will be prevented by the abſorption of the air: which in this caſe is generally too gradual to produce inflammation. The metallic ſubſtance in this ſtate of impregnation with inflammable matter, although not a pyrophorus, is an exceeding quick tinder. For when touched, however ſlightly, by an ignited body, it will inſtantly kindle, and the fire will ſpread over the whole piece, reviving the lead wherever it goes, and exhibiting a very beautiful example of metallic reduction, not unlike the familiar experiment of reviving the lead of a wafer containing minium at the flame of a candle; but with this difference, that the fire in the wafer requires to be kept up by flame; whereas in this metallic tinder it ſpreads and creeps ſpontaneouſly along without flame over the maſs.

PYROTECHNY;

THE art of fire, or a ſcience which teaches the management and application of fire in ſeveral operations. See FIRE, FURNACE, CHEMISTRY, DISTILLATION, METALLURGY, &c.

But the term is more particularly uſed to denote the doctrine of artificial fire-works and fire-arms, teaching the ſtructure and uſe, 1. Of thoſe uſed in war, the attacking of fortifications, &c. for which ſee the articles FUSEE, GUN, GUNNERY, GUNPOWDER, MINE, &c.; and, 2. Of thoſe made for amuſement's ſake, as rockets, ſtars, ſerpents, &c. the preparation and conſtruction of which fall to be explained in the preſent article.

SECT. I. *Of Ingredients and Compoſitions.*

1. *Saltpetre.*

Saltpetre being the principal ingredient in fire-works, and a volatile body, by reaſon of its aqueous and aerial parts, is eaſily rarefied by fire; but not ſo ſoon when foul and groſs as when purified from its crude and earthy parts, which greatly retard its velocity: therefore, when any quantity of fire-works are to be made, it ſhould be examined; for if it is not well cleanſed, and of a good ſort, your works will not have their proper effect; neither will it agree with the ſtanding proportions of compoſitions. Therefore,

To refine it, put into a copper, or any other veſſel, 100 lb. of rough nitre with 14 gallons of clean water; let it boil gently half an hour, and as it boils take off the ſcum; then ſtir it, and before it ſettles put it into your filtering bags, which muſt be hung on a rack, with glazed earthen pans under them, in which muſt be ſticks laid acroſs for the cryſtals to adhere to: it muſt ſtand in the pans two or three days to ſhoot; then take out the cryſtals, and let them dry. The water that remains in the pans boil again an hour, and ſtrain it into the pans as before, and the ſaltpetre will be quite clear and tranſparent; if not, it wants more refining; to do which proceed as uſual, till it be well cleanſed of all its earthy parts.

N. B. Thoſe who do not chooſe to procure their ſaltpetre by the above method, may buy it ready done, which for fire-works in general will do.

To pulveriſe Saltpetre. Take a copper kettle, whoſe bottom muſt be ſpherical, and put into it 14 lb. of refined ſaltpetre, with 2 quarts or 5 pints of clean water: then put the kettle on a ſlow fire; and when the ſaltpetre is diſſolved, if any impurities ariſe, ſkim them off, and keep conſtantly ſtirring with two large ſpatulas, till all the water exhales; and when done enough, it will appear like white ſand, and as fine as flour; but if it ſhould boil too faſt, take the kettle off the fire, and ſet it on ſome wet ſand, which will prevent the nitre from ſticking to the kettle. When you have pulveriſed a quantity of ſaltpetre, be careful to keep it in a dry place.

To extract Saltpetre from damaged Gunpowder.—Have ſome filtering bags, hung on a rack, with glazed earthen pans under them, in the ſame manner as thoſe for refining ſaltpetre; then take any quantity of damaged powder, and put it into a copper, with as much clean water as will cover it: when it begins to boil, take off the ſcum; and after it has boiled a few minutes, ſtir it up: then take it out of the copper with a ſmall hand-kettle for that purpoſe, and put ſome into each bag, beginning at one end of the rack, ſo that by the time you have got to the laſt bag, the firſt will be ready for more. Continue thus till all the bags are full: then take the liquor out of the pans; which boil and filter, as before, two or three times, till the water run quite clear, which you muſt let ſtand in the pan ſome time, and the ſaltpetre will appear at top. To get the ſaltpetre entirely out of the powder, take the water from that already extracted, to which add ſome freſh and the dregs of the powder that remain in the bags, and put them in a veſſel, to ſtand as long as you pleaſe: and when you want to extract the nitre, you muſt proceed with this mixture as with the powder at firſt, by which means you will draw out all the ſaltpetre; but this proceſs muſt be boiled longer than the firſt.

2. *Sulphur, or Brimſtone.*

Sulphur is one of the principal ingredients in gun-powder, and almoſt in all compoſitions of fire-works; and therefore great care muſt be taken of its being good, and brought to the higheſt perfection. To know when ſulphur is good, you are to obſerve that it is of a high yellow; and if, when held in one's hand, it crackles and bounces, it is a ſign that it is freſh and good: but as the method of reducing brimſtone to a powder is very troubleſome, it is better to buy the flour ready made, which is done in large quantities, and in great perfection; though when a grand collection of fire-works is to be made, the ſtrongeſt and beſt ſulphur is the lump brimſtone ground in the manner directed in art. 8.

3. *Charcoal.*

Charcoal is a preſervative by which the ſaltpetre and the brimſtone are made into gunpowder, by preventing the ſulphur from ſuffocating the ſtrong and windy exhalation of the nitre. Charcoal for fire-works muſt always be ſoft and well burnt, which may be bought ready done.

4. *Gunpowder.*

See GUNPOWDER in the order of the alphabet. To grind or meal it, is directed in art. 8.

5. *Camphor.*

This may be had in the ſhops; and is of two kinds, differing in regard to the degree of their purity, and diſtinguiſhed by the name of *rough* and *refined*. Refined camphor muſt be choſen of a perfectly clean white colour, very bright and pellucid, of the ſame ſmell and taſte with the rough, but more acrid and pungent. It is ſo volatile, that merchants uſually incloſe it in linſeed, that the viſcoſity of that grain may keep its particles together.

6. *Benjamin.*

This is a reſin found of different ſorts; and diſtinguiſhed by their colours, viz. yellow, gray, and brown; but the beſt is that which is eaſy to break, and full of white ſpots. It is one of the ingredients in odoriferous fire-works, when reduced to a fine flour; which may be done by putting into a deep and narrow earthen pot 3 or 4 oz. of benjamin groſsly pounded; cover the pot with paper, which tie very cloſe round the edge; then ſet the pot on a ſlow fire, and once in an hour take off the paper, and you will find ſome flour ſticking to it, which return again in the pot; this you muſt continue till the flour appears white and fine. There is alſo an oil of benjamin, which is ſometimes drawn from the dregs of the flour; it affords a very good ſcent, and may be uſed in wet compoſitions.

7. *Spur-fire.*

This fire is the moſt beautiful and curious of any yet known; and was invented by the Chineſe, but now is in greater perfection in England than in China. As it requires great trouble to make it to perfection, it will be neceſſary that beginners ſhould have full inſtructions; therefore care ſhould be taken that all the ingredients are of the beſt, that the lamp-black is not damp and clodded, that the ſaltpetre and brimſtone are thoroughly refined. This compoſition is generally rammed in 1 or 2 oz. caſes about 5 or 6 inches long, but not drove very hard; and the caſes muſt have their concave ſtroke ſtruck very ſmooth, and the choak or vent not quite ſo large as the uſual proportion: this charge, when driven and kept a few months, will be much better than when rammed; and will not ſpoil, if kept dry, in many years.

As the beauty of this compoſition cannot be ſeen at ſo great a diſtance as brilliant fire, it has a better effect in a room than in the open air, and may be fired in a chamber without any danger: it is of ſo innocent a nature, that, though with an improper phraſe, it may be called a *cold fire*; and ſo extraordinary is the fire produced from this compoſition, that, if well made, the ſparks will not burn a handkerchief when held in the midſt of them; you may hold them in your hand while burning, with as much ſafety as a candle; and if you put your hand within a foot of the mouth of the caſe, you will feel the ſparks like drops of rain.—When any of theſe ſpur-fires are fired ſingly, they are called *artificial flower-pots*; but ſome of them placed round a tranſparent pyramid of paper, and fired in a large room, make a very pretty appearance.

The compoſition conſiſts of ſaltpetre 4lb. 8 oz. ſulphur 2lb. and lamp-black 1lb. 8 oz.; or, ſaltpetre 1lb. ſulphur $\frac{1}{2}$lb. and lamp black 4 quarts.—This compoſition is very difficult to mix. The ſaltpetre and brimſtone muſt be firſt ſifted together, and then put into a marble mortar, and the lamp-black with them, which you work down by degrees with a wooden peſtle, till all the ingredients appear of one colour, which will be ſomething grayiſh, but very near black: then drive a little into a caſe for trial, and fire it in a dark place; and if the ſparks, which are called *ſtars*, or *pinks*, come out in cluſters, and afterwards ſpread well without any other ſparks, it is a ſign of its being good, otherwiſe not; for if any droſſy ſparks appear, and the ſtars not full, it is then not mixed enough; but if the pinks are very ſmall, and ſoon break, it is a ſign that you have rubbed it too much.

This mixture, when rubbed too much, will be too fierce, and hardly ſhow any ſtars; and, on the contrary, when not mixed enough, will be too weak, and throw out an obſcure ſmoke, and lumps of droſs, without any ſtars. The reaſon of this charge being called the *ſpur-fire*, is becauſe the ſparks it yields have a great reſemblance to the rowel of a ſpur, from whence it takes its name.

8. *To meal Gunpowder, Brimſtone, and Charcoal.*

There have been many methods uſed to grind theſe ingredients to a powder for fire-works, ſuch as large mortars and peſtiles made of ebony and other hard wood, and horizontal mills with braſs barrels: but none have proved ſo effectual and ſpeedy as the laſt invention, that of the mealing-table, repreſented in plate 33. fig. 1. made of elm, with a rim round its edge four or five inches high; and at the narrow end A, is a ſlider that runs in a groove, and forms part of the rim: ſo that when you have taken out of the table as much powder as you can with the copper ſhovel (fig. 2.) ſweep all clean out at the ſlider A. When you are going to meal a quantity of powder, obſerve not to put too much in the table at once; but when you have put in a good proportion, take the muller (fig. 3.) and rub it till all the grains are broke; then ſearce it in a lawn ſieve that has a receiver and top to it; and that which does not paſs through the ſieve, return again to the table, and grind it till you have brought it all fine enough to go through the ſieve. Brimſtone and charcoal are ground in the ſame manner, only the muller muſt be made of ebony; for theſe ingredients being harder than powder, would ſtick in the grain of elm, and be difficult to grind. As brimſtone is apt to ſtick and clod to the table, it will be beſt to keep one for that purpoſe, by which means you will always have your brimſtone clean and well ground.

2d. 8. *To make Wheels and other Works incombuſtible.*

It being neceſſary, when your works are new, to paint them of ſome dark colour; therefore, if, inſtead of which, you make uſe of the following compoſition, it will give them a good colour, and in a great meaſure prevent their taking fire ſo ſoon as if painted. Take brick-duſt, coal-aſhes, and iron-filings, of each an equal quantity, and mix them with a double ſize, made hot. With this waſh over your works, and when dry waſh them over again; this will preſerve the wood greatly againſt fire. Let the brick-duſt and aſhes be beat to a fine powder.

9. *To prepare Caſt iron for Gerbes, white Fountains, and Chineſe Fire.*

Caſt iron being of ſo hard a nature as not to be cut by a file, we are obliged to reduce it into grains, though ſomewhat difficult to perform; but if we conſider what beautiful ſparks this ſort of iron yields, no pains ſhould be ſpared to granulate ſuch an eſſential material: to do which, get at an iron-foundery ſome thin pieces of iron, ſuch as generally run over the mould at the time of caſting: then have a ſquare block made of caſt iron, and an iron ſquare hammer about four pound weight; then, having covered the floor with cloth or ſomething to catch the beatings, lay the thin pieces of iron on the block, and beat them with the hammer till reduced into ſmall grains: which afterwards ſearce with a very fine ſieve, to ſeparate the fine duſt, which is ſometimes uſed in ſmall caſes of brilliant fire, inſtead of ſteel duſt; and when you have got out all the duſt ſift what remains with a ſieve a little larger, and ſo on with ſieves of different ſizes, till the iron paſſes through about the bigneſs of ſmall bird-ſhot: your iron thus beat and ſifted, put each ſort into wooden boxes or oiled paper, to keep it from ruſting. When you uſe it, obſerve the difference of its ſize, in proportion to the caſes for which the charge is intended; for the coarſe ſort is only deſigned for very large gerbes of 6 or 8lb.

10. *Charges for Sky-rockets, &c.*

Rockets of four ounces. Mealed powder 1lb. 4 oz. ſaltpetre 4 oz. and charcoal 2 oz.

Rockets of eight ounces. I. Mealed powder 1lb. ſaltpetre 4 oz. brimſtone 3 oz. and charcoal 1$\frac{1}{2}$ oz. II. Meal powder 1$\frac{1}{2}$lb. and charcoal 4$\frac{1}{2}$ oz.

Rockets of one pound. Meal-powder 2lb. ſaltpetre 8 oz. brimſtone 4 oz. charcoal 2 oz and ſteel filings 1$\frac{1}{2}$ oz.

Sky-rockets in general. I. Saltpetre [illegible]lb. brimſtone 1lb. and charcoal 1$\frac{1}{2}$lb. II. Saltpetre 4lb. brimſtone 1$\frac{1}{2}$lb. charcoal 1lb. 12 oz. and meal-powder 2 oz.

Large Sky rockets. Saltpetre 4lb. meal-powder 1lb. and brimſtone 1lb.

Rockets of a middling ſize. I. Saltpetre 8lb. ſulphur 3lb. meal-powder 3lb. II. Saltpetre 3lb. ſulphur 2lb. meal-powder 1lb. charcoal [illegible]lb.

11. *For Rocket Stars.*

White Stars. Meal-powder 4 oz. ſaltpetre 12 oz. ſulphur vivum 6 oz. oil of ſpike 2 oz. and camphor 5 oz.

Blue Stars. Meal-powder 8 oz. ſaltpetre 4, ſulphur 2, ſpirit of wine 2, and oil of ſpike 2.

Coloured or variegated Stars. Meal-powder 8 drams, rochpetre 4 oz. ſulphur vivum 2, and camphor 2.

Brilliant Stars. Saltpetre 3$\frac{1}{2}$ oz. ſulphur 1$\frac{1}{2}$, and meal-powder $\frac{3}{4}$, worked up with ſpirits of wine only.

Common Stars. Saltpetre 1lb. brimſtone 4 oz. antimony $4\frac{3}{4}$, iſinglaſs $\frac{1}{2}$, camphor $\frac{1}{2}$, and ſpirit of wine $\frac{3}{4}$.

Tailed Stars. Meal powder 3 oz. brimſtone 2, ſaltpetre 1, and charcoal (coarſely ground) $\frac{3}{4}$.

Drove Stars. I. Saltpetre 3lb. ſulphur 1lb. braſs duſt 12 oz. antimony 3. II. Saltpetre 1lb. antimony 4 oz. and ſulphur 8.

Fixed pointed Stars. Saltpetre $8\frac{1}{2}$ oz. ſulphur 2, antimony 1 oz. 10 dr.

Stars of a fine colour. Sulphur 1 oz. meal-powder 1, ſaltpetre 1, camphor 4 dr. oil of turpentine 4 dr.

12. *Rains.*

Gold rain for ſky-rockets. I. Saltpetre 1lb. meal-powder 4 oz. ſulphur 4, braſs-duſt 1, ſaw-duſt $2\frac{1}{4}$, and glaſs-duſt 6 dr. II. Meal-powder 12 oz. ſaltpetre 2, charcoal 4. III. Saltpetre 8 oz. brimſtone 2, glaſs-duſt 1, antimony $\frac{3}{4}$, braſs-duſt $\frac{1}{4}$, and ſaw-duſt 12 dr.

Silver rain. I. Saltpetre 4 oz. ſulphur, meal-powder, and antimony, of each 2 oz. ſal prunella $\frac{1}{2}$ oz. II. Saltpetre $\frac{1}{2}$lb. brimſtone 2 oz. and charcoal 4. III. Saltpetre 1lb. brimſtone $\frac{1}{2}$lb. antimony 6 oz. IV. Saltpetre 4 oz. brimſtone 1, powder 2, and ſteel-duſt $\frac{3}{4}$ oz.

13. *Water Rockets.*

I. Meal-powder 6lb, ſaltpetre 4, brimſtone 3, charcoal 5. II. Saltpetre 1lb. brimſtone $4\frac{1}{2}$ oz. charcoal 6. III. Saltpetre 1lb. brimſtone 4 oz. charcoal 12. IV. Saltpetre 4lb. brimſtone $1\frac{1}{2}$lb. charcoal 1lb. 12 oz. V. Brimſtone 2lb. ſaltpetre 4lb. and meal-powder 4. VI. Saltpetre 1lb. meal-powder 4 oz. brimſtone $8\frac{1}{2}$, charcoal 2. VII. Meal powder 1lb. ſaltpetre 3, brimſtone 1; ſea-coal 1 oz. charcoal $8\frac{1}{2}$, ſaw-duſt $\frac{3}{4}$, ſteel-duſt $\frac{1}{2}$, and coarſe charcoal $\frac{1}{4}$ oz. VIII. Meal-powder $1\frac{3}{4}$lb. ſaltpetre 3, ſulphur $1\frac{1}{2}$, charcoal 12 oz. ſaw-duſt 2.

Sinking charge for water-rockets. Meal-powder 8 oz, charcoal $\frac{3}{4}$ oz.

14. *Of Wheels.*

Wheel caſes from two ounces to four pounds. I. Meal-powder 2lb. ſaltpetre 4 oz. iron-filings 7. II. Meal-powder 2lb. ſaltpetre 12 oz. ſulphur 4, ſteel-duſt 3. III. Meal-powder 4lb. ſaltpetre 1lb. brimſtone 8 oz. charcoal $4\frac{1}{2}$. IV. Meal-powder 8 oz. ſaltpetre 4, ſaw-duſt $1\frac{1}{2}$, ſea-coal $\frac{3}{4}$. V. Meal-powder 1lb. 4 oz. brimſtone 4 oz. 10 dr. ſaltpetre 8 oz. glaſs-duſt $2\frac{1}{2}$. VI. Meal-powder 12 oz. charcoal 1, ſaw-duſt $\frac{1}{2}$. VII. Saltpetre 1lb. 9 oz. brimſtone 4 oz. charcoal $4\frac{1}{2}$. VIII. Meal-powder 2lb. ſaltpetre 1; brimſtone $\frac{1}{2}$, and ſea coal 2. IX. Saltpetre 2lb. brimſtone 1, meal-powder 4, and glaſs duſt 4 oz. X. Meal-powder 1lb. ſaltpetre 2 oz. and ſteel-duſt $3\frac{1}{2}$. XI. Meal-powder 2lb. and ſteel-duſt $2\frac{1}{2}$ oz with $2\frac{1}{2}$ of the fine duſt of beat iron. XII. Saltpetre 2lb. 13 oz. brimſtone 8 oz. and charcoal.

Slow fire for wheels. I. Saltpetre 4 oz. brimſtone 2. and meal-powder $1\frac{1}{2}$. II. Saltpetre 4 oz. brimſtone 1, and antimony 1 oz. 6 dr. III. Saltpetre $4\frac{1}{2}$ oz. brimſtone 1 oz. and mealed-powder $1\frac{1}{2}$.

Dead fire for wheels. I. Saltpetre $1\frac{1}{4}$ oz. brimſtone $\frac{1}{4}$, lapis-calaminaris $\frac{1}{4}$, and antimony 2 dr.

15. *Standing or fixed Caſes.*

I. Meal-powder 4 lb. ſaltpetre 2, brimſtone and charcoal 1. II. Meal-powder 2 lb. ſaltpetre 1, and ſteel-duſt 8 oz. III. Meal-powder 1lb. 4 oz. and charcoal 4 oz. IV. Meal-powder 1 lb. and ſteel-duſt 4 oz. V. Meal-powder $2\frac{1}{2}$ lb. brimſtone 4 oz. and ſea-coal 6. VI. Meal-powder 3 lb. charcoal 5 oz. and ſaw-duſt $1\frac{1}{2}$.

16. *Sun Caſes.*

I. Meal-powder $8\frac{1}{2}$ lb. ſaltpetre 1lb. 2 oz. ſteel-duſt 2 lb. 10 oz. brimſtone 4. II. Meal-powder 3 lb. ſaltpetre 6 oz. and ſteel-duſt $7\frac{1}{2}$.

17. *A brilliant Fire.*

Meal-powder 11 lb. ſaltpetre 1, brimſtone 4 oz. ſteel-duſt $1\frac{1}{2}$ lb.

18. *Gerbes.*

Meal-powder 6 lb. and beat-iron 2 lb. $1\frac{1}{2}$ oz.

19. *Chineſe Fire,*

Saltpetre 12 oz. meal-powder 2 lb. brimſtone 1 lb. 2 oz. and beat-iron 12 oz.

20. *Tourbillons.*

Charge for four-ounce Tourbillons. Meal-powder 2 lb. 4 oz. and charcoal $4\frac{1}{2}$ oz.

Eight-ounce Tourbillons. Meal-powder 2lb. and charcoal $4\frac{3}{4}$ oz.

Large Tourbillons. Meal-powder 2lb. ſaltpetre 1, brimſtone 8 oz. and beat-iron 8.

N. B. Tourbillons may be made very large, and of different coloured fires: only you are to obſerve, that the larger they are, the weaker muſt be the charge; and, on the contrary, the ſmaller, the ſtronger their charge.

21. *Water Balloons.*

I. Saltpetre 4lb. brimſtone 2, meal-powder 2, antimony 4 oz. ſaw-duſt 4, glaſs-duſt $1\frac{1}{4}$. II. Saltpetre 9lb. brimſtone 3lb. meal-powder 6lb. roſin 12 oz. and antimony 8 oz.

22. *Water Squibs.*

I. Meal-powder 1lb. and charcoal 1lb. II. Meal-powder 1lb. and charcoal 9 oz.

23. *Mine Ports or Serpents.*

I. Meal-powder 1lb. and charcoal 1 oz. II. Meal-powder 9 oz. charcoal 1 oz.

24. *Port-fires.*

For firing rockets, &c. I. Saltpetre 12 oz. brimſtone 4 oz. and meal-powder 2 oz. II. Saltpetre 8 oz. brimſtone 4 oz. and meal-powder 2 oz. III. Saltpetre 1lb. 2 oz. meal-powder $1\frac{1}{2}$lb. and brimſtone 10 oz. This compoſition muſt be moiſtened with one gill of linſeed oil. IV. Meal-powder 6 oz. ſaltpetre 2lb. 2 oz. and brimſtone 10 oz. V. Saltpetre 1lb. 4 oz. meal-powder 4 oz. brimſtone 5 oz. ſaw-duſt 8 oz. VI. Saltpetre 8 oz. brimſtone 2 oz. and meal-powder 2 oz.

For illuminations. Saltpetre 1lb. brimſtone 8 oz. and meal-powder 6 oz.

25. *Cones or ſpiral Wheels.*

Saltpetre $1\frac{1}{2}$lb. brimſtone 6 oz. meal-powder 14 oz. and glaſs-duſt 14 oz.

26. *Crowns or Globes.*

Saltpetre 6 oz. brimſtone 2lb. antimony 4 oz. and camphor 2 oz.

27. *Air Balloon Fuzes.*

I. Saltpetre 1lb. 10 oz. brimſtone 8 oz. and meal powder 1lb. 6 oz. II. Saltpetre $1\frac{1}{2}$lb. brimſtone 8 oz. and meal-powder 1lb. 8 oz.

28. *Serpents for Pots des Brins.*

Meal-powder 1lb. 8 oz. ſaltpetre 12 oz. and charcoal 2 oz.

29. *Fire Pumps.*

I. Saltpetre 5lb. brimſtone 1lb. meal powder $1\frac{1}{2}$lb. and glaſs-duſt 1lb. II. Saltpetre 5lb. 8 oz. brimſtone 2lb. meal-powder 1lb. 8 oz. and glaſs-duſt 1lb. 8 oz.

30. *A ſlow white Flame.*

I. Saltpetre 2lb. brimſtone 3lb. antimony 1lb. II. Saltpetre $3\frac{1}{2}$lb. ſulphur $2\frac{1}{2}$lb. meal-powder 1lb. antimony $\frac{1}{2}$lb. glaſs duſt 4 oz. braſs duſt 1 oz.

N. B. Theſe compoſitions, driven $1\frac{1}{4}$ inch in a 1 oz. caſe, will burn one minute; which is much longer time than an equal quantity of any compoſition yet known will laſt.

31. *Amber Lights.*

Meal-powder 9 oz. amber 3 oz. This charge may be drove in ſmall caſes, for illuminations.

32. *Lights of another Kind.*

Saltpetre 3lb. brimſtone 1lb. meal-powder 1lb. antimony $10\frac{1}{2}$ oz. All theſe muſt be mixed with the oil of ſpike.

33. *A red Fire.*

Meal-powder 3lb. charcoal 12 oz. and ſaw-duſt 8 oz.

34. *A common Fire.*

Saltpetre 3lb. charcoal 10 oz. and brimſtone 2 oz.

35. *To make an artificial Earthquake.*

Mix the following ingredients to a paſte with water, and then bury it in the ground, and in a few hours the earth will break and open in ſeveral places. The compoſition: ſulphur 4lb. and ſteel-duſt 4lb.

36. *Compoſitions for Stars of different Colours.*

I. Meal-powder 4 oz. ſaltpetre 2 oz. brimſtone 2 oz. ſteel-duſt $1\frac{1}{2}$ oz. and camphor, white amber, antimony, and mercury ſublimate, of each $\frac{1}{2}$ oz. II. Rochepetre 10 oz. brimſtone, charcoal, antimony, meal powder, and camphor, of each $\frac{1}{4}$ oz. moiſtened with oil of turpentine. Theſe compoſitions are made into ſtars, by working into a paſte, with aqua vitæ, in which has been diſſolved ſome gum-tragacanth: after you have rolled them in powder, make a hole through the middle of each, and ſtring them on quick-match, leaving two inches between each. III. Saltpetre 8 oz. brimſtone 2 oz. yellow amber 1 oz. antimony 1 oz. and powder 3 oz. IV. Brimſtone $2\frac{1}{2}$ oz. ſaltpetre 6 oz. olibanum or frankincenſe in drops 4 oz.; maſtic, and mercury ſublimate, of each 4 oz. meal-powder 5 oz. white amber, yellow amber, and camphor, of each 1 oz. antimony and orpiment $\frac{1}{2}$ oz. each. V. Saltpetre 1lb. brimſtone $\frac{1}{2}$lb. and meal powder 8 oz. moiſtened with petrolio-oil. VI. Powder $\frac{1}{2}$lb. brimſtone and ſaltpetre of each 4 oz. VII. Saltpetre 4 oz. brimſtone 2 oz. and meal-powder 1 oz.

Stars that carry tails of ſparks. I. Brimſtone 6 oz. antimony crude 2 oz. ſaltpetre 4 oz. and roſin 4 oz. II. Saltpetre, roſin, and charcoal, of each 2 oz. brimſtone 1 oz. and pitch, 1 oz.

Theſe compoſitions are ſometimes melted in an earthen pan, and mixed with chopped cotton-match, before they are rolled into ſtars; but will do as well if wetted, and worked up in the uſual manner.

Stars that yield ſome ſparks. I. Camphor 2 oz. ſaltpetre 1 oz. meal powder 1 oz. II. Saltpetre 1 oz. ditto melted $\frac{1}{2}$ oz. and camphor 2 oz. When you would make ſtars of either of theſe compoſitions, you muſt wet them with gum water, or ſpirit of wine, in which has been diſſolved ſome gum arabic, or gum-tragacanth, that the whole may have the conſiſtence of a pretty thick liquid; having thus done, take 1 ounce of lint, and ſtir it about in the compoſition till it becomes dry enough to roll into ſtars.

Stars of a yellowiſh colour. Take 4 oz. of gum-tragacanth or gum-arabic, pounded and ſifted through a fine ſieve, camphor diſſolved in brandy 2 oz. ſaltpetre 1lb. ſulphur $\frac{1}{2}$lb. coarſe powder of glaſs 4 oz. white amber $1\frac{1}{2}$ oz. orpiment 2 oz. Being well incorporated, make them into ſtars after the common method.

Stars of another kind. Take 1lb. of camphor, and melt it in a pint of ſpirit of wine over a ſlow fire; then add to it 1lb. of gum-arabic that has been diſſolved; with this liquor mix 1lb. of ſaltpetre, 6 oz. of ſulphur, and 5 oz. of meal-powder; and after you have ſtirred them well together, roll them into ſtars proportionable to the rockets for which you intend them.

37. *Colours produced by the different Compoſitions.*

As variety of fires adds greatly to a collection of works, it is neceſſary that every artiſt ſhould know the different effect of each ingredient. For which reaſon we ſhall here explain the colours they produce of themſelves; and likewiſe how to make them retain the ſame when mixed with other bodies: as for example, ſulphur gives a blue, camphor a white or pale colour, ſaltpetre a clear white-yellow, amber a colour inclining to yellow, ſal ammoniac a green, antimony a reddiſh, roſin a copper colour, and Greek pitch a kind of bronze, or between red and yellow. All theſe ingredients are ſuch as ſhow themſelves in a flame, viz.

White flame. Saltpetre, ſulphur, meal-powder, and camphor; the ſaltpetre muſt be the chief part.

Blue flame. Meal-powder, ſaltpetre, and ſulphur vivum; ſulphur muſt be the chief: or meal-powder, ſaltpetre, brimſtone, ſpirit of wine, and oil of ſpike; but let the powder be the principal part.

Flame inclining to red. Saltpetre, ſulphur, antimony, and Greek pitch; ſaltpetre the chief.

By the above method may be made various colours of fire, as the practitioner pleaſes; for, by making a few trials, he may cauſe any ingredient to be predominant in colour.

38. *Ingredients that ſhow in Sparks when rammed in choaked Caſes.*

The ſet colours of fire produced by ſparks are divided into four ſorts, viz. the black, white, gray, and red. The black charges are compoſed of two ingredients, which are meal-powder and charcoal; the white of three, viz. ſaltpetre, ſulphur, and charcoal; the gray of four, viz. meal-powder, ſaltpetre, brimſtone, and charcoal; and the red of 3, viz. meal-powder, charcoal, and ſaw-duſt.

There are, beſides theſe four regular or ſet charges, two others, which are diſtinguiſhed by the names of *compound* and *brilliant charges*; the compound being made of many ingredients, ſuch as meal-powder, ſaltpetre, brimſtone, charcoal, ſaw-duſt, ſea-coal, antimony, glaſs-duſt, braſs-duſt, ſteel-filings, caſt iron, tanner's duſt, &c. or any thing that will yield ſparks; all which muſt be managed with diſcretion. The brilliant fires are compoſed of meal powder, ſaltpetre, brimſtone, and ſteel-duſt, or with meal-powder and ſteel-filings only.

39. *Cotton Quick-match,*

Is generally made of ſuch cotton as is put in candles, of ſeveral ſizes, from one to ſix threads thick, according to the pipe it is deſigned for; which pipe muſt be large enough for the match. when made, to be puſhed in eaſily without breaking it. Having doubled the cotton into as many threads as you think proper, coil it very lightly into a flat bottomed copper or earthen pan; then put in the ſaltpetre and the liquor, and boil them about 20 minutes; after which coil it again into another pan, as in pl. 33. fig. 4. and pour on it what liquor remains; then put in ſome meal-powder, and preſs it down with your hands till it is quite wet; afterwards place the pan before the wooden frame (fig. 5.) which muſt be ſuſpended by a point in the centre of each end: and place yourſelf before the pan, tying the upper end of the cotton to the end of one of the ſides of the frame.

When every thing is ready, you muſt have one to turn the frame round, while you let the cotton paſs through your hands, holding it very lightly, and at the ſame time keeping your hands full of the wet powder; but if the powder ſhould be too wet to ſtick to the cotton, put more in the pan, ſo as to keep a continual ſupply till the match is all wound up: you may wind it as cloſe on the frame as you pleaſe, ſo that it do not ſtick together. When the frame is full, take it off the points, and ſift dry meal-powder on both ſides the match till it appear quite dry: in winter the match will be a fortnight before it is fit for uſe; when it is thorougly dry, cut it along the outſide of one of the ſides of the frame, and tie it up in ſkins for uſe.

N. B. The match muſt be wound tight on the frames.

The ingredients for the match, are, cotton 1lb. 12 oz. ſaltpetre 1lb. ſpirit of wine 2 quarts, water 3 quarts, iſinglaſs 3 gills, and meal powder 10lb. To diſſolve 4 oz. of iſinglaſs take 3 pints of water.

2d 39. *Touch paper for capping of Serpents, Crackers, &c.*

Diſſolve in ſpirits of wine or vinegar, a little ſaltpetre; then take ſome purple or blue paper, and wet it with this liquor, and when dry it will be fit for uſe. When you paſte this paper on any of your works, take care that the paſte does not touch that part which is to burn. The method of uſing this paper is by cutting it into ſlips, long enough to go once round the mouth of the ſerpent, cracker, &c. When you paſte on theſe ſlips, leave a little above the mouth of the caſe not paſted; then prime the caſe with meal-powder, and twiſt the paper to a point.

SECT. II. *Of Moulds, Caſes, Mixture, Inſtruments, &c.*

40. *Rocket-moulds.*

As the performance of rockets depends much on their moulds, it is requiſite to give a definition of them, and their proportions. They are made and proportioned by the diameter of their orifice, which is divided into equal parts. Fig. 6. repreſents a mould made by its diameter AB: its height from C to D is 6 diameters and 2 thirds; from D to E is the height of the foot, which is 1 diameter and 2-thirds; F the choak or cylinder, whoſe height is 1 diameter and 1 3d; it muſt be made out of the ſame piece as the foot, and fit tight in the mould; G an iron pin that goes through the cylinder to keep the foot faſt; H the nipple, which is ½ a diameter high, and 2 3ds thick, and of the ſame piece of metal as the former I, whoſe height is 3½ diameters, and at the bottom is 1-3d of the diameter thick, and from thence tapering to 1 6th of the diameter. The beſt way to fix the piercer in the cylinder, is to make that part below the nipple long enough to go quite through the foot, and rivet at bottom. Fig. 7. is a former or roller for the caſes, whoſe length from the handle is 7½ diameters, and its diameter 2-3ds of the bore. Fig. 8. the end of the former, which is of the ſame thickneſs, and 1 diameter and 2-3ds long; the ſmall part which fits into the hole in the end of the roller when the caſe is pinching, is 1 6th and ½ of the mould's diameter thick. Fig. 9. the firſt drift, which muſt be 6 diameters from the handle; and this, as well as all other rammers, muſt be a little thinner than the former, to prevent the facking of the paper when you are driving in the charge. In the end of this rammer is a hole to fit over the piercer: the line K marked on this is 2 diameters and 1-3d from the handle; ſo that, when you are filling the rocket, this line appears at top of the caſe: you muſt then take the ſecond rammer (fig. 10.) which from the handle is 4 diameters, and the hole for the piercer is 1½ diameter long. Fig. 11. is the ſhort and ſolid drift which you uſe when you have filled the caſe as high as the top of the piercer.

Rammers muſt have a collar of braſs at the bottom, to keep the wood from ſpreading or ſplitting, and the ſame proportion muſt be given to all moulds, from 1 oz. to 6lb. We mentioned nothing concerning the handles of the rammers; however, if their diameter be equal to the bore of the mould, and 2 diameters long, it will be a very good proportion: but the ſhorter you can uſe them, the better; for the longer the drift, the leſs will be the preſſure on the compoſition by the blow given with the mallet.

Dimenſions for Rocket Moulds, if the Rockets are rammed ſolid.

Weight of rockets.	Length of the moulds without their feet.	Interior diameter of the moulds.	Height of the nipples.
lb. oz.	Inches.	Inches.	Inches.
6 0	34,7	3,5	1,5
4 0	38,6	2 9	1,4
2 0	13,35	2,1	1,0
1 0	12,25	1,7	0,85
0 8	10,125	1,333, &c.	0,6
0 4	7,75	1,125	0,5
0 2	6,2	0,9	0,45
0 1	4.9	0,7	0,35
0 ½	3,9	0,55	0,25
6 drams	3,5	0,5	0,225
4 drams	2,2	0,3	0,2

The diameter of the nipple muſt always be equal to that of the former.

The thickneſs of the moulds is omitted, being very immaterial, provided they are ſubſtantial and ſtrong.

Our author adviſes thoſe who make rockets for private amuſement, not to ram them ſolid; for it requires a very ſkilful hand, and an expenſive apparatus for boring them, which will be ſhown hereafter. Driving of rockets ſolid is the moſt expeditious method, but not ſo certain as ramming them over a piercer.

41. *Moulds for Wheel-caſes or Serpents.*

Fig. 12. repreſents a mould, in which the caſes are drove ſolid; L the nipple *, with a point † at top, which, when the caſe is filling, ſerves to ſtop the neck, and prevent the compoſition from falling out: which without this point it would do; and, in conſequence, the air would get into the vacancy in the charge, and at the time of firing cauſe the caſe to burſt. Theſe ſort of moulds are made of any length or diameter, according as the caſes are required; but the diameter of the rollers muſt be equal to half the bore, and the rammers made quite ſolid.

42. *To roll Rocket and other Caſes.*

Sky-rocket caſes are to be made 6½ of their exterior diameter long; and all other caſes that are to be filled in moulds muſt be as long as the moulds, within half its interior diameter.

Rocket caſes, from the ſmalleſt to 4 or 6lb. are generally made of the ſtrongeſt ſort of cartridge paper, and rolled dry; but the large ſort are made of paſted paſteboard. As it is very difficult to roll the ends of the caſes quite even, the beſt way will be to keep a pattern of the paper for the different ſorts of caſes; which pattern ſhould be ſomewhat longer than the caſe it is deſigned for, and on it marked the number of ſheets required, which will prevent any paper being cut to waſte. Having cut your papers of a proper ſize, and the laſt ſheet for each caſe with a ſlope at one end, ſo that when the caſes are rolled it may form a ſpiral line round the outſide, and that this ſlope may always be the ſame, let the pattern be ſo cut for a guide. Before you begin to roll, fold down one end of the firſt ſheet, ſo far that the fold will go two or three times round the former: then, on the double edge, lay the former with its handle off the table; and when you have rolled on the paper within two or three turns, lay the next ſheet on that part which is looſe, and roll it all on.

Having thus done, you muſt have a ſmooth board, about 20 inches long, and equal in breadth to the length of the caſe. In the middle of this board muſt be a handle placed lengthwiſe. Under this board lay your caſe, and let one end of the board lie on the table; then preſs hard on it, and puſh it forwards, which will roll the paper very tight: do this three or four times before you roll on any more paper. This muſt be repeated every other ſheet of paper, till the caſe is thick enough; but if the rolling-board be drawn backwards, it will looſen the paper: you are to obſerve, when you roll on the laſt ſheet, that the point of the ſlope be placed at the ſmall end of the roller. Having rolled your caſe to fit the mould, puſh in the ſmall end of the former F, about 1 diameter from the end of the caſe, and put in the end-piece within a little diſtance of the former; then give the pinching-cord one turn round the caſe, between the former and the end-piece; at firſt pull eaſy, and keep moving the caſe, which will make the neck ſmooth, and without large wrinkles. When the caſes are hard to choak, let each ſheet of paper (except the firſt and laſt, in that part where the neck is formed) be a little moiſtened with water: immediately after you have ſtruck the concave ſtroke, bind the neck of the caſe round with ſmall twine, which muſt not be tied in a knot, but faſtened with two or three hitches.

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* The nipple and cylinders to bear the ſame proportion as thoſe for rockets.

† A round bit of braſs, equal in length to the neck of the caſe, and flat at the top.

Having thus pinched and tied the caſe ſo as not to give way, put it into the mould without its foot, and with a mallet drive the former hard on the end piece, which will force the neck cloſe and ſmooth.* This done, cut the caſe to its proper length, allowing from the neck to the edge of the mouth half a diameter, which is equal to the height of the nipple; then take out the former, and drive the caſe over the piercer with the long rammer, and the vent will be of a proper ſize. Wheel caſes muſt be drove on a nipple with a point to cloſe the neck, and make the vent of the ſize required; which, in moſt caſes, is generally ¼ of their interior diameter. As it is very often difficult, when the caſes are rolled, to draw the roller out, you may make a hole through the handle, and put in it a ſmall iron pin, by which you may eaſily turn the former round and pull it out. Fig. 17. ſhows the method of pinching caſes; P a treddle, which, when preſſed hard with the foot, will draw the cord tight, and force the neck as cloſe as you pleaſe; Q a ſmall wheel or pulley, with a groove round it for the cord to run in.

Caſes are commonly rolled wet, for wheels and fixed pieces; and when they are required to contain a great length of charge, the method of making thoſe caſes is thus: Your paper muſt be cut as uſual, only the laſt ſheet muſt not be cut with a ſlope; having your paper ready, paſte each ſheet on one ſide; then fold down the firſt ſheet as before directed: but be careful that the paſte do not touch the upper part of the fold; for if the roller be wetted, it will tear the paper in drawing it out. In paſting the laſt ſheet, obſerve not to wet the laſt turn or two in that part where it is to be pinched; for if that part be damp, the pinching cord will ſtick to it, and tear the paper; therefore, when you choak thoſe caſes, roll a bit of dry paper once round the caſe, before you put on the pinching-cord; but this bit of paper muſt be taken off after the caſe is choaked. The rolling-board, and all other methods, according to the former directions for the rolling and pinching of caſes, muſt be uſed to theſe as well as all other caſes.

43. *To make Tourbillon Caſes.*

Thoſe ſort of caſes are generally made about 8 diameters long; but if very large 7 will be ſufficient: tourbillons will anſwer very well from 4 oz. to 2lb. but when larger there is no certainty. The caſes are beſt rolled wet with paſte, and the laſt ſheet muſt have a ſtraight edge, ſo that the caſe may be all of a thickneſs: when you have rolled your caſes after the manner of wheel-caſes, pinch them at one end quite cloſe; then with the rammer drive the ends down flat, and afterwards ram in about 1-3d of a diameter of dried clay. The diameter of the former for theſe caſes muſt be the ſame as for ſky-rockets.

N. B. Tourbillons are to be rammed in moulds without a nipple, or in a mould without its foot.

44. *Balloon Caſes, or Paper Shells.*

Firſt, you muſt have an oval former turned of ſmooth wood; then paſte a quantity of brown or cartridge paper, and let it lie till the paſte has quite ſoaked through; this done, rub the former with ſoap or greaſe, to prevent the paper from ſticking to it; then lay the paper on in ſmall ſlips, till you have made it 1-3d of the thickneſs of the ſhell intended. Having thus done, ſet it to dry; and when dry, cut it round the middle, and the two halves will eaſily come off: but obſerve, when you cut, to leave about one inch not cut, which will make the halves join much better than if quite ſeparated. When you have ſome ready to join, place the halves even together, paſte a ſlip of paper round the opening to hold them together, and let that dry; then lay on paper all over as before, every where equal, excepting that end which goes downwards in the mortar, which may be a little thicker than the reſt; for that part which receives the blow from the powder in the chamber of the mortar conſequently requires the greateſt ſtrength. When the ſhell is thoroughly dry, burn a round vent at top, with ſquare iron, large enough for the fuze: this method will do for balloons from 4 inches 2-5ths, to eight inches diameter; but if they are larger, or required to be thrown a great height, let the firſt ſhell be turned of elm, inſtead of being made of paper.

For a balloon of 4 inches 2-5ths, let the former be 3 inches 1-8th diameter, and 5½ inches long. For a balloon of 5½ inches, the diameter of the former muſt be 4 inches, and 8 inches long. For a balloon of 8 inches, let the diameter of the former be 5 inches and 15-16ths, and 11 inches 7-8ths long. For a 10-inch balloon, let the former be 7 inches 3-16ths diameter, and 14½ inches long. The thickneſs of a ſhell for a balloon of 4 inches 2-5ths muſt be half an inch. For a balloon of 5½ inches, let the thickneſs of the paper be 5-8ths of an inch. For an 8 inch balloon, 7-8ths of an inch. And for a 10 inch balloon, let the ſhell be 1 inch 1-8th thick.

Shells that are deſigned for ſtars only, may be made quite round, and the thinner they are at the opening, the better; for if they are too ſtrong, the ſtars are apt to break at the burſting of the ſhell: when you are making the ſhell, make uſe of a pair of calibres, or a round gage, ſo that you may not lay the paper thicker in one place than another; and alſo to know when the ſhell is of a proper thickneſs. Balloons muſt always be made to go eaſy into the mortars.

Caſes for illumination Port-fires. Theſe muſt be made very thin of paper, and rolled on formers, from 2 to 5 8ths of an inch diameter, and from 2 to 6 inches long: they are pinched cloſe at one end, and left open at the other. When you fill them, put in but a little compoſition at a time, and ram it in lightly, ſo as not to break the caſe: three or four rounds of paper, with the laſt round paſted, will be ſtrong enough for theſe caſes.

Caſes and moulds for common Port fires. Common port-fires are intended purpoſely to fire the works, their fire being very ſlow, and the heat of the flame ſo intenſe, that, if applied to rockets, leaders, &c. it will fire them immediately. Port-fires may be made of any length, but are ſeldom made more than 21 inches long: the interior diameter of port-fire moulds ſhould be 10-16ths of an inch, and the diameter of the former ½ an inch. The caſes muſt be rolled wet with paſte, and one end pinched, or folded down. The moulds ſhould be made of braſs, and to take in two pieces lengthwiſe; when the caſe is in the two ſides, they are held together by braſs rings, or hoops, which are made to fit over the outſide. The bore of the mould muſt not be made quite through, ſo that there will be no occaſion for a foot. Thoſe port fires, when uſed, are held in copper ſockets, fixed on the end of a long ſtick: theſe ſockets are made like port-crayons, only with a ſcrew inſtead of a ring.

45. *Of mixing the Compoſitions.*

The performance of the principal part of fire-works depends much on the compoſitions being well mixed; therefore great care muſt be taken in this part of the work, paticularly for the compoſition for ſky-rockets. When you have four or five pounds of ingredients to mix, which is a ſufficient quantity at a time (for a larger proportion will not do ſo well), firſt put the different ingredients together; then work them about with your hands, till you think they are pretty well incorporated: after which put them into a lawn ſieve with a receiver and top to it; and if, after it is ſifted, any remains that will not paſs through the ſieve, grind it again till fine enough; and if it be twice ſifted, it will not be amiſs; but the compoſitions for wheels and common works are not ſo material, nor need be ſo fine. But in all fixed works, from which the fire is to play regular, the ingredient muſt be very fine, and great care taken in mixing them well together; and obſerve, that in all compoſitions wherein are ſteel or iron filings, the hands muſt not touch; nor will any works which have iron or ſteel in their charge keep long in damp weather, unleſs properly prepared, according to the following directions.

46. *To preſerve Steel or Iron filings.*

It ſometimes may happen, that fire-works may be required to be kept a long time, or ſent abroad; neither of which could be done with brilliant fires, if made with filings unprepared; for this reaſon, that the ſaltpetre being of a damp nature, it cauſes the iron to ruſt; the conſequence of which is, that when the works are fired, there will appear but very few brilliant ſparks, but inſtead of them a number of red and droſſy ſparks; and beſides, the charge will be ſo much weakened, that if this were to happen to wheels, the fire will hardly be ſtrong enough to force them round. But to prevent ſuch accidents, prepare your filings thus: Melt in a glazed earthen pan ſome brimſtone over a ſlow fire, and when melted throw in ſome filings, which keep ſtirring about till they are covered with brimſtone: this you muſt do while it is on the fire; then take it off, and ſtir it very quick till cold, when you muſt roll it on a board with a wooden roller, till you have broken it as fine as corn powder; after which ſiſt from it as much of the brimſtone as you can. There is another method of preparing filings, ſo as to keep two or three months in winter; this may be done by rubbing them between the ſtrongeſt ſort of brown-paper, which before has been moiſtened with linſeed oil.

N. B. If the brimſtone ſhould take fire, you may put it out, by covering the pan cloſe at top: it is not of much ſignification what quantity of brimſtone you uſe, ſo that there is enough to give each grain of iron a coat; but as much as will cover the bottom of a pan of about one foot diameter, will do for five or ſix pound of filings, or caſt-iron for gerbes.

47. *To drive or ram Sky-rockets*, &c.

Rockets drove over a piercer muſt not have ſo much compoſition put in them at a time as when drove ſolid; for the piercer, taking up great part of the bore of the caſe, would cauſe the rammer to riſe too high; ſo that the preſſure of it would not be ſo great on the compoſition, nor would it be drove everywhere equal. To prevent this, obſerve the following rule: That for thoſe rockets which are rammed over a piercer, let the ladle hold as much compoſition as, when drove, will raiſe the drift $\frac{1}{2}$ the interior diameter of the caſe, and for thoſe drove ſolid to contain as much as will raiſe it $\frac{1}{2}$ the exterior diameter of the caſe: ladles are generally made to go eaſy in the caſe, and the length of the ſcoop about $1\frac{1}{2}$ of its own diameter.

The chager of rockets muſt always be drove 1 diameter above the piercer, and on it muſt be rammed 1-3d of a diameter of clay; through the middle of which bore a ſmall hole to the compoſition, that, when the charge is burnt to the top, it may communicate its fire, through the hole, to the ſtars in the head. Great care muſt be taken to ſtrike with the mallet, and with an equal force, the ſame number of ſtrokes to each ladle-full of charge; otherwiſe the rockets will not riſe with an uniform motion, nor will the compoſition burn equal and regular: for which reaſon they cannot carry a proper tail: for it will break before the rocket has got half way up, inſtead of reaching from the ground to the top, where the rocket breaks and diſperſes the ſtars, rains, or whatever is contained in the head. When you are ramming, keep the drift conſtantly turning or moving; and when you uſe the hollow rammers, knock out of them the compoſition now and then, or the piercer will ſplit them. To a rocket of 4 oz. give to each ladle-full of charge 16 ſtrokes; to a rocket of 1 lb. 28; to a 2-pounder, 36; to a 4-pounder, 42; and to a 6-pounder, 56: but rockets of a larger ſort cannot be drove well by hand, but muſt be rammed with a machine made in the ſame manner as thoſe for driving piles.

The method of ramming of wheel-caſes, or any other ſort in which the charge is drove ſolid, is much the ſame as ſky-rockets; for the ſame proportion may be obſerved in the ladle, and the ſame number of ſtrokes given, according to their diameters, all caſes being diſtinguiſhed by their diameters. In this manner, a caſe, whoſe bore is equal to a rocket of 4 oz. is called a 4-oz. caſe, and that which is equal to an 8-oz. rocket an 8-oz. caſe, and ſo on, according to the different rockets.

Having taught the method of ramming caſes in moulds, we ſhall here ſay ſomething concerning thoſe filled without moulds; which method, for ſtrong paſted caſes, will do extremely well, and ſave the expenſe of making ſo many moulds. The reader muſt here obſerve, when he fills any ſort of caſes, to place the mould on a perpendicular block of wood, and not on any place that is hollow; for we have found by experience, that when caſes were rammed on driving benches, which were formerly uſed, the works frequently miſcarried, on account of the hollow reſiſtance of the benches, which oft jarred and looſened the charge in the caſes; but this accident never happens when the driving blocks are uſed.

When caſes are to be filled without moulds, proceed thus. Have ſome nipples made of braſs or iron, of ſeveral ſorts and ſizes, in proportion to the caſes, and to ſcrew or fix in the top of the driving block; when you have fixed in a nipple, make, at about $1\frac{1}{2}$ inch from it, a ſquare hole in the block, 6 inches deep and 1 inch diameter; then have a piece of wood, 6 inches longer than the caſe intended to be filled, and 2 inches ſquare; on one ſide of it cut a groove almoſt the length of the caſe, whoſe breadth and depth muſt be ſufficient to cover near $\frac{1}{2}$ the caſe; then cut the other end to fit the hole in the block, but take care to cut it ſo that the groove may be of a proper diſtance from the nipple; this half mould being made and fixed tight in the block, cut, in another piece of wood nearly of the ſame length as the caſe, a groove of the ſame dimenſions as as that in the fixed piece; then put the caſe on the nipple, and with a cord tie it and the 2 half-moulds together, and your caſe will be ready for filling.

The dimenſions of the above-deſcribed half-moulds are proportionable for caſes of 8 ounces; but notice muſt be taken, that they differ in ſize in proportion to the caſes.

Note, The clay, mentioned in this article, muſt be prepared after this manner: Get ſome clay, in which there are no ſtones nor ſand, and bake it in an oven till quite dry; then take it out and beat it to a powder, and afterwards ſift it through a common hair-ſieve, and it will be fit for uſe.

48. *Proportion of Mallets.*

The beſt wood for mallets is dry beech. If a perſon uſes a mallet of a moderate ſize, in proportion to the rocket, according to his judgment, and if the rocket ſucceeds, he may depend on the reſt, by uſing the ſame mallet; yet it will be neceſſary that caſes of different ſorts be drove with mallets of different ſizes.

The following proportion of the mallets for rockets of any ſize, from 1 oz. to 6 lb. may be obſerved; but as rockets are ſeldom made leſs than 1 oz. or larger than 6 lb. we ſhall leave the management of them to the curious; but all caſes under 1 oz. may be rammed with an oz. rocket mallet. Your mallets will ſtrike more ſolid, by having their handles turned out of the ſame piece as the head, and made in a cylindrical form. Let their dimenſions be worked by the diameters of the rockets: for example; let the thickneſs of the head be 3 diameters, and its length 4, and the length of the handle 5 diameters, whoſe thickneſs muſt be in proportion to the hand.

49. *Proportion of Sky-rockets, and manner of beading them.*

Fig. 13. repreſents a rocket complete without its ſtick, whoſe length from the neck is 5 diameters 1-6th: the caſes ſhould always be cut to this length after they are filled. M is the head, which is two diameters high, and 1 diameter 1-6th ½ in breadth; N the cone or cap, whoſe perpendicular height muſt be 1 diameter 1-3d. Fig. 14. the collar to which the head is fixed: this is turned out of deal or any light wood, and its exterior diameter muſt be equal to the interior diameter of the head; 1-6th will be ſufficient for its thickneſs, and round the outſide edge muſt be a groove; the interior diameter of the collar muſt not be quite ſo wide as the exterior diameter of the rocket: when this is to be glued on the rocket, you muſt cut two or three rounds of paper off the caſe, which will make a ſhoulder for it to reſt upon. Fig. 15. a former for the head: two or three rounds of paper well paſted will be enough for the head, which, when rolled, put the collar on that part of the former marked O, which muſt fit the inſide of it; then, with the pinching-cord pinch the bottom of the head into the groove, and tie it with ſmall twine. Fig. 16. a former for the cone. To make the caps, cut your paper in round pieces, equal in diameter to twice the length of the cone you intend to make; which pieces being cut into halves, will make two caps each, without waſting any paper; having formed the caps, paſte over each of them a thin white paper, which muſt be a little longer than the cone, ſo as to project about half an inch below the bottom: this projection of paper, being notched and paſted, ſerves to faſten the cap to the head.

When you load the heads of your rockets with ſtars, rains, ſerpents, crackers, ſcrolls, or any thing elſe, according to your fancy, remember always to put one ladlefull of meal-powder into each head, which will be enough to burſt the head, and diſperſe the ſtars, of whatever it contains: when the heads are loaded with any ſort of caſes, let their mouths be placed downwards; and after the heads are filled, paſte on the top of them a piece of paper, before you put on the caps. As the ſize of the ſtars often differ, it would be needleſs to give an axact number for each rocket; but this rule may be obſerved, that the heads may be nearly filled with whatever they are loaded with.

50. *Decorations for Sky-rockets.*

Sky-rockets bearing the pre-eminence of all fire-works, it will not be improper to treat of their various kinds of decorations, which are directed according to fancy. Some are headed with ſtars of different ſorts, ſuch as tailed, brilliant, white, blue, and yellow ſtars, &c.; ſome with gold and ſilver rain; others with ſerpents, crackers, fireſcrolls, marrons; and ſome with ſmall rockets, and many other devices, as the maker pleaſes.

Dimenſions and poiſe of Rocket-ſticks.

Weight of the rocket.		Length of the ſtick.		Thickneſs at top.	Breadth at top.	Square at bottom.	Poiſe from the point of the cone.	
L.	oz.	F.	in.	Inches.	Inches.	Inches.	F.	in.
6	0	14	0	1,5	1,85	0,75	4	1,5
4	0	12	10	1,25	1,40	0,625	3	9,
2	0	9	4	1,125	1,	0,525	2	9,
1	0	8	2	0,725	0,80	0,375	2	1,
	8	6	6	0,5	0,70	0,25	1	10,5
	4	5	3	0,3750	0,55	0,35	1	8,5
	2	4	1	0,3	0,45	0,15	1	3,
	1	3	6	0,25	0,35	0,10	11	0,
	½	2	4	0,125	0,20	0,16	8	0,
	¼	1	10½	0,1	0,15	0,	5	0,5

The laſt column on the right, in the above table, expreſſes the diſtance from the top of the cone, where the ſtick, when tied on, ſhould balance the rocket, ſo as to ſtand in an equilibrium on one's finger or the edge of a knife. The beſt wood for the ſtick is dry deal, made thus: When you have cut and planed the ſticks according to the dimenſions given in the table, cut, on one of the flat ſides at the top, a groove the length of the rocket, and as broad as the ſtick will allow; then on the oppoſite flat ſide, cut two notches for the cord, which ties on the rocket, to lie in: one of theſe notches muſt be near the top of the ſtick, and the other facing the neck of the rockets; the diſtance between theſe notches may eaſily be known, for the top of the ſtick ſhould always touch the head of the rocket. When your rockets and ſticks are ready, lay the rockets in the grooves in the ſticks, and tie them on. Thoſe who, merely for curioſity, may chooſe to make rockets of different ſizes from thoſe expreſſed in the table of dimenſions, may find the length of their ſticks, by making them for rockets, from ½ oz. to 1lb. 60 diameters of the rocket long; and for rockets above 1lb. 50 or 52 diameters will be a good length; their thickneſs at top may be about half a diameter, and their breadth a very little more; their ſquare at bottom is generally equal to half the thickneſs at top. But although the dimenſions of the ſticks be very nicely obſerved, you muſt depend only on their balance; for, without a proper counterpoiſe, your rockets, inſtead of mounting perpendicularly, will take an oblique direction, and fall to the ground before they are burnt out.

51. *Boring Rockets which have been driven ſolid.*

Fig. 18. repreſents the plan of an apparatus, or lathe, for boring of rockets. A the large wheel, which turns the ſmall one B, that works the rammer C: theſe rammers are of different ſizes according to the rockets; they muſt be of the ſame diameter as the top of the bore intended, and continue that thickneſs a little longer than the depth of the bore required, and their points muſt be like that of an augre: the thick end of each rammer muſt be made ſquare, and all of the ſame ſize, ſo as to fit into one ſocket, wherein they are faſtened by a ſcrew D. E the guide for the rammer, which is made to move backwards and forwards: ſo that, after you have marked the rammer 3½ diameters of the rocket from the point, ſet the guide, allowing for the thickneſs of the fronts of the rocket boxes, and the neck and mouth of the rocket; ſo that when the front of the large box is cloſe to the guide, the rammer may not go too far up the charge. F, boxes for holding the rockets, which are made ſo as to fit one in another; their ſides muſt be equal in thickneſs to the difference of the diameters of the rockets, and their interior diameters equal to the exterior diameters of the rockets. To prevent the rocket's turning round while boring, a piece of wood muſt be placed againſt the end of the box in the inſide, and preſſed againſt the tail of the rocket; this will alſo hinder the rammer from forcing the rocket backwards. G, a rocket in the box. H, a box that ſlides under the rocket-boxes to receive the borings for the rockets, which fall through holes made on purpoſe in the boxes; theſe holes muſt be juſt under the mouth of the rocket, one in each box, and all to correſpond with each other.

Fig. 19. is a front view of the large rocket-box. I, an iron plate, in which are holes of different ſizes, through which the rammer paſſes: this plate is faſtened with a ſcrew in the centre, ſo that when you change the rammer, you turn the plate round, but always let the hole you are going to uſe be at the bottom; the fronts of the other boxes muſt have holes in them to correſpond with thoſe in the plate. K, the lower part of the large box; which is made to fit the inſide of the lathe, that all the boxes may move quite ſteadily.

Fig. 20. is a perſpective view of the leathe. L, the guide for the rammer, which is ſet by the ſcrew at bottom.

Fig. 21. A view of the front of the guide facing the rammer. M, an iron plate, of the ſame dimenſions as that on the front of the box, and placed in the ſame direction, and alſo to turn on a ſcrew in the centre. N, the rocket-box which ſlides backwards and forwards: when you have fixed a rocket in the box,

puſh it forwards againſt the rammer; and when you think the ſcoop of the rammer is full, draw the box back, and knock out the compoſition: this you muſt do till the rocket is bored, or it will be in danger of taking fire; and if you bore in a hurry, wet the end of the rammer now and then with oil to keep it cool.

Having bored a number of rockets, you muſt have taps of different ſorts according to the rockets. Theſe taps are a little longer than the bore: but when you uſe them, mark them 3½ diameters from the point, allowing for the thickneſs of the rocket's neck; then, holding the rocket in one hand, you tap it with the other. One of theſe taps is repreſented by fig. 22. They are made in the ſame proportion as the fixed piercers, and are hollowed their whole length.

52. *Hand Machine uſed for boring of Rockets inſtead of a Lathe.*

Theſe ſort of machines anſwer very well, though not ſo expeditious as the lathes. But they are not ſo expenſive to make, and they may be worked by one man; whereas the lathe will require three. Fig. 23. repreſents the machine. O, the rocket boxes, which are to be fixed, and not to ſlide as thoſe in the lathe. PQ are guides for the rammers that are made to ſlide together, as the rammer moves forward: the rammers for theſe ſorts of machines muſt be made of a proper length, allowing for the thickneſs of the front of the boxes, and the length of the mouth and neck of the caſe; on the ſquare end of theſe rammers muſt be a round ſhoulder of iron, to turn againſt the outſide of the guide Q, by which means the guides are forced forwards. R, the ſtock which turns the rammer, and while turning muſt be preſſed towards the rocket by the body of the man who works it; all the rammers are to be made to fit one ſtock.

To make large Gerbes.

Fig. 1. in plate 34. repreſents a wooden former; fig. 2. a gerbe complete, with its foot or ſtand. The caſes for gerbes are made very ſtrong, on account of the ſtrength of the compoſition; which, when fired, comes out with great velocity: therefore, to prevent their burſting, the paper ſhould be paſted, and the caſes made as thick at the top as at the bottom. They ſhould alſo have very long necks, for this reaſon; firſt, that the particles of iron will have more time to be heated, by meeting with greater reſiſtance in getting out, than with a ſhort neck, which would be burnt too wide before the charge be conſumed, and ſpoil the effect: ſecondly, that with long necks the ſtars will be thrown to a great height, and will not fall before they are ſpent, or ſpread too much; but, when made to perfection, will riſe and ſpread in ſuch a manner as to form exactly a wheat ſheaf.

In the ramming of gerbes, there will be no need of a mould, the caſes being ſufficiently ſtrong to ſupport themſelves. But you are to be careful, before you begin to ram, to have a piece of wood made to fit in the neck; for if this be not done, the compoſition will fall into the neck, and leave a vacancy in the caſe, which will cauſe the caſe to burſt ſo ſoon as the fire arrives at the vacancy. You muſt likewiſe obſerve, that the firſt ladle of charge, or ſecond, if you think proper, be of ſome weak compoſition. When the caſe is filled, take out the piece of wood, and fill the neck with ſome ſlow charge. Gerbes are generally made about 6 diameters long, from the bottom to the top of the neck; their bore muſt be 1-5th narrower at top than at bottom. The neck S is 1-6th diameter and ¾ long. T, a wooden foot or ſtand, on which the gerbe is fixed. This may be made with a choak or cylinder four or five inches long to fit the inſide of the caſe, or with a hole in it to put in the gerbe; both theſe methods will anſwer the ſame. Gerbes produce a moſt brilliant fire, and are very beautiful when a number of them are fixed in the front of a building or a collection of fireworks.

N. B. Gerbes are made by their diameters, and their caſes at bottom ¼ thick. The method of finding the interior diameter of a gerbe is thus: Suppoſing you would have the exterior diameter of the caſe, when made, to be 5 inches, then, by taking 2-4ths for the ſides of the caſe, there will remain 2½ inches for the bore, which will be a very good ſize. This ſort of gerbes ſhould be rammed very hard.

54. *Small Gerbes, or white Fountains.*

May be made of 4 oz. 8 oz. or 1 lb. caſes, paſted and made very ſtrong, of what length you pleaſe: but, before you fill them, drive in clay one diameter of their orifice high; and when you have filled a caſe, bore a vent through the centre of the clay to the compoſition: the common proportion will do for the vent, which muſt be primed with a ſlow charge. Theſe ſort of caſes, without the clay, may be filled with Chineſe fire.

55. *To make Paſteboard and Paper Mortars.*

In plate 34. fig. 3. repreſents a former, and fig. 4. an elm foot, for the mortar. Fig. 5. repreſents a mortar complete: theſe mortars are beſt when made with paſteboard, well paſted before you begin; or, inſtead of paſte, you may uſe glue. For a coehorn mortar, which is 4 inches 2 5ths diameter, roll the paſteboard on the former 1-6th of its diameter thick; and, when dry, cut one end ſmooth and even; then nail and glue it on the upper part of the foot: when done, cut off the paſteboard at top, allowing for the length of the mortar 2½ diameters from the mouth of the powder-chamber; then bind the mortar round with a ſtrong cord wetted with glue. U, the bottom part of the foot 1 diameter 2-3ds broad, and 1 diameter high; and that part which goes into the mortar is 2-3ds of its diameter high. W, is a copper chamber for powder, made in a conical form; and is 1-3d of the diameter wide, 1½ of its own diameter long. In the centre of the bottom of this chamber, make a ſmall hole a little way down the foot; this hole muſt be met by another of the ſame ſize, made in the ſide of the foot, as is ſhown in the figure. If theſe holes are made true, and a copper pipe fitted into both, the mortar when loaded will prime itſelf; for the powder will naturally fall to the bottom of the firſt hole; then by putting a bit of quick-match in the ſide hole, your mortar will be ready to be fired.

Mortars of 5½, eight and ten inches diameter, may be made of paper or paſteboard, by the above method, and in the ſame proportion; but if larger, it will be beſt to have them made of braſs. *N. B.* The copper chamber muſt have a ſmall rim round its edge with holes in it, for ſcrews to make it faſt in the foot.

SECT. III. *To load Air-balloons, with the number of Stars, Serpents, Snakes, Rain-falls, &c. in Shells of each nature.*

56. *Mortars to throw Aigrettes, &c.*

WHEN you fill your ſhells, you muſt firſt put in the ſerpents, rains, ſtars, &c. or whatever they are compoſed of; then the blowing powder; but the ſhells muſt not be quite filled. All thoſe things muſt be put in at the fuze hole; but marrons being too large to go in at the fuze hole, muſt be put in before the inſide ſhall be joined. When the ſhells are loaded, glue and drive in the fuzes very tight. For a coehorn balloon, let the diameter of the fuze-hole be ⅞ths of an inch; for a royal balloon, which is near 5½ inches diameter, make the fuze-hole 1 inch ⅙ diameter; for an 8-inch balloon, 1 inch ⅜ths; and for a 10 inch balloon, 1 inch ⅝ths,

Air-balloons are divided into four ſorts, viz. firſt, illuminated balloons; ſecond, balloons of ſerpents; third, balloons of reports, marrons, and crackers; and fourth, compound balloons. The number and quantities of each article for the different ſhells are as follow:

Coehorn balloon illuminated.	oz.
Meal powder	1½
Corn powder	0½
Powder for the mortar	2

Length of the fuze compoſition, $\frac{3}{4}$ths of an inch; 1 oz. drove or rolled ſtars, as many as will nearly fill the ſhell.

Coehorn balloon of ſerpents.

	oz.
Meal powder	$1\frac{1}{4}$
Corn powder	1
Powder for the mortar	$2\frac{1}{4}$

Length of the fuze compoſition $\frac{13}{16}$ths of an inch: half-ounce caſes drove 3 diameters, and bounced 3 diameters, and half-ounce caſes drove 2 diameters and bounced 4, of each an equal quantity, and as many of them as will fit in eaſily placed head to tail.

Coehorn balloons of crackers and reports.

	oz.
Meal powder	$1\frac{1}{4}$
Corn powder	$0\frac{3}{4}$
Powder for the mortar	2

Length of the fuze compoſition $\frac{3}{4}$ths of an inch. Reports 4, and crackers of 6 bounces as many as will fill the ſhell.

Compound coehorn balloons.

	oz.	dr.
Meal powder	1	4
Corn powder	0	12
Powder for the mortar	2	4

Length of the fuze compoſition $\frac{13}{16}$ths of an inch: half-ounce caſes drove $3\frac{1}{2}$ diameters and bounced 2, 16; half-ounce caſes drove 4 diameters and not bounced, 10; blue ſtrung ſtars, 10; rolled ſtars, as many as will complete the balloon.

Royal balloons illuminated.

	oz.	dr.
Meal powder	1	8
Corn powder	0	12
Powder for the mortar	3	0

Length of the fuze compoſition $\frac{15}{16}$ths of an inch; 2-ounce ſtrung ſtars, 34; rolled ſtars, as many as the ſhell will contain, allowing room for the fuze.

Royal balloons of ſerpents.

	oz.	dr.
Meal powder	1	0
Corn powder	1	8
Powder for the mortar	3	8

Length of the fuze compoſition 1-inch: 1-ounce caſes drove $3\frac{1}{2}$ and 4 diameters, and bounced 2, of each an equal quantity, ſufficient to load the ſhell.

Royal balloons with crackers and marrons.

	oz.	dr.
Meal powder	1	8
Corn powder	1	4
Powder for firing the mortar	3	0

Length of the fuze compoſition $\frac{14}{16}$ths of an inch; reports 12, and completed with crackers of 8 bounces.

Compound royal balloons.

	oz.	dr.
Meal powder	1	5
Corn powder	1	6
Powder for the mortar	3	12

Length of the fuze compoſition 1 inch: half-ounce caſes drove and bounced 2 diameters, 8; 2-ounce caſes filled $\frac{3}{8}$ths of an inch with ſtar compoſition, and bounced 2 diameters, 8; ſilver rain-falls, 10; 2 ounce tailed ſtars, 16; rolled brilliant ſtars, 30. If this ſhould not be ſufficient to load the ſhell, you may complete it with gold rain-falls.

Eight-inch balloons illuminated.

	oz.	dr.
Meal powder	2	8
Corn powder	1	4
Powder for the mortar	9	0

Length of the fuze compoſition 1 inch $\frac{1}{8}$th: 2-ounce drove ſtars, 48; 2-ounce caſes drove with ſtar compoſition $\frac{3}{8}$ths of an inch, and bounced 3 diameters, 12; and the balloon completed with 2 ounce drove brilliant ſtars.

Eight-inch balloons of ſerpents.

	oz.	dr.
Meal powder	2	0
Corn powder	2	0
Powder for the mortar	9	8

Length of the fuze compoſition 1 inch $\frac{3}{16}$ths: 2-ounce caſes drove $1\frac{1}{2}$ diameter and bounced 2, and 1 ounce caſes drove 2 diameters and bounced $2\frac{1}{2}$, of each an equal quantity ſufficient for the ſhell.

N. B. The ſtar compoſition drove in bounced caſes muſt be managed thus: Firſt, the caſes muſt be pinched cloſe at one end, then the corn-powder put in for a report, and the caſe pinched again cloſe to the powder, only leaving a ſmall vent for the ſtar compoſition, which is drove at top, to communicate to the powder at the bounce end.

Compound eight-inch balloons.

	oz.	dr.
Meal powder	2	8
Corn powder	1	12
Powder for the mortar	9	4

Length of the fuze compoſition $\frac{1}{8}$th: 4 ounce caſes drove with ſtar compoſition $\frac{3}{8}$ths of an inch, and bounced 3 diameters, 16; 2-ounce tailed ſtars, 16; 2-ounce drove briliant ſtars, 12; ſilver rain-falls, 20; 1-ounce drove blue ſtars, 20; and 1-ounce caſes drove and bounced 2 diameters, as many as will fill the ſhell.

Another of eight inches.

	oz.	dr.
Meal powder	2	8
Corn powder	1	12
Powder for the mortar	9	4

Length of the fuze compoſition 1 inch $\frac{1}{8}$th: crackers of 6 reports, 10; gold rains, 14; 2-ounce caſes drove with ſtar compoſition $\frac{3}{8}$ths of an inch, and bounced 2 diameters, 16; 2-ounce tailed ſtars, 16; 2-ounce drove brilliant ſtars, 12; ſilver rains, 10; 1-ounce drove blue ſtar, 20; and 1-ounce caſes drove with a brilliant charge 2 diameters and bounced 3, as many as the ſhell will hold.

A compound ten-inch balloon.

	oz.	dr.
Meal powder	3	4
Corn powder	2	8
Powder for the mortar	12	8

Length of the fuze compoſition $\frac{15}{16}$ths of an inch: 1-ounce caſes drove and bounced 3 diameters 16. Crackers of 8 reports, 12; 4-ounce caſes drove $\frac{1}{2}$ inch with ſtar compoſition, and bounced 2 diameters, 14; 2-ounce caſes drove with brilliant fire $1\frac{1}{4}$ diameter, and bounced 2 diameters, 16: 2-ounce drove bril. ſtars, 30: 2-ounce drove blue ſtars, 3; gold rains, 20; ſilver rains, 20. After all theſe are put in, fill the remainder of the caſe with tailed and rolled ſtars.

Ten-inch balloons of three charges.

	oz.	dr.
Meal powder	3	0
Corn powder	3	2
Powder for the mortar	13	0

Length of the fuze compoſition 1 inch. The ſhell muſt be loaded with 2-ounce caſes, drove with ſtar compoſition $\frac{1}{4}$th of an inch, and on that 1 diameter of gold fire; then bounced 3 diameters; or with 2-ounce caſes firſt filled 1 diameter with gold fire, then $\frac{1}{4}$th of an inch with ſtar compoſition, and on that $1\frac{1}{4}$th diameter of brilliant fire. Theſe caſes muſt be well ſecured at top of the charge, leſt they ſhould take fire at both ends: but their necks muſt be larger than the common proportion.

57. *To make Balloon Fuzes.*

Fuzes for air-balloons are ſometimes turned out of dry beech, with a cup at top to hold the quick-match, as you ſee in fig. 5. but if made with paſted paper, they will do as well: the diameter of the former for fuzes for coehorn balloons muſt be $\frac{1}{2}$ an inch; for a royal fuze, $\frac{5}{8}$ths of an inch; for an 8-inch fuze, $\frac{3}{4}$ths of an inch; and for a 10-inch fuze, $\frac{7}{8}$ths of an inch. Having rolled your caſes, pinch and tie them almoſt cloſe at one end; then drive them down, and let them dry. Before you begin to fill them, mark on the outſide of the caſe the length of the charge required, allowing for the thickneſs of the bottom; and when you have rammed in the compoſition, take two pieces of quick-match about 6 inches long, and lay one end of each on the charge, and then a little meal-powder, which ram down hard; the looſe ends of the match double up into the top of the fuze, and cover it with a paper cap to keep it dry. When you put the ſhells in the mortars, uncap the fuzes, and pull out the looſe ends of the match, and let them hang on the ſides of the balloons. The uſe of the match is, to receive the fire from the powder in the chamber of the mortar, in order to light the fuze: the ſhell being put in the mortar with the fuze uppermoſt, and exactly in the centre, ſprinkle over it a little meal-powder, and it will be ready to be fired. Fuzes made of wood muſt be longer than thoſe of paper, and not bored quite through, but left ſolid about half an inch at bottom; and when you uſe them, ſaw them off to a proper length, meaſuring the charge from the cup at top.

58. *Tourbillons.*

Having filled ſome caſes within about $1\frac{1}{2}$ diameter, drive in a ladleful of clay; then pinch their ends cloſe, and drive them down with a mallet. When done, find the centre of gravity of each caſe; where you nail and tie a ſtick, which ſhould he half an inch broad at the middle, and run a little narrower to the ends: theſe ſticks muſt have their ends turned upwards, ſo that the caſes may turn horizontally on their centres: at the oppoſite ſides of the caſes, at each end, bore a hole cloſe to the clay with a gimlet, the ſize of the neck of a common caſe of the ſame nature; from theſe holes draw a line round the caſe, and at the under part of the caſe bore a hole with the ſame gimlet, within one-half diameter of each line towards the centre; then from one hole to the other draw a right line. This line divide into three equal parts; and at X and Y (fig. 6.) bore a hole; then from theſe holes to the other two lead a quick-match, over which paſte a thin paper. Fig. 7. repreſents a tourbillon as it ſhould lie to be fired, with a leader from one ſide-hole A to the other B. When you fire tourbillons, lay them on a ſmooth table, with their ſticks downwards, and burn the leader through the middle with a port-fire. They ſhould ſpin three or four ſeconds on the table before they riſe, which is about the time the compoſition will be burning from the ſide-holes to thoſe at bottom.

To tourbillons may be fixed reports in this manner: in the centre of the caſe at top make a ſmall hole, and in the middle of the report make another; then place them together, and tie on the report, and with a ſingle paper ſecure it from fire: this done, your tourbillon is completed. By this method you may fix on tourbillons ſmall cones of ſtars, rains, &c. but be careful not to load them too much. One eighth of an inch will be enough for the thickneſs of the ſticks, and their length equal to that of the caſes.

59. *To make Mortars to throw Aigrettes, and to load and fire them.*

Mortars to throw aigrettes are generally made of paſteboard, of the ſame thickneſs as balloon mortars, and $2\frac{1}{2}$ diameters long in the inſide from the top of the foot: the foot muſt be made of elm without a chamber, but flat at top, and in the ſame proportion as thoſe for balloon mortars; theſe mortars muſt alſo be bound round with a cord as before mentioned: ſometimes 8 or 9 of theſe mortars, of about three or four inches diameter, are bound all together, ſo as to appear but one; but when they are made for this purpoſe, the bottom of the foot muſt be of the ſame diameter as the mortars, and only $\frac{1}{2}$ diameter high. Your mortars being bound well together, fix them on a heavy ſolid block of wood. To load theſe mortars, firſt put on the inſide bottom of each a piece of paper, and on it ſpread $1\frac{1}{2}$ oz. of meal and corn-powder mixed; then tie your ſerpents up in parcels with quick-match, and put them in the mortar with their mouths downwards; but take care the parcels do not fit too tight in the mortars, and that all the ſerpents have been well primed with powder wetted with ſpirit of wine. On the top of the ſerpents in each mortar lay ſome paper or tow; then carry a leader from one mortar to the other all round, and then from all the outſide mortars into that in the middle: theſe leaders muſt be put between the caſes and the ſides of the mortar, down to the powder at bottom: in the centre of the middle mortar fix a fire-pump, or brilliant fountain, which muſt be open at bottom, and long enough to project out of the mouth of the mortar; then paſte paper on the tops of all the mortars.

Mortars thus prepared are called a *neſt of ſerpents*, as repreſented by fig. 8. When you would fire theſe mortars, light the fire pump C, which when conſumed will communicate to all the mortars at once by means of the leaders. For mortars of 6, 8, or 10 inches diameter, the ſerpents ſhould be made in 1 and 2-ounce caſes 6 or 7 inches long, and fired by a leader brought out of the mouth of the mortar, and turned down the outſide, and the end of it covered with paper to prevent the ſparks of the other works from ſetting it on fire. For a ſix inch mortar, let the quantity of powder for firing be 2 oz. for an 8-inch $2\frac{3}{4}$ oz. and for a 10-inch, $3\frac{1}{4}$ oz. Care muſt be taken in theſe, as well as ſmall mortars, not to put the ſerpents in too tight, for fear of burſting the mortars. Theſe mortars may be loaded with ſtars, crackers, &c.

If the mortars, when loaded, are ſent to any diſtance, or liable to be much moved, the firing powder ſhould be ſecured from getting amongſt the ſerpents, which would endanger the mortars, as well as hurt their performance. To prevent which, load your mortars thus: Firſt put in the firing powder, and ſpread it equally about; then cut a round piece of blue touch-paper, equal to the exterior diameter of the mortar, and draw on it a circle equal to the interior diameter of the mortar, and notch it all round as far as that circle; then paſte that part which is notched, and put it down the mortar cloſe to the powder, and ſtick the paſted edge to the mortar: this will keep the powder always ſmooth at bottom, ſo that it may be moved or carried anywhere without receiving damage. The large ſingle mortars are called *pots des agriettes.*

60. *Making, loading, and firing, of Pots des Brins.*

Theſe are formed of paſteboard, and muſt be rolled pretty thick. They are uſually made 3 or 4 inches in diameter, and 4 diameters long; and pinched with a neck at one end, like common caſes. A number of theſe are placed on a plank thus: Having fixed on a plank two rows of wooden pegs, cut in the bottom of the plank a groove the whole length under each row of pegs; then, through the centre of each peg, bore a hole down to the groove at bottom, and on every peg fix and glue a pot, whoſe mouth muſt fit tight on the peg: through all the holes run a quick-match, one end of which muſt go into the pot, and the other into the groove, which muſt have a match laid in it from end to end, and covered with paper, ſo that when lighted at one end it may diſcharge the whole almoſt inſtantaneouſly: in all the pots put about 1 oz. of meal and corn-powder; then in ſome put ſtars, and in others rains, ſnakes, ſerpents, crackers, &c.; when they are all loaded, paſte paper over their mouths. Two or three hundred of theſe pots being fired together make a very pretty ſhow, by affording ſo great a variety of fires. Fig. 9. is a range of pots des brins, with a leader A, by which they are fired.

61. *Pots des Sauciſſons.*

Are generally fired out of large mortars without chambers, the ſame as thoſe for aigrettes, only ſomewhat ſtronger. Sauciſſons are made of 1 and 2 ounce caſes, 5 or 6 inches long and choaked in the ſame manner as ſerpents. Half the number which the mortar contains muſt be drove $1\frac{1}{2}$ diameter with compoſition, and the other half two diameters, ſo that when fired they may give two volleys of reports. But if the mortars are very ſtrong, and will bear a ſufficient charge to throw the ſauciſſons very high, you may make three volleys of reports, by dividing the number of caſes into three parts, and making a difference in the height of the charge. After they are filled, pinch and tie them at top of the charge almoſt cloſe; only leaving a ſmall vent to communicate the fire to the upper part of the caſe, which muſt be filled with corn-powder very near the top; then pinch the end quite cloſe, and tie it: after this is done, bind the caſe very tight with waxed packthread, from the choak at top of the compoſition to the end of the caſe; this will make the caſe very ſtrong in that part, and cauſe the report to be very loud. Sauciſſons ſhould be rolled a little thicker of paper than the common proportion. When they are to be put in the mortar, they muſt be primed in their mouths, and fired by a caſe of brilliant fire fixed in their centre.

The charge of theſe mortars ſhould be $\frac{1}{6}$th or $\frac{1}{8}$th more than for *pots des aigrettes* of the ſame diameter.

Sect. IV. *Different kinds of Rockets, with their Appendages and Combinations.*

62. *To fix one Rocket on the top of another.*

When ſky-rockets are thus managed, they are called *towering rockets*, on account of their mounting ſo very high. Towering rockets are made after this manner: Fix on a pound rocket a head without a collar; then take a four-ounce rocket, which may be headed or bounced, and rub the mouth of it with meal-powder wetted with ſpirit of wine: when done, put it in the head of the large rocket with its mouth downwards; but before you put it in, ſtick a bit of quick-match in the hole of the clay of the pound-rocket, which match ſhould be long enough to go a little way up the bore of the ſmall rocket, to fire it when the large is burnt out, the 4-ounce rocket being too ſmall to fill the head of the other, roll round it as much tow as will make it ſtand upright in the centre of the head: the rocket being thus fixed, paſte a ſingle paper round the opening of the top of the head of the large rocket. The large rocket muſt have only half a diameter of charge rammed above the piercer; for, if filled to the uſual height, it would turn before the ſmall one takes fire, and entirely deſtroy the intended effect: when one rocket is headed with another, there will be no occaſion for any blowing powder; for the force with which it ſets off will be ſufficient to diſengage it from the head of the firſt fired rocket. The ſticks for theſe rockets muſt be a little longer than for thoſe headed with ſtars, rains, &c.

63. *Caduceus Rockets.*

In riſing, form two ſpiral lines, or double worm, by reaſon of their being placed obliquely, one oppoſite the other; and their counterpoiſe in their centre, which cauſes them to riſe in a vertical direction. Rockets for this purpoſe muſt have their ends choaked cloſe, without either head or bounce, for a weight at top would be a great obſtruction to their mounting; though I have known them ſometimes to be bounced, but then they did not riſe ſo high as thoſe that were not; nor do any caduceus rockets aſcend ſo high as ſingle, becauſe of their ſerpentine motion, and likewiſe the reſiſtance of air, which is much greater than two rockets of the ſame ſize would meet with if fired ſingly.

By fig. 19. you ſee the method of fixing theſe rockets: the ſticks for this purpoſe muſt have all their ſides alike, which ſides ſhould be equal to the breadth of a ſtick proper for a ſky-rocket of the ſame weight as thoſe you intend to uſe, and to taper downwards as uſual, long enough to balance them, one length of a rocket from the croſs ſtick; which muſt be placed from the large ſtick 6 diameters of one of the rockets, and its length 7 diameters; ſo that each rocket, when tied on, may form with the large ſtick an angle of 60 degrees. In tying on the rockets, place their heads on the oppoſite ſides of the croſs ſtick, and their ends on the oppoſite ſides of the long ſtick; then carry a leader from the mouth of one into that of the other. When theſe rockets are to be fired, ſuſpend them between two hooks or nails, then burn the leader through the middle, and both will take fire at the ſame time. Rockets of 1 lb. are a good ſize for this uſe.

64. *Honorary Rockets,*

Are the ſame as ſky rockets, except that they carry no head nor report, but are cloſed at top, on which is fixed a cone; then on the caſe, cloſe to the top of the ſtick, you tie a 2-ounce caſe, about 5 or 6 inches long, filled with a ſtrong charge, and pinched cloſe at both ends; then in the reverſe ſides, at each end, bore a hole in the ſame manner as in tourbillons; from each hole carry a leader into the top of the rocket. When the rocket is fired, and arrived to its proper height, it will give fire to the caſe at top; which will cauſe both rocket and ſtick to ſpin very faſt in their return, and repreſent a worm of fire deſcending to the ground.

There is another method of placing the ſmall caſe, which is by letting the ſtick riſe a little above the top of the rocket, and tying the caſe to it, ſo as to reſt on the rocket: theſe rockets have no cones.

There is alſo a third method by which they are managed, which is thus: In the top of a rocket fix a piece of wood, in which drive a ſmall iron ſpindle; then make a hole in the middle of the ſmall caſe, through which put the ſpindle: then fix on the top of it a nut, to keep the caſe from falling off; when this is done, the caſe will turn very faſt without the rocket: but this method does not anſwer ſo well as either of the former.

Fig. 10. is the honorary rocket complete. The beſt ſized rockets for this purpoſe are thoſe of 1 lb.

65. *To divide the tail of a Sky-rocket ſo as to form an Arch when aſcending.*

Having ſome rockets made, and headed according to fancy, and tied on their ſticks; get ſome ſheet tin, and cut it into round pieces about 3 or 4 inches diameter; then on the ſtick of each rocket, under the mouth of the caſe, fix one of theſe pieces of tin 16 inches from the rocket's neck, and ſupport it by a wooden bracket, as ſtrong as poſſible: the uſe of this is, that when the rocket is aſcending the fire will play with great force on the tin, which will divide the tail in ſuch a manner that it will form an arch as it mounts, and will have a very good effect when well managed: if there is a ſhort piece of port-fire, of a ſtrong charge, tied to the end of the ſtick, it will make a great addition; but this muſt be lighted before you fire the rocket.

66. *To make ſeveral Sky-rockets riſe in the ſame direction, and equally diſtant from each other.*

Take ſix, or any number of ſky-rockets, of what ſize you pleaſe, then cut ſome ſtrong packthread into pieces of 3 or or 4 yards long, and tie each end of theſe pieces to a rocket in this manner: Having tied one end of your packthread round the body of one rocket, and the other end to another, take a ſecond piece of packthread and make one end of it faſt to one of the rockets already tied, and the other end to a third rocket, ſo that all the rockets, except the two outſide, will be faſtened to two pieces of packthread: the length of thread from one rocket to the other may be what the maker pleaſes; but the rockets muſt be all of a ſize, and their heads filled with the ſame weight of ſtars, rains, &c.

Having thus done, fix in the mouth of each rocket a leader of the ſame length; and when you are going to fire them, hang them almoſt cloſe; then tie the ends of the leaders together, and prime them: this prime being fired, all the rockets will mount at the ſame time, and divide as far as the ſtrings will allow; which diviſion they will keep, provided they are all rammed alike, and well made. They are called by ſome *chained rockets*.

67. *Signal Sky-rockets*

Are made of ſeveral kinds, according to the different ſignals intended to be given; but in artificial fireworks, two ſorts are only uſed, which are one with reports and the other without; but thoſe for the uſe of the navy and army are headed with ſtars, ſerpents, &c.—Rockets which are to be bounced muſt have their caſes made 1½ or 2 diameters longer than the common proportion; and after they are filled, drive in a double quantity of clay, then bounce and pinch them after the uſual manner and fix on each a cap.

Signal ſky-rockets without bounces, are only ſky-rockets cloſed and capped: theſe are very light, therefore do not require ſuch heavy ſticks as thoſe with loaded heads; for which reaſon you may cut one length of the rocket off the ſtick, or elſe make them thinner.

Signal rockets with reports are fired in ſmall flights; and often both theſe, and thoſe without reports, are uſed for a ſignal to begin firing a collection of works.

68. *To fix a Sky-rocket with its Stick on the top of another.*

Rockets thus managed make a pretty appearance, by reaſon of a freſh tail being ſeen when the ſecond rocket takes fire, which will mount to a great height. The method of preparing theſe rockets is thus: Having filled a two-pounder, which muſt be filled only half a diameter above the piercer, and its head not more than 10 or 12 ſtars; the ſtick of this rocket muſt be made a little thicker than common; and when made, cut it in half the flat way, and in each half make a groove, ſo that when the two halves are joined, the hollow made by the grooves may be large enough to hold the ſtick of a half-pound rocket; which rocket make and head as uſual: put the ſtick of this rocket into the hollow of the large one, ſo far that the mouth of the rocket may reſt on the head of the two-pounder; from whoſe head carry a leader into the mouth of the ſmall rocket; which being done, your rockets will be ready for firing.

2d 68. *To fix two or more Sky-rockets on one Stick.*

Two, three, or ſix ſky-rockets, fixed on one ſtick, and fired together, make a grand and beautiful appearance; for the tails of all will ſeem but as one of an immenſe ſize, and the breaking of ſo many heads at once will reſemble the burſting of an air-balloon. The management of this device requires a ſkilful hand; but if the following inſtructions be well obſerved, even by thoſe who have not made a great progreſs in this art, there will be no doubt of the rockets having the deſired effect.

Rockets for this purpoſe muſt be made with the greateſt exactneſs, all rammed by the ſame hand, in the ſame mould, and out of the ſame proportion of compoſition; and after they are filled and headed, muſt all be of the ſame weight. The ſtick muſt alſo be well made (and proportioned) to the following directions: firſt, ſuppoſing your rockets to be ½ pounders, whoſe ſticks are 6 feet 6 inches long, then if 2, 3, or 6 of theſe are to be fixed on 1 ſtick, let the length of it be 9 feet 9 inches; then cut the top of it into as many ſides as there are rockets, and let the length of each ſide be equal to the length of 1 of the rockets without its head; and in each ſide cut a groove (as uſual); then from the grooves plane it round, down to the bottom, where its thickneſs muſt be equal to half the top of the round part. As their thickneſs cannot be exactly aſcertained, we ſhall give a rule which generally anſwers for any number of rockets above two: the rule is this; that the ſtick at top muſt be thick enough, when the grooves are cut, for all the rockets to lie, without preſſing each other, though as near as poſſible.

When only 2 rockets are to be fixed on one ſtick, let the length of the ſtick be the laſt given proportion, but ſhaped after the common method, and the breadth and thickneſs double the uſual dimenſions. The point of poiſe muſt be in the uſual place (let the number of rockets be what they will): if ſticks made by the above directions ſhould be too heavy, plane them thinner; and if too light, make them thicker; but always make them of the ſame length.

When more than two rockets are tied on one ſtick, there will be ſome danger of their flying up without the ſtick, unleſs the following precaution is taken: For caſes being placed on all ſides, there can be no notches for the cord which ties on the rockets to lie in; therefore, inſtead of notches, drive a ſmall nail in each ſide of the ſtick, between the necks of the caſes: and let the cord, which goes round their necks, be brought cloſe under the nails; by this means the rockets will be as ſecure as when tied on ſingly. Your rockets being thus fixed, carry a quick-match, without a pipe, from the mouth of one rocket to the other; this match being lighted will give fire to all at once.

Though the directions already given may be ſufficient for theſe rockets, we ſhall here add an improvement on a very eſſential part of this device, which is, that of hanging the rockets to be fired; for before the following method was hit upon, many eſſays proved unſucceſsful. Inſtead, therefore, of the old and common manner of hanging them on nails or hooks, make uſe of this contrivance: Have a ring made of ſtrong iron wire, large enough for the ſtick to go in as far as the mouths of the rockets; then let this ring be ſupported by a ſmall iron, at ſome diſtance from the poſt or ſtand to which it is fixed; then have another ring, fit to receive and guide the ſmall end of the ſtick. Rockets thus ſuſpended will have nothing to obſtruct their fire; but when they are hung on nails or hooks, in ſuch a manner that ſome of their mouths are againſt or upon a rail, there can be no certainty of their riſing in a vertical direction.

69. *To fire Sky-rockets without Sticks.*

You muſt have a ſtand, of a block of wood, a foot diameter, and make the bottom flat, ſo that it may ſtand ſteady: in the centre of the top of this block draw a circle 2½ inches diameter, and divide the circumference of it into three equal parts; then take 3 pieces of thick iron wire, each about 3 feet long, and drive them into the block, 1 at each point made on the circle; when theſe wires are driven in deep enough to hold them faſt and upright, ſo that the diſtance from one to the other is the ſame at top as at bottom, the ſtand is complete.

The ſtand being thus made, prepare your rockets thus: Take ſome common ſky-rockets, of any ſize, and head them as you pleaſe; then get ſome balls of lead, and tie to each a ſmall wire 2 or 2½ feet long, and the other end of each wire tie to the neck of a rocket. Theſe balls anſwer the purpoſe of ſticks when made of a proper weight, which is about 2-3ds the weight of the rocket; but when they are of a proper ſize, they will balance the rocket in the ſame manner as a ſtick, at the uſual point of poiſe. To fire theſe, hang them, one at a time, between the tops of the wires, letting their heads reſt on the point of the wires, and the balls hang down between them: if the wires ſhould be too wide for the rockets, preſs them together till they fit; and if too cloſe, force them open; the wires for this purpoſe muſt be ſoftened, ſo as not to have any ſpring, or they will not keep their poſition when preſſed cloſe or opened.

70. *Rain-falls and Stars for Sky-rockets, Double and Single.*

Gold and ſilver rain compoſitions are driven in caſes that are pinched quite cloſe at one end: if you roll them dry, 4 or 5 rounds of paper will be ſtrong enough; but if they are paſted, 3 rounds will do; and the thin ſort of cartridge-paper is beſt for thoſe ſmall caſes, in rolling which you muſt not turn down the inſide edge as in other caſes, for a double edge would be too thick for ſo ſmall a bore. The moulds for rain-falls ſhould be made of braſs, and turned very ſmooth in the inſide ; or the caſes, which are ſo very thin, would tear in coming out ; for the charge muſt be drove in tight ; and the better the caſe fits the mould, the more driving it will bear. Theſe moulds have no nipple, but inſtead thereof they are made flat. As it would be very tedious and troubleſome to ſhake the compoſition out of ſuch ſmall ladles as are uſed for theſe caſes, it will be neceſſary to have a funnel made of thin tin, to fit on the top of the caſe, by the help of which you may fill them very faſt. For ſingle rain-falls for 4 oz. rockets, let the diameter of the former be 2-16ths of an inch, and the length of the caſe 2 inches; for 8 oz. rockets, 4-16ths and 2 diameters of the rocket long ; for 1 lb. rockets, 5-16ths, and 2 diameters of the rocket long ; for 2 lb. rockets, 5-16ths, and 3½ inches long ; for 4 lb. rockets, 6-16ths, and 4½ inches long ; and for 6-pounders, 7-16ths diameter, and 5 inches long.

Of double rain-falls there are two ſorts. For example, ſome appear firſt like a ſtar, and then as rain ; and ſome appear firſt as rain, and then like a ſtar. When you would have ſtars firſt, you muſt fill the caſes, within ½ inch of the top, with rain-compoſition, and the remainder with ſtar-compoſition ; but when you intend the rain ſhould be firſt, drive the caſe ½ an inch with ſtar-compoſition, and the reſt with rain. By this method may be made many changes of fire ; for in large rockets you may make them firſt burn as ſtars, then rain, and again as ſtars ; or they may firſt ſhow rain, then ſtars, and finiſh with a report ; but when they are thus managed, cut open the firſt rammed end, after they are filled and bounced, at which place prime them. The ſtar-compoſition for this purpoſe muſt be a little ſtronger than for rolled ſtars.

Strung ſtars. Firſt take ſome thin paper, and cut it into pieces of 1½ inch ſquare, or thereabouts ; then on each piece lay as much dry ſtar-compoſition as you think the paper will eaſily contain ; then twiſt up the paper as tight as you can ; when done, rub ſome paſte on your hands, and roll the ſtars between them ; then ſet them to dry : your ſtars being thus made, get ſome flax or fine tow, and roll a little of it over each ſtar ; then paſte your hands and roll the ſtars as before, and ſet them again to dry ; when they are quite dry, with a piercer make a hole through the middle of each, into which run a cotton quick-match, long enough to hold 10 or 12 ſtars at 3 or 4 inches diſtance : but any number of ſtars may be ſtrung together by joining the match.

Tailed ſtars. Theſe are called *tailed ſtars*, becauſe there are a great number of ſparks iſſue from them, which repreſent a tail like that of a comet. Of theſe there are two ſorts ; which are *rolled* and *drove* : when rolled, they muſt be moiſtened with a liquor made of half a pint of ſpirit of wine and half a gill of thin ſize, of this as much as will wet the compoſition enough to make it roll eaſy ; when they are rolled, ſift meal-powder over them, and ſet them to dry.

When tailed ſtars are drove, the compoſition muſt be moiſtened with ſpirit of wine only, and not made ſo wet as for rolling : 1 and 2 oz. caſes, rolled dry, are beſt for this purpoſe ; and when they are filled, unroll the caſe within 3 or 4 rounds of the charge, and all that you unroll cut off ; then paſte down the looſe edge : 2 or 3 days after the caſes are filled, cut them in pieces 5 or 6-8ths of an inch in length : then melt ſome wax, and dip one end of each piece into it, ſo as to cover the compoſition : the other end muſt be rubbed with meal-powder wetted with ſpirit of wine.

Drove ſtars. Caſes for drove ſtars are rolled with paſte, but are made very thin of paper. Before you begin to fill them, damp the compoſition with ſpirit of wine that has had ſome camphor diſſolved in it : you may ram them indifferently hard, ſo that you do not break or ſack the caſe ; to prevent which, they ſhould fit tight in the mould. They are drove in caſes of ſeveral ſizes, from 8 drams to 4 oz. When they are filled in ½-oz. caſes, cut them in pieces of ¾ of an inch long ; if 1-oz. caſes, cut them in pieces of 1 inch ; if 2-oz. caſes, cut them in pieces of 1¼ inch long ; and if 4-oz. caſes, cut them in pieces of 1½ inch long : having cut your ſtars of a proper ſize, prime both ends with wet meal-powder. Theſe ſtars are ſeldom put in rockets, they being chiefly intended for air-balloons, and drove in caſes, to prevent the compoſition from being broke by the force of the blowing powder in the ſhell.

Rolling ſtars are commonly made about the ſize of a muſket-ball ; though they are rolled of ſeveral ſizes, from the bigneſs of a piſtol-ball to 1 inch diameter ; and ſometimes very ſmall, but are then called *ſparks*. Great care muſt be taken in making ſtars, firſt, that the ſeveral ingredients are reduced to a fine powder ; ſecondly, that the compoſition is well worked and mixed. Before you begin to roll, take about a pound of compoſition, and wet it with the following liquid, enough to make it ſtick together and roll eaſy : Spirit of wine 1 quart, in which diſſolve ¼ of an ounce of iſinglaſs. If a great quantity of compoſition be wetted at once, the ſpirit will evaporate, and leave it dry, before you can roll it into ſtars : having rolled up one proportion, ſhake the ſtars in meal powder, and ſet them to dry, which they will do in 3 or 4 days ; but if you ſhould want them for immediate uſe, dry them in an earthern pan over a ſlow heat, or in an oven. It is very difficult to make the ſtars all of an equal ſize when the compoſition is taken up promiſcuouſly with the fingers ; but by the following method they may be made very exact : When the mixture is moiſtened properly, roll it on a flat ſmooth ſtone, and cut it into ſquare pieces, making each ſquare large enough for the ſtars you intend. There is another method uſed by ſome to make ſtars, which is by rolling the compoſition in long pieces, and then cutting off the ſtar, ſo that each ſtar will be of a cylindrical form : but this method is not ſo good as the former ; for, to make the compoſition roll this way, it muſt be made very wet, which makes the ſtars heavy, as well as weakens them. All ſtars muſt be kept as much from air as poſſible, otherwiſe they will grow weak and bad.

71. *Scrolls for Sky-rockets.*

Caſes for ſcrolls ſhould be made 4 or 5 inches in length, and their interior diameter 3-8ths of an inch : one end of theſe caſes muſt be pinched quite cloſe, before you begin to fill ; and when filled, cloſe the other end : then in the oppoſite ſides make a ſmall hole at each end, to the compoſition, in the ſame manner as in tourbillons ; and prime them with wet meal-powder. You may put in the head of a rocket as many of theſe caſes as it will contain : being fired they turn very quick in the air, and form a ſcroll or ſpiral line. They are generally filled with a ſtrong charge, as that of ſerpents or brilliant fire.

72. *Swarmers, or ſmall Rockets.*

Rockets that go under the denomination of *ſwarmers*, are thoſe from 2 oz. downwards. Theſe rockets are fired ſometimes in flights, and in large water-works, &c. Swarmers of 1 and 2 oz. are bored, and made in the ſame manner as large rockets, except that, when headed, their heads muſt be put on without a collar : the number of ſtrokes for driving 1 oz. muſt be 8, and for 2 oz. 12.

All rockets under 1 oz. are not bored, but muſt be filled to the uſual height with compoſition, which generally conſiſts of fine meal-powder 4 oz. and charcoal or ſteel-duſt 2 drams : the number of ſtrokes for ramming theſe ſmall ſwarmers is not material, provided they are rammed true, and moderately hard. The necks of unbored rockets muſt be in the ſame proportion as in common caſes.

73. *Stands for Sky rockets.*

Care muſt be taken, in placing the rockets when they are to be fired, to give them a vertical direction at their firſt ſetting out; which may be managed thus. Have two rails of wood, of any length, ſupported at each end by a perpendicular leg, ſo that the rails be horizontal, and let the diſtance from one to the other be almoſt equal to the length of the ſticks of the rockets intended to be fired; then in the front of the top rail drive ſquare hooks at 8 inches diſtance, with their points turning ſidewiſe, ſo that when the rockets are hung on them, the points will be before the ſticks and keep them from falling or being blown off by the wind: in the front of the rail at bottom muſt be ſtaples, drove perpendicular under the hooks at top; through theſe ſtaples put the ſmall ends of the rocket-ſticks. Rockets are fired by applying a lighted port-fire to their mouths.

N. B. When ſky-rockets are made to perfection, and fired, they will ſtand 2 or 3 ſeconds on the hook before they riſe, and then mount up briſkly, with a ſteady motion, carrying a large tail from the ground all the way up, and juſt as they turn break and diſperſe the ſtars.

74. *Girandole Cheſts for Flights of rockets.*

Theſe are generally compoſed of four ſides, of equal dimenſions; but may be made of any diameter, according to the num-number of rockets deſigned to be fired; its height muſt be in proportion to the rockets, but muſt always be a little higher than the rockets with their ſticks. When the ſides are joined, fix in the top, as far down the cheſt as the length of one of the rockets with its cap on. In this top, make as many ſquare or round holes to receive the rocket-ſticks, as you intend to have rockets; but let the diſtance between them be ſufficient for the rockets to ſtand without touching one another; then from one hole to another cut a groove large enough for a quick-match to lie in: the top being thus fixed, put in the bottom, at about $1\frac{1}{2}$ foot diſtance from the bottom of the cheſt; in this bottom muſt be as many holes as in the top, and all to correſpond; but theſe holes need not be ſo large as thoſe in the top.

To prepare your cheſt, you muſt lay a quick-match, in all the grooves, from hole to hole; then take ſome ſky-rockets, and rub them in the mouth with wet meal-powder, and put a bit of match up the cavity of each; which match muſt be long enough to hang a little below the mouth of the rocket. Your rockets and cheſt being prepared according to the above directions, put the ſticks of the rockets through the holes in the top and bottom of the cheſt, ſo that their mouths may reſt on the quick match in the grooves: by which all the rockets will be fired at once; for by giving fire to any part of the match, it will communicate to all the rockets in an inſtant. As it would be rather troubleſome to direct the ſticks from the top to the proper holes in the bottom, it will be neceſſary to have a ſmall door in one of the ſides, which when opened, you may ſee how to place the ſticks. Flights of rockets being ſeldom ſet off at the beginning of any fire-works, they are in danger of being fired from the ſparks from wheels, &c. therefore, to preſerve them, a cover ſhould be made to fit on the cheſt, and the door in the ſide kept ſhut

75. *Serpents or Snakes for Pots of Aigrettes, ſmall Mortars, Sky-rockets, &c.*

Serpents for this uſe are made from $2\frac{1}{2}$ inches to 7 inches long, and their formers from 3-16ths to 5-8ths of an inch diameter; but the diameter of the caſes muſt always be equal to 2 diameters of the former. They are rolled and choaked like other caſes, and filled with compoſition from 5 8ths of an inch to $1\frac{1}{2}$ inch high, according to the ſize of the mortars or rockets they are deſigned for; and the remainder of the caſes bounced with corn powder, and afterwards their ends pinched and tied cloſe: before they are uſed their mouths muſt be primed with wet meal-powder.

76. *Leaders, or Pipes of Communication.*

The beſt paper for leaders is elephant; which you cut into long ſlips 2 or 3 inches broad, ſo that they may go 3 or 4 times round the former, but not more: when they are very thick, they are too ſtrong for the paper which faſtens them to the works, and will ſometimes fly off without leading the fire. The formers for theſe leaders are made from 2 to 6-16ths of an inch diameter; but 4-16ths is the ſize generally made uſe of. The formers are made of ſmooth braſs wire: when you uſe them, rub them over with greaſe, or keep them wet with paſte, to prevent their ſticking to the paper, which muſt be paſted all over. In rolling of pipes, make uſe of a rolling-board, but uſe it lightly: having rolled a pipe, draw out the former with one hand, holding the pipe as light as poſſible with the other; for if it preſs againſt the former, it will ſtick and tear the paper.

N. B. Make your leaders of different lengths, or in cloathing of works you will cut a great many to waſte. Leaders for marron batteries muſt be made of ſtrong cartridge paper.

77. *Crackers.*

Cut ſome cartridge paper into pieces $3\frac{1}{2}$ inches broad, and one foot long; one edge of each fold down lengthwiſe about $\frac{3}{4}$ of an inch broad; then fold the double edge down $\frac{1}{4}$ of an inch, and turn the ſingle edge back half over the double fold; then open it, and lay all along the channel, which is formed by the folding of the paper, ſome meal powder; then fold it over and over till all the paper is doubled up, rubbing it down every turn; this done, bend it backwards and forwards, $2\frac{1}{2}$ inches, or thereabouts, at a time, as oft as the paper will allow; then hold all theſe folds flat and cloſe, and with a ſmall pinching cord give one turn round the middle of the cracker, and pinch it cloſe; then bind it with a packthread as tight as you can; then, in the place where it was pinched, prime one end of it, and cap it with touch paper. When theſe crackers are fired, they will give a report at every turn of the paper: if you would have a great number of bounces, you muſt cut the paper longer, or join them after they are made; but if they are made very long before they are pinched, you muſt have a piece of wood with a groove in it, deep enough to let in half the cracker; this will hold it ſtraight while it is pinching. Fig. 12. repreſents a cracker complete.

78. *Single Reports.*

Caſes for reports are generally rolled on one and two-oz. formers, and ſeldom made larger but on particular occaſions; they are made from two to four inches long, and very thick of paper. Having rolled a caſe, pinch one end quite cloſe, and drive it down: then fill the caſe with corn-powder, only leaving room to pinch it at top; but before you pinch it, put in a piece of paper at top of the powder. Reports are fired by a vent, bored in the middle, or at one end, juſt as required.

79. *Marrons.*

Formers for marrons are from $\frac{3}{4}$ of an inch to $1\frac{1}{2}$ diameter. Cut the paper for the caſes twice the diameter of the former broad, and long enough to go three times round: when you have rolled a caſe, paſte down the edge and tie one end cloſe; then with the former drive it down to take away the wrinkles, and make it flat at bottom; then fill the caſe with corn-powder one diameter and $\frac{1}{4}$ high, and fold down the reſt of the caſe tight on the powder. The marron being thus made, wax ſome ſtrong packthread with ſhoemakers wax; this thread wind up in a ball, then unwind two or three yards of it, and that part which is near the ball make faſt to a hook; then take a marron, and ſtand as far from the hook as the packthread will reach, and wind it lengthwiſe round the marron as cloſe as you can, till it will hold no more that way; then turn it, and wind the packthread on a ſhort way, then lengthwiſe again, and ſo on till the paper is all covered; then make faſt the end of the packthread, and beat down both ends of the marron to bring it in ſhape. The method of firing marrons is by making a hole at one end with an awl, and putting in a piece of quick-match; then take a piece of ſtrong paper, in which wrap up the marron with two leaders, which muſt be put down to the vent, and the paper tied tight round them with ſmall twine: theſe leaders are bent on each ſide, and their looſe ends tied to other marrons, and are nailed in the middle to the rail of the ſtand, as in fig. 13. The uſe of winding the packthread in a ball is, that you may let it out as you want it, according to the quantity the marron may require; and that it may not be tied in knots, which would ſpoil the marron.

80. *Marron Batteries,*

If well managed, will keep time to a march, or a ſlow piece of muſic. Marron batteries are made of ſeveral ſtands, with a number of croſs rails for the marrons; which are regulated by leaders, by cutting them of different lengths, and nailing them tight, or looſe, according to the time of the muſic. In marron batteries you muſt uſe the large and ſmall marrons, and the nails for the pipes muſt have flat heads.

81. *Line Rockets,*

Are made and drove as the ſky-rockets, but have no heads, and the caſes muſt be cut cloſe to the clay: they are ſometimes made with ſix or ſeven changes, but in general not more than four or five. The method of managing thoſe rockets is thus: Firſt, have a piece of light wood, the length of one of the rockets, turned round about 2½ inches diameter, with a hole through the middle lengthwiſe, large enough for the line to go eaſily through: if you deſign four changes, have four grooves cut in the ſwivel, one oppoſite the other, to lay the rockets in.

The mouths of the rockets being rubbed with wet meal-powder, lay them in the grooves head to tail, and tie them faſt; from the tail of the firſt rocket carry a leader to the mouth of the ſecond, and from the ſecond to the third, and ſo on to as many as there are on the ſwivel, making every leader very ſecure; but in the fixing theſe pipes, take care that the quick-match does not enter the bores of the rockets: the rockets being fixed on the ſwivel and ready to be fired, have a line 100 yards long, ſtretched and fixed up tight, at any height from the ground; but be ſure to place it horizontally: this length of line will do for ½ lb. rockets; but if larger, the line muſt be longer. Before you put up the line, put one end of it through the the ſwivel; and when you fire the line rocket, let the mouth of that rocket which you fire firſt face that end of the line where you ſtand; then the firſt rocket will carry the reſt to the other end of the line, and the ſecond will bring them back; and ſo they will run out and in according to the number of rockets: at each end of the line there muſt be a piece of flat wood for the rocket to ſtrike againſt, or its force will cut the line. Let the line be well ſoaped, and the hole in the ſwivel very ſmooth.

82. *Different Decorations for Line Rockts.*

To line rockets may be fixed great variety of figures, ſuch as flying dragons, Mercuries, ſhips, &c. Or they may be made to run on the line like a wheel; which is done in this manner. Have a flat ſwivel made very exact, and on it tie two rockets obliquely, one on each ſide, which will make it turn round all the way it goes, and form a circle of fire; the charge for theſe rockets ſhould be a little weaker than common. If you would ſhow two dragons fighting, get two ſwivels made ſquare, and on each tie three rockets together on the under ſide; then have two flying dragons made of tin, and fix one of them on the top of each ſwivel, ſo as to ſtand upright; in the mouth of each dragon put a ſmall caſe of common fire, and another at the end of the tail; you may put two or three port-fires, of a ſtrong charge, on one ſide of their bodies, to ſhow them. This done, put them on the line, one at each end; but let there be a ſwivel in the middle of the line to keep the dragons from ſtriking together: before you fire the rockets, light the caſes on the dragons; and if care be taken in firing both at the ſame time, they will meet in the middle of the line, and ſeem to fight. Then they will run back and return with great violence; which will have a very pleaſing effect. The line for theſe rockets muſt be very long, or they will ſtrike too hard together.

83. *Chineſe Flyers.*

Caſes for flyers may be made of different ſizes, from one to eight ounces: they muſt be made thick of paper, and eight interior diameters long; they are rolled in the ſame manner as tourbillons, with a ſtraight paſted edge, and pinched cloſe at one end. The method of filling them is, the caſe being put in a mould, whoſe cylinder, or foot, muſt be flat at top without a nipple, fill it within ½ a diameter of the middle; then ram in ½ a diameter of clay, on that as much compoſition as before, on which drive ½ a diameter of clay; then pinch the caſe cloſe, and drive it down flat: after this is done, bore a hole exactly through the centre of the clay in the middle; then in the oppoſite ſides, at both ends, make a vent; and in that ſide you intend to fire firſt make a ſmall hole to the compoſition near the clay in the middle, from which carry a quick-match, covered with a ſingle paper, to the vent at the other end; then, when the charge is burnt on one ſide, it will by means of the quick-match, communicate to the charge on the other (which may be of a different ſort). Then flyers being thus made, put an iron pin, that muſt be fixed in the work on which they are to be fired, and on which they are to run, through the hole in the middle; on the end of this pin muſt be a nut to keep the flyer from running off. If you would have them turn back again after they are burnt, make both the vents at the ends on the ſame ſide, which will alter its courſe the contrary way.

84. *Table Rockets*

Are deſigned merely to ſhow the truth of driving, and the judgment of a fire worker, they having no other effect, when fired, than ſpinning round in the ſame place where they begin, till they are burnt out, and ſhowing nothing more than a horizontal circle of fire.

The method of making theſe rockets is—Have a cone turned out of hard wood 2½ inches diameter, and as much high; round the baſe of it draw a line; on this line fix four ſpokes, two inches long each, ſo as to ſtand one oppoſite the other; then fill four nine-inch 1 lb caſes with any ſtrong compoſition, within two inches of the top: theſe caſes are made like tourbillons, and muſt be rammed with the greateſt exactneſs.

Your rockets being filled, fix their open ends on the ſhort ſpokes; then in the ſide of each caſe bore a hole near the clay; all theſe holes, or vents, muſt be ſo made that the fire of each caſe may act the ſame way; from theſe vents carry leaders to the top of the cone, and tie them together. When you would fire the rockets, ſet them on a ſmooth table, and light the leaders in the middle, and all the caſes will fire together (ſee pl. 34. fig. 14.) and ſpin on the point of the cone.

Theſe rockets may be made to riſe like tourbillons, by making the caſes ſhorter, and boring four holes in the under ſide of each at equal diſtances: this being done they are called *double tourbillons*.

Note, All the vents in the under ſide of the caſes muſt be lighted at once; and the ſharp point of the cone cut off, at which place make it ſpherical.

SECT. V. *Of Wheels and other Works.*

85. *Single Vertical Wheels.*

THERE are different ſorts of vertical wheels; ſome having their fells of a circular form, others of a hexagon, octagon, or decagon form, or any number of ſides, according to the length of the caſes you deſign for the wheel: your ſpokes being fixed in the nave, nail ſlips of tin, with their edges turned up, ſo as to form grooves for the caſes to lie in, from the end of one ſpoke to another; then tie your caſes in the grooves head to tail, in the ſame manner as thoſe on the horizontal water-wheel, ſo that the caſes ſucceſſively taking fire from one another, will keep the wheel in an equal rotation. Two of theſe wheels are very oft fired together, one on each ſide of a building; and both lighted at the ſame time and all the caſes filled alike, to make them keep time together; which they will do if made by the following directions. In all the caſes of both wheels, except the firſt, on each wheel drive two or three ladlefuls of ſlow fire, in any part of the caſes; but be careful to ram the ſame quantity in each caſe, and in the end of one of the caſes, on each wheel, you may ram one ladleful of dead-fire compoſition, which muſt be very lightly drove; you may alſo make may changes of fire by this method.

Let the hole in the nave of the wheel be lined with braſs, and made to turn on a ſmooth iron ſpindle. On the end of this ſpindle let there be a nut to ſcrew off and on; when you have put the wheel on the ſpindle, ſcrew on the nut, which will keep the wheel from flying off. Let the mouth of the firſt caſe be a little raiſed. See fig. 15. Vertical wheels are made from 10 inches to 3 feet diameter, and the ſize of the caſes muſt differ accordingly; 4 oz. caſes will do for wheels of 14 or 16 inches diameter, which is the proportion generally uſed. The beſt wood for wheels of all ſorts is a light and dry beech.

86. *Horizontal Wheels,*

Are beſt when their fells are made circular; in the middle of the top of the nave muſt a be pintle, turned out of the ſame piece as the nave, two inches long, and equal in diameter to the bore of one of the caſes of the wheel: there muſt be a hole bored up the centre of the nave, within half an inch of the top of the pintle. The wheel being made, nail at the end of each ſpoke (of which there ſhould be ſix or eight) a piece of wood, with a groove cut in it to receive the caſe. Fix theſe pieces in ſuch a manner that half the caſes may incline upwards and half downwards, and that, when they are tied on, their heads and tails may come very near together; from the tail of one caſe to the mouth of the other carry a leader, which ſecure with paſted paper. Beſides theſe pipes, it will be neceſſary to put a little meal-powder inſide the paſted paper, to blow off the pipe, that there may be no obſtruction to the fire from the caſes. By means of theſe pipes the caſe will ſucceſſively take fire, burning one upwards and the other downwards. On the pintle fix a caſe of the ſame ſort as thoſe on the wheel; this caſe muſt be fired by a leader from the mouth of the laſt caſe on the wheel, which caſe muſt play downwards: inſtead of a common caſe in the middle, you may put a caſe of Chineſe fire, long enough to burn as long as two or three of the caſes on the wheel.

Horizontal wheels are oft fired two at a time, and made to keep time like vertical wheels only they are made without any ſlow or dead fire; 10 or 12 inches will be enough for the diameter of wheels with ſix ſpokes. Fig. 16. repreſents a wheel on fire, with the firſt caſe burning.

87. *Spiral Wheels.*

Are only double horizontal wheels, and made thus: The nave muſt be about 6 inches long, and ſomewhat thicker than the ſingle ſort; inſtead of the pintle at top, make a hole for the caſe to be fixed in, and two ſets of ſpokes, one ſet near the top of the nave, and the other near the bottom. At the end of each ſpoke cut a groove wherein you tie the caſes, there being no fell; the ſpokes ſhould not be more than 3½ inches long from the nave, ſo that the wheel may not be more than 8 or 9 inches diameter; the caſes are placed in ſuch a manner, that thoſe at top play down, and thoſe at bottom play up, but let the third or fourth caſe play horizontally. The caſe in the middle may begin with any of the others you pleaſe. 6 ſpokes will be enough for each ſet, ſo that the wheel may conſiſt of 12 caſes, beſides that on the top: the caſes 6 inches each.

88. *Plural Wheels,*

Are made to turn horizontally, and to conſiſt of three ſets of ſpokes, placed 6 at top, 6 at bottom, and 4 in the middle, which muſt be a little ſhorter than the reſt: let the diameter of the wheel be 10 inches; the caſes muſt be tied on the ends of the ſpokes in groves cut on purpoſe, or in pieces of wood nailed on the ends of the ſpokes, with grooves cut in them as uſual: in clothing theſe wheels, make the upper ſet of caſes play obliquely downwards, the bottom ſet obliquely upwards, and the middle ſet horizontally. In placing the leaders, you muſt order it ſo that the caſes may burn thus, viz. firſt up, then down, then horizontal, and ſo on with the reſt. But another change may be made, by driving in the end of the 8th caſe two or three ladlefuls of ſlow fire, to burn till the wheel has ſtopped its courſe; then let the other caſes be fixed the contrary way, which will make the wheel run back again: for the caſe at top you may put a ſmall gerbe; and let the caſes on the ſpokes be ſhort, and filled with a ſtrong brilliant charge.

89. *Illuminated Spiral Wheel.*

Firſt have a circular horizontal wheel made two feet diameter, with a hole quite through the nave; then take three thin pieces of deal, three feet long each, and ¾ of an inch broad each: one end of each of theſe pieces nail to the fell of the wheel, at an equal diſtance from one another, and the other end nail to a block with a hole in its bottom, which muſt be perpendicular with that in the block of the wheel, but not ſo large. The wheel being thus made, have a hoop planed down very thin and flat; then nail one end of it to the fell of the wheel, and wind it round the three ſticks in a ſpiral line from the wheel to the block at top: on the top of this block fix a caſe of Chineſe fire; on the wheel you may place any number of caſes, which muſt incline downwards, and burn two at a time. If the wheel ſhould conſiſt of 10 caſes, you may let the illuminations and Chineſe fire begin with the ſecond caſes. The ſpindle for this wheel muſt be a little longer than the cone, and made very ſmooth at top, on which the upper block is to turn, and the whole weight of the wheel to reſt. See fig. 17.

90. *Double Spiral Wheel.*

For this wheel the block, or nave, muſt be as long as the height of the worms, or ſpiral lines, but muſt be made very thin, and as light as poſſible. In this block muſt be fixed ſeveral ſpokes, which muſt diminiſh in length, from the wheel to the top, ſo as not to exceed the ſurface of a cone of the ſame height. To the ends of theſe ſpokes nail the worms, which muſt croſs each other ſeveral times: theſe worms clothe with illuminations, the ſame as thoſe on the ſingle wheels; but the horizontal wheel you may clothe as you like. At top of the worm place a caſe of ſpur-fire, or an amber light. See fig. 18. This figure is ſhown without leaders to prevent a confuſion of lines.

91. *Balloon Wheels,*

Are made to turn horizontally: they muſt be made 2 feet diameter, without any ſpokes; very ſtrong, with any number of ſides. On the top of a wheel range and fix in pots, 3 inches diameter and 7 inches high each, as many of theſe as there are caſes on the wheel: near the bottom of each pot make a ſmall vent; into each of theſe vents carry a leader from the tail of each caſe; ſome of the pots load with ſtars, and ſome with ſerpents, crackers, &c. As the wheels turn, the pots will ſucceſſively be fired, and throw into the air a great variety of fires.

92. *Fruiloni Wheels.*

Firſt have a nave made 9 inches long and 3 in diameter: near the bottom of this nave fix 8 ſpokes, with a hole in the end of each, large enough to receive a 2- or 4-ounce caſe: each of theſe ſpokes may be 14 inches long from the block.

Near the top of this block fix 8 more of the ſame ſpokes, exactly over the others, but not ſo long by 2 inches. As this wheel is to run horizontally, all the caſes in the ſpokes muſt play obliquely upwards, and all thoſe in the ſpokes at bottom obliquely downwards. This being done, have a ſmall horizontal wheel made with 8 ſpokes, each 5 inches long from the block: on the top of this wheel place a caſe of brilliant fire: all the caſes on this wheel muſt play in an oblique direction downwards, and burn 2 at a time, and thoſe on the large wheel 4 at a time; that is, 2 of thoſe in the top ſet of ſpokes, and 2 of thoſe in the bottom ſet of ſpokes.

The 4 firſt caſes on the large wheel, and the 2 firſt on the ſmall, muſt be fired at the ſame time, and the brilliant fire at top at the beginning of the laſt caſes. The caſes of the wheels may be filled with a gray charge. When theſe wheels are completed, you muſt have a ſtrong iron ſpindle, made 4 feet 6 inches long, and fixed perpendicularly on the top of a ſtand: on this put the large wheel, whoſe nave muſt have a hole quite through from the bottom to the top. This hole muſt be large enough to turn eaſy round the bottom of the ſpindle, at which place there muſt be a ſhoulder, to keep the wheel from touching the ſtand: at the top of the ſpindle put the ſmall wheel, and join it to a large one with a leader, in order that they may be fired both together.

93. *Caſcades of Fire*

Are made of any ſize; but one made according to the dimenſions of that ſhown in pl. 35. fig. 1. will be large enough for 8-oz. caſes. Let the diſtance from A to B be 3 feet; from B to C 2 feet 6 inches; and from CD 2 feet; and let the croſs piece at A be 4 feet long: then from each end of this piece draw a line to D; then make the other croſs pieces ſo long as to come within thoſe lines. The top piece D may be of any length, ſo as to hold the caſes, at a little diſtance from each other; all the croſs pieces are fixed horizontally, and ſupported by brackets; the bottom croſs piece ſhould be about 1 foot 6 inches broad in the middle, the ſecond 1 foot, the third 9 inches, and the top piece 4 inches: the caſes may be made of any length, but muſt be filled with a brilliant charge. On the edges of the croſs pieces muſt be nailed bits of wood, with a groove cut in each piece, large enough for a caſe to lie in. Theſe bits of wood are fixed ſo as to incline downwards, and that the fire from one tier of caſes may play over the other. All the caſes being tied faſt on, carry leaders from one to the other; and let there be a pipe hung from the mouth of one of the caſes, covered at the end with a ſingle paper, which you burn to fire the caſcade.

94. *The Fire-Tree.*

To make a fire-tree, as ſhown by fig. 2. you muſt firſt have a piece of wood 6 feet long, and 3 inches ſquare; then at E, 9 inches from the top, make a hole in the front, and in each ſide; or, inſtead of holes, you may fix ſhort pegs, to fit the inſide of the caſes. At F, 9 inches from E, fix 3 more pegs; at G, 1 foot 9 inches from F, fix 3 pegs; at H, 9 inches from G, fix 3 pegs; at I, 9 inches from H, fix 3 pegs, inclining downwards; but all the other pegs muſt incline upwards, that the caſes may have the ſame inclination as you ſee in the figure: then at top place a 4-inch mortar, loaded with ſtars, rains, or crackers. In the middle of this mortar place a caſe filled with any ſort of charge, but let it be fired with the other caſes: a brilliant charge will do for all the caſes; but the mortar may be made of any diameter, and the tree of any ſize; and on it any number of caſes, provided they are placed in the manner deſcribed.

95 *Chineſe Fountains.*

To make a Chineſe fountain, you muſt have a perpendicular piece of wood 7 feet long and 2½ inches ſquare. Sixteen inches from the top, fix on the front a croſs piece 1 inch thick, and 2½ broad, with the broad ſide up: below this, fix 3 more pieces of the ſame width and thickneſs, at 16 inches from each other: let the bottom rail be 5 feet long, and the others of ſuch a length as to allow the fire-pumps to ſtand in the middle of the intervals of each other. The pyramid being thus made, fix in the holes made in the bottom rail 5 fire-pumps, at equal diſtances; on the 2d rail, place 4 pumps; on the 3d, 3; on the 4th, 2; and on the top of the poſt, 1; but place them all to incline a little forwards, that, when they throw out the ſtars, they may not ſtrike againſt the croſs rails. Having fixed your fire-pumps, clothe them with leaders, ſo that they may all be fired together. See fig. 3.

96. *Of illuminated Globes with horizontal Wheels.*

The hoops for theſe globes may be made of wood, tin, or iron wire, about 2 feet diameter. For a ſingle globe take two hoops, and tie them together, one within the other, at right angles; then have a horizontal wheel made, whoſe diameter muſt be a little wider than the globe, and its nave 6 inches long; on the top of which the globe is fixed, ſo as to ſtand 3 or 4 inches from the wheel: on this wheel you may put any number of caſes, filled with what charge you like; but let two of them burn at a time: they may be placed horizontally, or to incline downwards, juſt as you chooſe. Now when the wheel is clothed, fix on the hoops as many illuminations as will ſtand within 2½ inches of each other: theſe you faſten on the hoops with ſmall iron binding wire; and when they are all on, put on your pipes of communication, which muſt be ſo managed as to light them all with the 2d or 3d caſe on the wheel. The ſpindle on which the globe is to run muſt go through the block of the wheel, up to the inſide of the top of the globe; where muſt be fixed a bit of braſs, or iron, with a hole in it to receive the point of the ſpindle, on which the whole weight of the wheel is to bear, as in fig. 4. which repreſents a globe on its ſpindle. By this method may be made a crown, which is done by having the hoops bent in the form of a crown. Sometimes globes and crowns are ordered ſo as to ſtand ſtill, and the wheel only to turn round; but when you would have the globe or crown to ſtand ſtill, and the wheel to run by itſelf, the block of the wheel muſt not be ſo long, nor the ſpindle any longer than juſt to raiſe the globe a little above the wheel; and the wheel caſes and illumination muſt begin together.

97. *Dodecaedron,*

So called becauſe it nearly repreſents a twelve-ſided figure, is made thus. Firſt have a ball turned out of ſome hard wood, 14 inches diameter: when done divide its ſurface into 14 equal parts, from which bore holes 1½ inch diameter, perpendicular to the centre, ſo that they may all meet in the middle: then let there be turned in the inſide of each hole a female ſcrew; and to all the holes but one, muſt be made a round ſpoke 5 feet long, with 4 inches of the ſcrew at one end to fit the holes; then in the ſcrew-end of all the ſpokes bore a hole, 5 inches up, which muſt be bored ſlanting, ſo as to come out at one ſide, a little above the ſcrew; from which cut a ſmall groove along the ſpoke, within 6 inches of the other end, where you make another hole through to the other ſide of the ſpoke. In this end fix a ſpindle, on which put a ſmall wheel of 3 or 4 ſides, each ſide 6 or 7 inches long: theſe ſides muſt have grooves cut in them, large enough to receive a 2 or 4-oz. caſe. When theſe wheels are clothed, put them on the ſpindles, and at the end of each ſpindle put a nut to keep the wheel from falling off. The wheels being thus fixed, carry a pipe from the mouth of the firſt caſe on each wheel, through the hole in the ſide of the ſpoke, and from thence along the grove, and through the other hole, ſo as to hang out at the ſcrew-end about an inch. The ſpokes being all prepared in this manner, you muſt have a poſt, on which you intend to fire the work, with an iron ſcrew in the top of it, to fit one of the holes in the ball: on the ſcrew fix the ball; then in the top hole of the ball put a little meal-powder, and ſome looſe quick-match: then ſcrew in all the ſpokes; and in one ſide of the ball bore a hole, in which put a leader, and ſecure it at the end; and your work will be ready to be fired. By this leader the powder and match in the centre is fired, which will light the match at the ends of the ſpokes all at once, whereby all the wheels will be lighted at once. There may be an addition to this piece, by fixing a ſmall globe on each wheel, or one on the top wheel only. A gray charge will be proper for the wheel-caſes.

98. *The Yew-Tree of brilliant Fire*

Is repreſented by fig. 5. as it appears when burning. Firſt, let A be an upright piece of wood, 4 feet long, 2 inches broad, and 1 thick: at top of this piece on the flat ſide, fix a hoop 14 inches diameter; and round its edge and front place illuminations, and in the centre a 5-pointed ſtar; then at E, which is 1½ foot from the edge of the hoop, place 2 caſes of brilliant fire, one on each ſide; theſe caſes ſhould be 1 foot long each: below theſe fix 2 more caſes of the ſame ſize, and at ſuch a diſtance, that their mouths may almoſt meet them at top: then cloſe to the ends of theſe caſes fix 2 more of the ſame caſes; they muſt ſtand parallel to them at E. The caſes being thus fixed, clothe them with leaders; ſo that they, with the illuminations and ſtars at top, may all take fire together.

99. *Stars with Points for regulated Pieces*, &c.

Theſe ſtars are made of different ſizes, according to the work for which they are intended: they are made with caſes from 1 oz. to 1 lb. but in general with 4-oz. caſes, 4 or 5 inches long: the caſes muſt be rolled with paſte, and twice as thick of paper as a rocket of the ſame bore. Having rolled a caſe, pinch one end of it quite cloſe: then drive in ½ a diameter of clay; and when the caſe is dry, fill it with compoſition, 2 or 3 inches to the length of the caſes with which it is to burn: at top of the charge drive ſome clay; as the ends of theſe caſes are ſeldom pinched, they would be liable to take fire. Having filled a caſe, divide the circumference of it at the pinched end cloſe to the clay into 5 equal parts; then bore 5 holes with a gimlet, about the ſize of the neck of a common 4-oz. caſe, into the compoſition: from one hole to the other carry a quick-match, and ſecure it with paper: this paper muſt be put on in the manner of that on the ends of wheel-caſes, ſo that the hollow part, which projects from the end of the caſe, may ſerve to receive a leader from any other work, to give fire to the points of the ſtars. Theſe ſtars may be made with any number of points.

100. *Fixed Sun with a tranſparent Face.*

To make a ſun of the beſt ſort, there ſhould be two rows of caſes, as in fig. 6. which will ſhow a double glory, and make the rays ſtrong and full. The frame, or ſun wheel, muſt be made thus: Have a circular flat nave made very ſtrong, 12 inches diameter: to this fix 6 ſtrong flat ſpokes, A, B, C, D, E, F. On the front of theſe fix a circular fell, 5 feet diameter; within which fix another fell, the length of one of the ſun caſes leſs in diameter; within this fix a 3d fell, whoſe diameter muſt be leſs than the 2d by the length of one caſe and ⅓d. The wheel being made, divide the fells into ſo many equal parts as you would have caſes (which may be done from 24 to 44): at each diviſion fix a flat iron ſtaple; theſe ſtaples muſt be made to fit the caſes, to hold them faſt on the wheel; let the ſtaples be ſo placed, that one row of caſes may lie in the middle of the intervals of the other.

In the centre of the block of the ſun drive a ſpindle, on which put a ſmall hexagon wheel, whoſe caſes muſt be filled with the ſame charge as the caſes of the ſun: two caſes of this wheel muſt burn at a time, and begin with them on the fells. Having fixed on all the caſes, carry pipes of communication from one to the other, as you ſee in the figure, and from one ſide of the ſun to the wheel in the middle, and from thence to the other ſide of the ſun. Theſe leaders will hold the wheel ſteady while the ſun is fixing up, and will alſo be a ſure method of lighting both caſes of the wheel together. A ſun thus made is called a *brilliant ſun*, becauſe the wood work is entirely covered with fire from the wheel in the middle, ſo that there appears nothing but ſparks of brilliant fire: but if you would have a tranſparent face in the centre, you muſt have one made of paſteboard of any ſize. The method of making a face is, by cutting out the eyes noſe, and mouth, for the ſparks of the wheel to appear through; but inſtead of this face, you may have one painted on oiled paper, or Perſian ſilk, ſtrained tight on a hoop; which hoop muſt be ſupported by 3 or 4 pieces of wire at 6 inches diſtance from the wheel in the centre, ſo that the light of it may illuminate the face. By this method you may have, in the front of a ſun, VIVAT REX, cut in paſteboard, or Apollo painted on ſilk; but, for a ſmall collection, a ſun with a ſingle glory, and a wheel in front, will be moſt ſuitable. Half-pound caſes, filled 10 inches with compoſition, will be a good ſize for a ſun 5 feet diameter; but, if larger, the caſes muſt be greater in proportion.

101. *Three Vertical Wheels illuminated, which turn on their own Naves upon a horizontal Table.*

A plan of this is ſhown by fig. 7. Let D be a deal table 3 feet in diameter: this table muſt be fixed horizontally on the top of a poſt; on this poſt muſt be a perpendicular iron ſpindle, which muſt come through the centre of the table: then let A, B, C, be 3 ſpokes joined to a triangular flat piece of wood, in the middle of which make a hole to fit eaſily over the ſpindle: let E, F, G, be pieces of wood, 4 or 5 inches long each, and 2 inches ſquare, fixed on the under ſides of the ſpokes; in theſe pieces make holes lengthwiſe to receive the thin part of the blocks of the wheels, which, when in, are prevented from coming out by a ſmall iron pin being run through the end of each. K, L, M, are 3 vertical octagon wheels, 18 inches diameter each: the blocks of theſe wheels muſt be long enough for 3 or 4 inches to reſt on the table; round which part drive a number of ſharp points of wire, which muſt not project out of the blocks more than 1-16th of an inch: the uſe of theſe points is, that, when the blocks run round, they will ſtick in the table, and help the wheels forward: if the naves are made of ſtrong wood, one inch will be enough for the diameter of the thin part, which ſhould be made to turn eaſy in the holes in the pieces E, F, G. On the front of the wheels make 4 or 5 circles of ſtrong wire, or flat hoops, and tie on them as many illuminations as they will hold at 2 inches from each other: inſtead of circles, you may make ſpiral lines, clothed with illuminations, at the ſame diſtance from each other as thoſe on the hoops. When illuminations are fixed on a ſpiral line in the front of a wheel, they muſt be placed a little on the ſlant, the contrary way that the wheel runs: the caſes for theſe wheels may be filled with any coloured charge, but muſt burn only one at a time.

The wheels being thus prepared, you muſt have a globe, crown, or ſpiral wheel, to put on the ſpindle in the middle of the table: this ſpindle ſhould be juſt long enough to raiſe the weeel of the globe, crown, or ſpiral wheel, ſo high that its fire may play over the 3 vertical wheels: by this means their fires will not be confuſed, nor will the wheels receive any damage from the fire of each other. In clothing this work, let the leaders be ſo managed, that all the wheels may light together, and the illuminations after 2 caſes of each wheel are burned.

102. *Illuminated Chandelier.*

Illuminated works are much admired by the Italians, and indeed are a great addition to a collection of works: in a grand exhibition an illuminated piece ſhould be fired after every two or three wheels, or fixed pieces of common and brilliant fires; and likewiſe illuminated works may be made cheap, quick, and eaſy.

To make an illuminated chandelier, you muſt firſt have one made of thin wood (ſee fig. 8.) The chandelier being made, bore in the front of the branches, and in the body, and alſo in the crown at top, as many holes for illuminations as they will contain at 3 inches diſtance from each other: in theſe holes put illuminations filled with white, blue, or brilliant charge. Having fixed in the port-fires, clothe them with leaders, ſo that the chandelier and crown may light together. The ſmall circles on this figure repreſent the mouths of the illuminations, which muſt project ſtraight from the front.

103. *Illuminated Yew Tree.*

Firſt have a tree made of wood, ſuch as is ſhown by fig. 9. The middle piece or ſtem, on which the branches are fixed, muſt be 8 feet 6 inches high: at the bottom of this piece draw a line, at right angles, 2 feet 6 inches long at each ſide; then from L, which is 1 foot 6 inches from the bottom, draw a line on each ſide to C and D: theſe lines will give the length of the two firſt branches. Then put on the two top branches parallel to them at bottom: let the length of each of theſe branches be 1 foot from the ſtem: from the ends of theſe two branches draw a line to C and D: then fix on 5 more branches at an equal diſtance from each other, and their length will be determined by the lines AC and ED. When the branches are fixed, place illuminating port-fires on the top of each, as many as you chooſe: behind the top of the ſtem faſten a gerbe or white fountain, which muſt be fired at the beginning of the illuminations on the tree.

104 *Flaming Stars with brilliant Wheels.*

To make a flaming ſtar, you muſt firſt have made a circular piece of ſtrong wood about 1 inch thick and 2 feet diameter: round this block fix 8 points, 2 feet 6 inches long each; 4 of theſe points muſt be ſtraight and 4 flaming: theſe points being joined on very ſtrong, and even with the ſurface of the block, nail tin or paſteboard on their edges, from the block to the end of each, where they muſt be joined: this tin muſt project in front 8 inches, and be joined where they meet at the block; round the front of the block fix 4 pieces of thick iron wire, 8 inches long each, equally diſtant from each other: this being done, cut a piece of paſteboard round, 2 feet diameter, and draw on it a ſtar, as may be ſeen in fig. 10. Cut out this ſtar, and on the back of it paſte oiled paper; then paint each point half red and half yellow, lengthwiſe; but the body of the ſtar muſt be left open, wherein muſt run a brilliant wheel, made thus: Have a light block turned nine inches long: at each end of it fix 6 ſpokes; at the end of each ſpoke put a 2-ounce caſe of brilliant fire: the length of theſe caſes muſt be in proportion to the wheel, and the diameter of the wheel when the caſes are on muſt be a little leſs than the diameter of the body of the ſmall ſtar: the caſes on the ſpokes in front muſt have their mouths incline outwards, and thoſe on the inſide ſpokes muſt be placed ſo as to form a vertical circle of fire. When you place your leaders, carry the firſt pipe from the tail of 1 of the caſes in front to the mouth of 1 of the inſide caſes, and from the tail of that to another in front, and ſo on to all the caſes. Your wheel being made, put it on a ſpindle, in the centre of the ſtar; this ſpindle muſt have a ſhoulder at bottom, to keep the wheel at a little diſtance from the block. This wheel muſt be kept on the ſpindle by a nut at the end; having fixed on the wheel, faſten the tranſparent ſtar to the 4 pieces of wire: when you fire it, you will only ſee a common horizontal wheel; but when the firſt caſe is burnt out, it will fire one of the vertical caſes, which will ſhow the tranſparent ſtar, and fill the large flames and points with fire; then it will again appear like a common wheel, and ſo on for 12 changes.

105. *Projected regulated Piece of nine Mutations.*

A regulated piece, if well executed, is as curious as any in fire-works: it conſiſts of fixed and moveable pieces on one ſpindle, repreſenting various figures, which take fire ſucceſſively one from another, without any aſſiſtance after lighting the firſt mutation. See fig. 11.

I. Names of the mutations, with the colour of fire and ſize of the caſe belonging to each.

Firſt mutation is a hexagon vertical wheel, illuminated in front with ſmall port-fires tied on the ſpokes; this wheel muſt be clothed with 2-ounce caſes, filled with black charge; the length of theſe caſes is determined by the ſize of the wheel, but muſt burn ſingly.

Second mutation is a fixed piece, called a *golden glory*, by reaſon of the caſes being filled with ſpur fire. The caſes muſt ſtand perpendicular to the block on which they are fixed, ſo that, when burning, they may repreſent a glory of fire. This mutation is generally compoſed of 5 or 7 two-ounce caſes.

Third mutation is moveable; and is only an octagon vertical wheel, clothed with 4-ounce caſes, filled with brilliant charge: 2 of theſe caſes muſt burn at a time. In this wheel you may make changes of fire.

Fourth mutation is a fixed ſun of brilliant fire, conſiſting of 12 four-ounce caſes: the necks of theſe caſes muſt be a little larger than thoſe of 4-ounce wheel-caſes. In this mutation may be made a change of fire, by filling the caſes half with brilliant charge, and half with gray.

Fifth mutation is a fixed piece, called the *porcupine's quills*. This piece conſiſts of 12 ſpokes, ſtanding perpendicular to the block in which they are fixed; on each of theſe ſpokes, near the end, muſt be placed a 4-ounce caſe of brilliant fire. All theſe caſes muſt incline either to the right or left, ſo that they may all play one way.

Sixth mutation is a ſtanding piece, called the *croſs fire*. This mutation conſiſts of 8 ſpokes fixed in a block; near the end of each of thoſe ſpokes muſt be tied two 4-ounce caſes of white charge, one acroſs the other, ſo that the fires from the caſes on one ſpoke may interſect the fire from the caſes on the other.

Seventh mutation is a fixed wheel, with 2 circular fells, on which are placed 16 eight-ounce caſes of brilliant fire, in the form of a ſtar. This piece is called a *fixed ſtar of wild fire*.

Eighth mutation. This is a beautiful piece, called a *brilliant ſtar-piece*. It conſiſts of 6 ſpokes, which are ſtrengthened by 2 fells of a hexagon form, at ſome diſtance from each other: at the end of each ſpoke, in the front, is fixed a brilliant ſtar of 5 points; and on each ſide of every ſtar is placed a 4-ounce caſe of black or gray charge; theſe caſes muſt be placed with their mouths ſidewiſe, ſo that their fires may croſs each other.

Ninth mutation is a wheel-piece. This is compoſed of 6 long ſpokes, with a hexagon vertical wheel at the end of each; theſe wheels run on ſpindles in the front of the ſpokes; all the wheels are lighted together: 2-ounce caſes will do for theſe wheels, and may be filled with any coloured charge.

II. Proportions of the mutations, with the method of conveying the fire from one to the other, and the diſtance they ſtand one from the other on the ſpindle.

Firſt mutation muſt be a hexagon vertical wheel, 14 inches diameter; on one ſide of the block, whoſe diameter is $2\frac{1}{4}$ inches, is fixed a tin barrel A (ſee fig 11. n° 1.) This barrel muſt be a little leſs in diameter than the nave; let the length of the barrel and block be 6 inches. Having fixed the caſes on the wheel, carry a leader from the tail of the laſt caſe into the tin barrel through a hole made on purpoſe, 2 inches from the block; at the end of this leader let there be about 1 or 2 inches of looſe match; but take care to ſecure well the hole wherein the pipe is put, to prevent any ſparks falling in, which would light the ſecond mutation before its time, and confuſe the whole.

Second mutation is thus made. Have a nave turned $2\frac{1}{2}$ inches diameter, and 3 long; then let $\frac{1}{2}$ an inch of that end which faces the firſt wheel be turned ſo as to fit eaſy into the tin barrel of the firſt mutation, which muſt turn round it without touching. On the other end of the block fix a tin barrel B, n° 2. This barrel muſt be 6 inches long, and only half an inch of it to fit on the block. Round the nave fix 5 ſpokes, $1\frac{1}{2}$ inch long each; the diameter of the ſpokes muſt be equal to a 2-oz former. On theſe ſpokes put five 7-inch 2-oz. caſes of ſpur-fire, and carry leaders from the mouth of one to the other, that they may all light together. Then from the mouth of one of the caſes carry a leader through a hole bored ſlantwiſe in the nave, from between the ſpokes, to the front of the block near the ſpindle hole: the end of this leader muſt project out of the hole into the barrel of the firſt mutation, ſo that when the pipe which comes from the end of the laſt caſe on the firſt wheel flaſhes, it may take fire, and light the 2d mutation. To communicate the fire to the 3d mutation, bore a hole near the bottom of one of the 5 caſes to the compoſition, and from thence carry a leader into a hole made in the middle of the barrel B: this hole muſt be covered with paſted paper.

Third mutation may be either an octagon or hexagon wheel, 20 inches diameter; let the nave be $3\frac{1}{4}$ inches diameter, and $3\frac{1}{2}$ in length; $1\frac{1}{2}$ inch of the front of the nave muſt be made to fit in the barrel B. On the other end of the block fix a tin barrel C, n° 3. This barrel muſt be $6\frac{1}{2}$ inches in length, one inch of which muſt fit over the block. The caſes of this wheel muſt burn 2 at a time; and from the mouths of the 2 firſt caſes carry a leader, through holes in the nave, into the barrel of the ſecond mutation, after the uſual manner: but beſides theſe leaders let a pipe go acroſs the wheel from one firſt caſe to the other; then from the tail of one of the laſt caſes carry a pipe into a hole in the middle of the barrel C: at the end of this pipe let there be ſome looſe quick-match.

Fourth and fifth mutations. Theſe may be deſcribed under one head, as their naves are made of one piece, which from E to F is 14 inches; E, a block 4 inches diameter, with 10 or 12 ſhort ſpokes, on which are fixed 11-inch 8-oz. caſes: let the front of this block be made to fit eaſy in the barrel C, and clothe the caſes ſo that they may all light together; and let a pipe be carried through a hole in the block into the barrel C, in order to receive the fire from the leader brought from the laſt caſe on the wheel. G. is the nave of the fifth mutation, whoſe diameter muſt be $4\frac{1}{2}$ inches: in this nave fix 10 or 12 ſpokes, $1\frac{1}{2}$ foot in length each; theſe ſpokes muſt ſtand 7 inches diſtant from the ſpokes of the 4th mutation; and at the end of each ſpoke tie a 4-oz. caſe, as n° 5. All theſe caſes are to be lighted together, by a leader brought from the end of one of the caſes on n° 4. Let F and H be of the ſame piece of wood as E and G, but as much thinner as poſſible, to make the work light.

Sixth and ſeventh mutations. The blocks of theſe 2 mutations are turned out of one piece of wood, whoſe length from F to P is 15 inches. L, a block 5 inches diameter, in which are fixed 8 ſpokes, each 2 feet 4 inches long; at the end of each ſpoke tie 2 4-oz caſes, as n° 6. All theſe caſes muſt be fired at the ſame time, by a pipe brought from the end of one of the caſes on the 5th mutation. Let the diſtance between the ſpokes at L, and thoſe in the 5th mutation, be 7 inches. M, the nave of the 7th mutation, whoſe diameter muſt be $5\frac{1}{2}$ inches: in this nave fix 8 ſpokes, and on the front of them 2 circular fells, one of 4 feet 8 inches diameter, and one of 3 feet 11 diameter; on theſe fells tie 16 8-oz. or pound caſes, as in n° 7. and carry leaders from one to the other, ſo that they may be all fired together. This mutation muſt be fired by a leader brought from the tail of one of the caſes on the 6th mutation.

Eighth and ninth mutations. The blocks of theſe may be turned out of one piece, whoſe length from P to D muſt be 12 inches. O, the block of the 8th mutation, which muſt be 6 inches diameter; and in it muſt be fixed 6 ſpokes each 3 feet in length, ſtrengthened by an hexagon fell within 3 or 4 inches of the ends of the ſpokes: cloſe to the end of each ſpoke, in the front, fix a five-pointed brilliant ſtar; then 7 inches below each ſtar tie two 10-inch 8-oz. caſes, ſo that the upper ends of the caſes may reſt on the fells, and their ends on the ſpokes. Each of theſe caſes muſt be placed parallel to the oppoſite fell (ſee n° 8.) NNN, &c. are the caſes, and kkk, &c. the ſtars.

The 9th mutation is thus made. Let D be a block 7 inches diameter. In this block muſt be ſcrewed 6 ſpokes, 6 feet long each, with holes and grooves for leaders, as thoſe in the dodecaedron; at the end of each ſpoke, in the front, fix a ſpindle for a hexagon vertical wheel, 10 inches diameter, as in n° 9. When theſe wheels are on, carry a leader from each into the block, ſo that they may all meet; then lead a pipe from the end of one of the caſes of the 8th mutation, through a hole bored in the block D, to meet the leaders from the vertical wheels, ſo that they may all be fired together.

The ſpindles for larger pieces are required to be made very ſtrong, and as exact as poſſible: for a piece of 9 mutations, let the ſpindle be at the large end 1 inch diameter, and continue that thickneſs as far as the 7th mutation; and thence to the 5th; let its diameter be $\frac{3}{4}$ of an inch; from the 5th to the 4th, $\frac{5}{8}$ of an inch; from the 4th to the 2d, $\frac{1}{2}$ inch; and from the 2d to the end, $\frac{3}{8}$ of an inch. At the ſmall end muſt be a nut to keep on the firſt wheel, and at the thick end muſt be a large nut, as ſhown by the figure; ſo that the ſcrew part of the ſpindle being put through a poſt, and a nut ſcrewed on tight, the ſpindle will be held faſt and ſteady: but you are to obſerve, that that part of the ſpindle on which the moveable pieces are to run, be made long enough for the wheels to run eaſy without ſticking; the fixed pieces being made on different blocks, the leaders muſt be joined, after they are fixed on the ſpindle. The beſt method of preventing the fixed mutations from moving on the ſpindle, is to make that part of the ſpindle which goes through them ſquare; but as it would be difficult to make ſquare holes through ſuch long blocks as are ſometimes required, it will be beſt to make them thus: Bore a hole a little larger than the diameter of the ſpindle; and at each end of the block, over the hole, faſten a piece of braſs with a ſquare hole in it to fit the ſpindle.

106. *To make an horizontal Wheel change to a Vertical Wheel with a Sun in front.*

The ſudden change of this piece is very pleaſing; and gives great ſurpriſe to thoſe who are not acquainted with the contrivance. A wheel for this purpoſe ſhould be about three feet diameter, and its fell circular; on which tie 16 half-pound caſes filled with brilliant charge: two of theſe caſes muſt burn at a time; and on each end of the nave muſt be a tin barrel of the ſame conſtruction as thoſe on the regulated piece. The wheel being completed, prepare the poſt or ſtand thus: Firſt have a ſtand made of any height, about three or four inches ſquare; then ſaw off from the top a piece two feet long; this piece join again at the place where it was cut, with a hinge on one ſide, ſo that it may lift up and down in the front of the ſtand; then fix on the top of the bottom part of the ſtand, on each ſide, a bracket; which brackets muſt project at right angles with the ſtand, one foot from the front, for the ſhort piece to reſt on. Theſe brackets muſt be placed a little above the joint of the poſt, ſo that when the upper ſtand falls, it may lie between them at right angles with the bottom ſtand; which may be done by fixing a piece of wood, one foot long, between the brackets, and even with the top of the bottom ſtand; then, as the brackets riſe above the bottom ſtand, they will form a channel for the ſhort poſt to lie in, and keep it ſteady without ſtraining the hinge. On the ſide of the ſhort poſt, oppoſite the hinge, nail a piece of wood, of ſuch a length, that, when the poſt is perpendicular, it may reach about $1\frac{1}{2}$ feet down the long poſt; to which being tied, it will hold the ſhort ſtand upright. The ſtand being thus prepared, in the top of it fix a ſpindle 10 inches long: on this ſpindle put the wheel: then fix on a brilliant ſun with a ſingle glory; the diameter of this ſun muſt be 6 inches leſs than that of the wheel. When you fire this piece, light the wheel firſt, and let it run horizontally till four caſes are conſumed: then from the end of the fourth caſe carry a leader into the tin barrel that turns over the end of the ſtand: this leader muſt be met by another brought through the top of the poſt, from a caſe filled with a ſtrong port-fire charge, and tied to the bottom poſt, with its mouth facing the packthread which holds up the ſtand; ſo that when this caſe is lighted, it will burn the packthread, and let the wheel fall forward, by which means it will become vertical: then from the laſt caſe of the wheel, carry a leader into the barrel next the ſun, which will begin as ſoon as the wheel is burnt out.

107. *Grand Volute illuminated with a projected Wheel in front.*

Firſt have two hoops made of ſtrong iron wire, one of 6 feet diameter, and one of 4 feet 2 inches; theſe hoops muſt be joined to ſcrolls A, A, A, &c. as in pl. 36. fig. 1. Theſe ſcrolls muſt be made of the ſame ſort of wire as the hoops; on theſe ſcrolls tie with iron-binding wire, as many illuminating port-fires as they will hold, at two inches diſtance; clothe theſe port-fires with leaders, ſo that they may all take fire together. Then let C be a circular wheel of four ſpokes, 3 feet 6 inches diameter; and on its fell tie as many 4-oz. caſes, head to tail, as will complete the circle, only allowing a ſufficient diſtance between the caſes, that the fire may paſs free; which may be done by cutting the upper part of the end of each caſe a little ſhelving: on each ſpoke fix a 4-oz. caſe, about three inches from the fell of the wheel: theſe caſes are to burn one at a time, and the firſt of them to begin with thoſe on the fell, of which four are to burn at a time; ſo that the wheel will laſt no longer than $\frac{1}{4}$ of the caſes on the fell, which in number ſhould be 16 or 20. On the front of the wheel form a ſpiral line with ſtrong wire, on which tie port-fires, placing them on a ſlant, with their mouths to face the ſame way as the caſes on the wheel; all theſe port fires muſt be fired with the ſecond caſes of the wheel. Let D, D, D, &c. be ſpokes of wood, all made to ſcrew into a block in the centre; each of theſe ſpokes may be in length about 4 feet 6 inches; in the top of each fix a ſpindle, and on each ſpindle put a ſpiral wheel of 8 ſpokes, ſuch as E, E, E, &c. The blocks of theſe wheels muſt have a hole at top for the centre caſes, and the ſpindle muſt have nuts ſcrewed on their ends; which nuts ſhould fit in the holes at top of the blocks, ſo that all the wheels muſt be put on before you fix in the centre caſes; as ſome of theſe wheels, by reaſon of their ſituation, will not bear on the nut, it will be neceſſary to have ſmooth ſhoulders made on the ſpindles for the blocks to run on. The caſes of theſe wheels are to burn double; and the method of firing them is by carrying a leader from each down the ſpokes into the block in the centre, as in the dodecaedron, but the centre caſe of each wheel muſt begin with the two laſt caſes as uſual. It is to be obſerved, that the large circular wheel in front muſt have a tin barrel on its block, into which a pipe muſt be carried from one of the ſecond caſes on the wheel; this pipe being met by another from the large block, in which the 8 ſpokes are ſcrewed, will fire all the ſpiral wheels and the illuminating port fires at the ſame time. The caſes of the projected wheel may be filled with a white charge, and thoſe of the ſpiral wheels with a gray.

108. *Moon and Seven Stars.*

Let fig. 2. be a ſmooth circular board 6 feet diameter: out of the middle of it cut a circular piece 12 or 14 inches diameter; and over the vacancy put white Perſian ſilk, on which paint a moon's face: then let I, I, I, &c. be ſtars, each 4 or 5 inches diameter, cut out with five points, and covered with oiled ſilk: on the front of the large circular board draw a 7-pointed ſtar, as large as the circle will allow; then on the lines which form this ſtar, bore holes, wherein fix pointed ſtars. When this caſe is to be fired, it muſt be fixed upon the front of a poſt, on a ſpindle, with a wheel of brilliant fire behind the face of the moon: ſo that, while the wheel burns, the moon and ſtars will appear tranſparent; and when the wheel has burnt out, they will diſappear, and the large ſtar in front, which is formed of pointed ſtars, will begin, being lighted by a pipe of communication from the laſt caſe of the vertical wheel, behind the moon; this pipe muſt be managed in the ſame manner as thoſe in regulated pieces.

109. *Double Cone-Wheel illuminated.*

This piece is repreſented by fig. 3. Let A be a ſtrong decagon wheel, 2 feet 6 inches diameter; then on each ſide of it fix a cone B and C: theſe cones are to conſiſt of a number of hoops, ſupported by 3 or 4 pieces of wood, in the manner of the ſpiral wheels. Let the height of each cone be 3 feet 6 inches; and on all the hoops tie port-fires horizontally, with their mouths outwards, and clothe the wheel with 8-oz. caſes, all to play horizontally, two at a time: the cones may be fired with the firſt or ſecond caſes. The ſpindle for this piece muſt go through both the cones, and riſe three feet above the point of the cone at top; ſo that its length will be 10 feet 4 inches from the top of the poſt H, in which it is fixed, allowing four inches for the thickneſs of the block of the wheel. The whole weight of the wheel and cones muſt bear on a ſhoulder in the ſpindle, on which the block of the wheel muſt turn.—Near the top of the ſpindle muſt be a hole in the front, into which ſcrew a ſmall ſpindle, after the cones are on: then on this ſmall ſpindle fix a ſun D, compoſed of ſixteen 9-inch 4 oz. caſes of brilliant fire; which caſes muſt not be placed on a fell, but only ſtuck into a block of 6 inches diameter: then in the front of this ſun muſt be a circular vertical wheel, 16 inches diameter; on the front of this wheel form with iron wire a ſpiral line, and clothe it with illuminations after the uſual method. As this wheel is not to be fired till the cones are burnt out, the method of firing it is thus: Let the hole in the block, at the top of the uppermoſt cone, be a little larger than the ſpindle which paſſes through it. Then, from the firſt caſe of the vertical wheel before the ſun, carry a leader down the ſide of the ſpindle to the top of the block of the horizontal wheel, on which muſt be a tin barrel: then this leader being met by another brought from the end of the laſt caſe of the horizontal wheel, will give fire to the vertical wheel ſo ſoon as the cones are extinguiſhed: but the ſun D muſt not be fired till the vertical wheel is quite burnt out.

110. *Fire-pumps.*

Caſes for fire-pumps are made as thoſe for tourbillons; only they are paſted, inſtead of being rolled dry. Having rolled and dried your caſes, fill them: firſt put in a little meal-powder, and then a ſtar; on which ram lightly a ladle or two of compoſition, then a little meal-powder, and on that a ſtar, then again compoſition; and ſo on till you have filled the caſe. Stars for fire-pumps ſhould not be round; but muſt be made either ſquare, or flat and circular, with a hole through the middle: the quantity of powder for throwing the ſtars muſt increaſe as you come near the top of the caſe; for, if much powder be put at the bottom, it will burſt the caſe. The ſtars muſt differ in ſize in this manner: Let the ſtar which you put in firſt be about $\frac{1}{4}$ leſs than the bore of the caſe; but let the next ſtar be a little larger, and the third ſtar a little larger than the ſecond, and ſo on: let them increaſe in diameter till within two of the top of the caſe, which two muſt fit in tight. As the loading of fire-pumps is ſomewhat difficult, it will be neceſſary to make two or three trials before you depend on their performance: when you fill a number of pumps, take care not to put in each an equal quantity of charge between the ſtars, ſo that when they are fired, they may not throw up too many ſtars together. Caſes for fire-pumps ſhould be made very ſtrong, and rolled on 4 or 8 oz. formers, 10 or 12 inches long each.

111. *Vertical Scroll Wheel.*

This wheel may be made of any diameter, but muſt be conſtructed as in plate 36. fig. 4. to do which proceed thus: Have a block made of a moderate ſize, in which fix four flat ſpokes, and on them fix a flat circular ſell of wood; round the front of this ſell place port-fires; then on the front of the ſpokes form a ſcroll, either with a hoop or ſtrong iron wire; on this ſcroll tie caſes of brilliant fire, in proportion to the wheel, head to tail, as in the figure. When you fire this wheel, light the firſt caſe near the ſell; then, as the caſes fire ſucceſſively, you will ſee the circle of fire gradually diminiſh: but whether the illuminations on the ſell begin with the ſcroll or not, is immaterial, that being left entirely to the maker.

N. B, This wheel may be put in the front of a regulated piece, or fired by itſelf occaſionally.

112. *Pin-Wheels.*

Firſt roll ſome paper pipes, about 14 inches long each; theſe pipes muſt not be made thick of paper, two or three rounds of elephant paper being ſufficient. When your pipes are thoroughly dried, you muſt have a tin tube 12 inches long, to fit eaſy into the pipes; at one end of this tube fix a ſmall conical cup, which cone is called a *funnel*; then bend one end of one of the pipes, and put the funnel in at the other as far as it will reach, and fill the cup with compoſition: then draw out the funnel by a little at a time, ſhaking it up and down, and it will fill the pipe as it comes out. Having filled ſome pipes, have ſome ſmall blocks made about one inch diameter and half an inch thick: round one of theſe blocks wind and paſte a pipe, and to the end of this pipe join another; which muſt be done by twiſting the end of one pipe to a point, and putting it into the end of the other with a little paſte: in this manner join four or five pipes, winding them one upon the other ſo as to form a ſpiral line. Having wound on your pipes, paſte two ſlips of paper acroſs them to hold them together: beſides theſe ſlips of paper, the pipes muſt be paſted together.

There is another method of making theſe wheels, viz. by winding on the pipes without paſte, and ſticking them together with ſealing-wax at every half turn; ſo that when they are fired, the end will fall looſe every time the fire paſſes the wax, by which means the circle of fire will be conſiderably increaſed. The formers for theſe pipes are made from $1\frac{1}{2}$ to 4-16ths of an inch diameter; and the compoſition for them is as follows: Meal-powder 8 oz. ſaltpetre 2 oz. and ſulphur 1: among theſe ingredients may be mixed a little ſteel-filings or the duſt of caſt iron: this compoſition ſhould be very dry, and not made too fine, or it will ſtick in the funnel. Theſe wheels may be fired on a large pin, and held in the hand with ſafety.

113. *Fire-globes.*

There are two ſorts of fire-globes; one with projected caſes; the other with the caſes concealed, thus: Have a globe made of wood, of any diameter you chooſe, and divide the ſurface of it into 14 equal parts, and at each diviſion bore a hole perpendicular to the centre: theſe holes muſt be in proportion to the caſes intended to be uſed: in every hole except one, put a caſe filled with brilliant, or any other charge, and let the mouths of the caſes be even with the ſurface of the globe; then cut in the globe a groove, from the mouth of one caſe to the other, for leaders, which muſt be carried from caſe to caſe, ſo that they may all be fired together; this done, cover the globe with a ſingle paper, and paint it. Theſe globes may be uſed to ornament a building.

Fire-globes with projected caſes are made thus: Your globe being made with 14 holes bored in it as uſual, fix in every hole except one, a caſe, and let each caſe project from the globe two-thirds of its length; then clothe all the caſes with leaders, ſo that they may all take fire at the ſame time. Fire-globes are ſupported by a pintle, made to fit the hole in which there is no caſe.

114. *To thread and join Leaders, and place them on different Works.*

Joining and placing leaders is a very eſſential part of fire-works, as it is on the leaders that the performance of all complex works depends; for which reaſon the method of conducting pipes of communication ſhall be here explained in as plain a manner as poſſible. Your works being ready to be clothed, proceed thus: Cut your pipes of a ſufficient length to reach from one caſe to the other; then put in the quick-match, which muſt always be made to go in very eaſy: when the match is in, cut it off within about an inch of the end of the pipe, and let it project as much at the other end; then faſten the pipe to the mouth of each caſe with a pin, and put the looſe ends of the match into the mouths of the caſes, with a little meal-powder: this done to all the caſes, paſte over the mouth of each two or three bits of paper. The preceding method is uſed for large caſes, and the following for ſmall, and for illuminations: Firſt thread a long pipe; then lay it on the tops of the caſes, and cut a bit of the under ſide, over the mouth of each caſe, ſo that the match may appear: then pin the pipe to every other caſe; but before you put on the pipes, put a little meal-powder in the mouth of each caſe. If the caſes thus clothed are port-fires on illuminated works, cover the mouth of each caſe with a ſingle paper; but if they are choaked caſes, ſituated ſo that a number of ſparks from other works may fall on them before they are fired, ſecure them with three or four papers, which muſt be paſted on very ſmooth, that there may be no creaſes for the ſparks to lodge in, which often ſet fire to the works before their time. Avoid as much as poſſible placing the leaders too near, or one acroſs the other ſo as to touch, as it may happen that the flaſh of one will fire the other; therefore if your works ſhould be ſo formed that the leaders muſt croſs or touch, be ſure to make them very ſtrong, and ſecure at the joints, and at every opening.

When a great length of pipe is required, it muſt be made by joining ſeveral pipes in this manner: Having put on one length of match as many pipes as it will hold, paſte paper over every joint; but, if a ſtill greater length is required, more pipes muſt be joined, by cutting about an inch off one ſide of each pipe near the end, and laying the quick-match together, and tying them faſt with ſmall twine; after which cover the joining with paſted paper.

115. *Placing Fire-works to be exhibited.*

Nothing adds more to the appearance of fire-works than the placing them properly; though the manner of placing them chiefly depends on the judgment of the maker. The following are the rules generally obſerved, whether the works are to be fired on a building or on ſtands: if they are a double ſet, place one wheel of a ſort on each ſide of the building; and next to each of them, towards the centre, place a fixed piece, then wheels, and ſo on; leaving a ſufficient diſtance between them for the fire to play from one without burning the other. Having fixed ſome of your works thus in front, place the reſt behind them, in the centre of their intervals: the largeſt piece, which is generally a regulated or tranſparent piece, muſt be placed in the centre of the building, and behind it a ſun, which muſt always ſtand above all the other works: a little before the building, or ſtands, place your large gerbes; and at the back of the works fix your marron batteries, *pots des aigrettes*, *pots des brins*, *pots des ſauciſſons*, air-balloons, and flights of rockets: the rocket-ſtands may be fixed behind, or anywhere elſe, ſo as not to be in the way of the works.

Single collections are fired on ſtands; which ſtands are made in the ſame manner as theodolite ſtands, only the top part muſt be long or ſhort occaſionally; theſe ſtands may be fixed up very ſoon without much trouble.

116. *Order of Firing.*

1. Two ſignal
2. Six ſky } rockets
3. Two honorary
4. Four caduceus
5. } Two { vertical } wheels illuminated
6. ſpiral
7. tranſparent ſtars
8. A line rocket of five changes
9. Four tourbillons
10. horizontal wheels
11. air balloons illuminated
12. } Two { Chineſe fountains
13. regulating pieces of four mutations each
14. pots des aigrettes
15. Three large gerbes
16. A flight of rockets
17. } Two { balloon wheels
18. caſcades of brilliant fire
19. Twelve ſky-rockets
20. } Two { illuminated yew trees
21. air-balloons of ſerpents, and 2 compound
22. Four tourbillons
23. } Two { Fruiloni wheels
24. illuminated globes with horizontal wheels
25. One pot des ſauciſſons
26. Two plural wheels
27. Marron battery
28. Two chandeliers illuminated
29. Range of pots des brins
30. Twelve ſky-rockets
31. Two yew-trees of fire
32. Neſt of ſerpents
33. Two double cones illuminated
34. Regulating piece of ſeven mutations, viz.
    1. Vertical wheel illuminated
    2. Golden glory
    3. Octagon vertical wheel
    4. Porcupine's quills
    5. Croſs fires
    6. Star-piece with brilliant rays
    7. Six vertical wheels
35. Brilliant ſun
36. Large flight of rockets.

When water works are to be exhibited, divide them into ſeveral ſets, and fire one ſet after every fifth or ſixth change of land and air-works. Obſerve this rule in firing a double ſet of works: Always begin with ſky rockets, then two moveable pieces, then two fixed pieces, and ſo on; ending with a large flight of rockets, or a marron battery: if a ſingle collection, fire a fixed piece after every wheel or two, and now and then ſome air and water-works.

117. *Fountain of Sky-rockets.*

Fig. 5. in plate 36. repreſents a fountain of 30 rockets. Let A be a perpendicular poſt, 16 feet high from the ground, and 4 inches ſquare. Let the rail, or croſs piece C, be 1 foot 6 inches long, 3 inches broad, and 1 thick. The rail D, at bottom, muſt be 6 feet long, 1 foot broad, and 1 inch thick. F and G are the two ſides which ſerve to ſupply the rails D, E, H, I, C: theſe ſides are 1 foot broad at bottom, and cut in the front with a regular ſlope, to three inches at top; but their back edges muſt be parallel with the front of the pots A. The breadth of the rails E, H, I, will be determined by the breadth of the ſides: all the rails muſt be fixed at 2 feet diſtance from each other, and at right angles with the pots. Having placed the rails thus, bore in the bottom rail 10 holes, at equal diſtances, large enough to receive the ſtick of a one-pound rocket: in the back edge of this rail cut a groove from one end to the other, fit to contain a quick-match; then cut a groove in the top of the rail, from the edge of each hole, into the groove in the back: in the ſame manner cut in the ſecond rail, E, 8 holes and grooves; in the third rail, H, 6 holes and grooves; in the fourth rail, I, 4 holes and grooves: and in the top rail, 2 holes and grooves. B, a rail with holes in it to guide the ends of the rocket-ſticks: this rail muſt be fixed 6 feet from the rail D. The fountain frame being thus made, prepare your rockets thus: Tie round the mouth of each a piece of thin paper, large enough to go twice round, and to project about $1\frac{1}{2}$ inch from the mouth of the rocket, which muſt be rubbed with wet meal-powder; in the mouth of each rocket put a leader, which ſecure well with the paper that projects from the mouth of the caſe: theſe leaders muſt be carried into the grooves in the back of the rails, in which lay a quick-match from one end to the other, and cover it with paſted paper: holes muſt be made in the rail D, to receive the ends of the ſticks of the rockets in the rail E, and ſo on to the fourth rail; ſo that the ſticks of the rockets at top will go through all the rails. The rockets being ſo prepared, fix a gerbe, or white flower-pot, on each rail, before the poſt, with their mouths inclining a little forwards: theſe gerbes muſt be lighted all at once. Behind or before each gerbe, fix a caſe of brilliant or ſlow fire: theſe caſes muſt be filled ſo that they may burn out one after the other, to regulate the fountain; which may be done by carrying a leader from the end of each ſlow or brilliant fire, into the groove in the back of each rail. Different fixed rockets may be uſed in theſe fountains: but it will be beſt to fill the heads of the rockets on each rail with different ſorts of things, in this manner; thoſe at top with crackers, the next with rains, the third with ſerpents, the fourth with tailed ſtars, and the laſt flight with common or brilliant ſtars.

118. *Palm Tree.*

This piece, though made of common fires, and of a ſimple conſtruction, has a very pleaſing effect; owing to the fires interſecting ſo often that they reſemble the branches of trees. Let A (pl. 36. fig 6) be a perpendicular poſt, of any thickneſs, ſo that it is ſufficiently ſtrong to hold the caſes; let the diſtance from B to C be 2 feet 6 inches, and C to D 2 feet 6 inches, and let the length of each croſs piece be 2 feet; on each end of each fix a five pointed ſtar: then fix, on pegs made on purpoſe, 12-inch half pound caſes of brilliant fire, as in the figure. All the caſes and ſtars muſt be fired at once. This piece ſhould be fixed high from the ground.

119. *Illuminated Pyramid, with Archimedian Screws, a Globe, and vertical Sun,*

May be of any ſize. One made according to the dimenſions of fig. 7. will be a good proportion, whoſe height is 21 feet; from C to D, 6 feet; from E to F, 9 feet: the ſpace between the rails muſt be 6 inches, and the rails as thin as poſſible: in all the rails ſtick port-fires at four inches diſtant. The Archimedian ſcrews, G, K, are nothing more than double ſpiral wheels, with the caſes placed on their wheels horizontally inſtead of obliquely. The vertical ſun, I, need not conſiſt of more that 12 rays, to form a ſingle glory. The globe at top muſt be made in proportion to the pyramid; which being prepared according to the preceding directions, place your leaders ſo that all the illuminating port-fires, ſcrews, globe, and ſun, may take fire together. The pyramid muſt be ſupported by the two ſides, and by a ſupport brought from a pole, which muſt be placed two feet from the back of the pyramid, that the wheels may run free.

120. *Roſe piece and Sun.*

A roſe-piece may be uſed for a mutation of a regulated piece, or fired by itſelf: it makes the beſt appearance when made large, if its exterior diameter be 6 feet, it will be a good ſize. Fig. 8. ſhows the manner it appears in before it is fired. Let the exterior fell be made of wood, and ſupported by 4 wooden ſpokes; all the other parts, on which the illuminations are fixed, muſt be made of ſtrong iron wire: on the exterior fell place as many half-pound caſes of brilliant charge as you think proper, but the more the better; for the nearer the caſes are placed, the ſtronger will be the rays of the ſun: the illuminations ſhould be placed within 3 inches of each other; they muſt all be fired together, and burn ſome time before the ſun is lighted, which may be done by carrying a leader from the middle of one of the illuminations to the mouth of one of the ſun caſes.

121. *Tranſparent Stars with illuminated Rays.*

Fig. 9. repreſents an illuminated ſtar. Let the diameter from A to B be 2 feet, and from C to D 7 feet. Firſt make a ſtrong circular back or body of the ſtar, 2 feet diameter, to which you fix the illuminated rays: in the center of the front of the body fix a ſpindle, on which put a double triangular wheel 6 inches diameter, clothed with 2-ounce caſes of brilliant charge: the caſes on this wheel muſt burn but one at a time. Round the edge of the body nail a hoop made of thin wood or tin: this hoop muſt project in front 6 or 7 inches: in this hoop cut 3 or 4 holes to let out the ſmoke from the wheel. The ſtar and garter may be cut out of ſtrong paſteboard or tin, made in this manner: Cut a round piece of paſteboard or tin, 2 feet diameter, on which draw a ſtar, and cut it out; then over the vacancy paſte Perſian ſilk; paint the letters yellow; 4 of the rays yellow, and 4 red; the croſs in the middle may be painted half red and half yellow, or yellow and blue. This tranſparent ſtar muſt be faſtened to the wooden hoop by a ſcrew, to take off and on; the illuminated rays are made of thin wood, with tin ſockets fixed on their ſides within 4 inches of each other; in theſe ſockets ſtick illuminating port-fires; behind the point of each ray fix a half pound caſe of gray, black, or Chineſe fire.

N. B. The illuminated rays to be lighted at the ſame time as the triangular wheel, or after it is burnt out; which may be done by a tin barrel being fixed to the wheel, after the manner of thoſe in the regulated pieces. Into this barrel carry a leader from the illuminated rays, through the back of the ſtar: which leader muſt be met by another, brought from the tail of the laſt caſe on the wheel.

122. *Tranſparent Table Star illuminated.*

Fig. 1. in pl. 37. repreſents a table ſtar, whoſe diameter, from E to F, is 12 feet; and from E to I, 4 feet. This proportion, obſerved on each ſide, will make the center frame 4 feet ſquare: in this ſquare fix a tranſparent ſtar, as in the figure.

This ſtar may be painted blue, and its rays made as thoſe of the flaming ſtars deſcribed before. The wheel for this ſtar may be compoſed of different coloured fires, with a charge or two of slow fire; the wheels *a, a, a, a,* may be clothed with any number of caſes, ſo that the ſtar-wheel conſiſt of the ſame: the illuminating port-fires, which muſt be placed very near each other on the frames, muſt be ſo managed as to burn as long as the wheel, and lighted at the ſame time.

123. *The regulated illuminated Spiral Piece, with a projected Star wheel illuminated.*

This piece is repreſented by fig. 2. and is thus made. Have a block made 8 inches diameter; in this block ſcrew 6 iron ſpokes, which muſt ſerve for ſpindles for the ſpiral wheels: theſe wheels are made as uſual, each 1½ foot diameter, and 3 feet in height: the ſpindles muſt be long enough to keep the wheels 4 or 5 inches from one another: at the end of each ſpindle muſt be a ſcrew-nut, on which the wheels that hang downwards will run; and on the ſpindles which ſtand upwards muſt be a ſhoulder, for the blocks of the wheels to run on.

The projected ſtar wheel muſt turn on the ſame ſpindle on which the large block is fixed; this ſpindle muſt be long enough to allow the ſtar wheel to project a little before the ſpiral wheels: the exterior diameter of the ſtar wheel muſt be 3 feet 5. On this wheel fix 3 circles of iron wire, and on them port-fires; on the block place a tranſparent ſtar, or a large 5-pointed brilliant ſtar. The caſes on this wheel may burn 4 at once, as it will contain near twice the number of one of the ſpiral wheels: the caſes on the ſpiral wheels muſt be placed parallel to their fells, and burn two at a time.

124. *A Figure-piece illuminated with five-pointed Stars.*

The conſtruction of this piece is very eaſy, as ſhown in pl. 37. by fig. 3. whoſe diameter from B to C is 8 feet, and from D to F 2 feet: the vertical wheel in the center muſt be 1 foot diameter, and conſiſt of 6 four-ounce caſes of different-coloured charge, which caſes muſt burn double: on the frames fix 5-pointed brilliant or blue ſtars, rammed 4 inches with compoſition: let the ſpace between each ſtar be 8 inches; at each point fix a gerbe, or caſe of Chineſe fire. When to be fired, let the gerbe, ſtars, and wheel, be lighted at the ſame time.

125. *The Star-wheel illuminated.*

This beautiful piece is ſhown by fig. 4. Its exterior fell is made of wood, 3 feet 6, or 4 feet diameter; within this fell form with iron wire 3 circles, one leſs than the other, ſo that the diameter of the leaſt may be about 10 inches: place the port-fires on theſe fells with their mouths inclining outwards, and the port-fires on the points of the ſtar with their mouths projecting in front: let the exterior fell be clothed with 4-ounce caſes of gray charge: theſe caſes muſt burn 4 at a time, and be lighted at the ſame time as the illuminations.

126. *Pyramid of Flower-pots*

Fig. 5. repreſents this curious piece, which muſt be made thus. Let the diſtance from A to B be 6 feet; and from one rail to the other, 2: on the bottom rail fix 5 paper mortars, each 3½ inches diameter; theſe mortars load with ſerpents, crackers, ſtars, &c.

In the centre of each mortar fix a caſe of ſpur fire; on the ſecond rail fix 4 mortars, ſo as to ſtand exactly in the middle of the intervals of them on the bottom rail; on the third rail place 3 mortars; on the fourth, 2; and on the top of the poſts, 1: the bottom rail muſt be 6 feet long: all the mortars muſt incline a little forwards, that they may eaſily diſcharge; and the ſpur-fires rammed exactly alike, that the mortars may all be fired at the ſame time. Having prepared your pyramid according to the preceding directions, carry pipes of communication from one ſpur-fire to the other.

127. *The illuminated Regulating Piece.*

Fig. 6. repreſents one half of this piece. A, A, A, A, are flat wooden ſpokes, each 5 feet long: at the end of each place a vertical wheel, 10 inches diameter, clothed with 6 four-ounce caſes of brilliant fire: theſe caſes muſt burn but one at a time; on two of the ſpokes of each wheel place 2 port-fires, which muſt be lighted with the firſt caſe of the wheel; on each ſpoke A, A, &c. behind the wheels, place 6 caſes of the ſame ſize with thoſe on the wheels: theſe caſes muſt be tied acroſs the ſpokes with their mouths all one way, and be made to take fire ſucceſſively one after the other, ſo that they may aſſiſt the whole pieces to turn round.

The diameter of the large wheel muſt be 2½ feet; and its fell made of wood, which muſt be fixed to the large ſpokes: on this wheel place 24 caſes of the ſame ſort with thoſe on the ſmall wheels; theſe caſes muſt burn 4 at a time: in this wheel make 3 circles with iron wire, and on them place illuminating port fires as in the figure: the ſtar-points on the large ſpokes may be made of thin aſh-hoops: the diameter of theſe points cloſe to the centre-wheel muſt be 12 inches: on theſe points place port-fires, at 3½ inches diſtance one from the other.

Fig. 7. repreſents the blocks of this piece. The diameters of theſe blocks, at A and B, muſt be [illegible] inches; and C and D, 4½ inches: the length of each of theſe blocks muſt be 6 inches: at the ſmall ends of theſe blocks fix an iron wheel 5 inches diameter, which wheels muſt have teeth, to turn the wheel [illegible]: this wheel is fixed on a ſmall ſpindle ſcrewed into the large ſpindle, which goes through the two blocks, and on which they run.

Suppoſing fig. 6. to be on the block A, in fig. 7. and to turn to the right, and another piece of the ſame conſtruction on the block B, with its fires placed ſo as to turn it to the left; you will find them move very true and faſt, by the help of the 3 iron wheels, which ſerve to regulate their motions, as well as to aſſiſt them in turning; let the iron circles in the front of the great wheels be of different diameters, ſo that when fired there may appear 6 circles. When this piece is fired, all the wheels and illuminations muſt be lighted at one time.

SECT. VI. *Aquatic Fire-works.*

WORKS that ſport in the water are much eſteemed by moſt admirers of fire-works, particularly water-rockets; and, as they ſeem of a very extraordinary nature to thoſe who are unacquainted with this art, they merit a particular explanation.

128. *Water rockets*

May be made from 4-oz. to 2 lb. If larger they are too heavy; ſo that it will be difficult to make them keep above water without a cork float, which muſt be tied to the neck of the caſe; but the rockets will not dive ſo well with as without floats.

Caſes for theſe are made in the ſame manner and proportion as ſky-rockets, only a little thicker of paper. When you fill thoſe which are driven ſolid, put in firſt 1 ladleful of ſlow fire, then 2 of the proper charge, and on that 1 or 2 ladles of ſinking charge, then the proper charge, then the ſinking charge again, and ſo on, till you have filled the caſe within 3 diameters; then drive on the compoſition 1 ladleful of clay; through which make a ſmall hole to the charge; then fill the caſe, within ½ a diameter, with corn-powder, on which turn down 2 or 3 rounds of the caſe in the inſide; then pinch and tie the end very tight: having filled your rockets (according to the above directions), dip their ends in melted roſin or ſealing-wax, or elſe ſecure them well with greaſe. When you fire thoſe rockets, throw in 6 or 8 at a time; but, if you would have them all ſink, or ſwim, at the ſame time, you muſt drive them with an equal quantity of compoſition, and fire them all together.

129. *To make Pipes of Communication, which may be uſed under Water.*

Pipes for this purpoſe muſt be a little thicker of paper than thoſe for land. Having rolled a ſufficient number of pipes, and kept them till dry, waſh them over with drying oil, and ſet them to dry; but when you oil them, leave about 1½ inch at each end dry, for joints: if they were oiled all over, when you come to join them, the paſte would not ſtick where the paper is greaſy: after the leaders are joined, and the paſte dry, oil the joints. Theſe pipes will lie many hours under water, without receiving any damage.

130. *Horizontal Wheels for the Water.*

Firſt get a large wooden bowl without a handle; then have an octagon wheel made of a flat board 18 inches in diameter, ſo that the length of each ſide will be near 7 inches: in all the ſides cut a groove for the caſes to lie in. This wheel being made, nail it on the top of the bowl; then take 4 eight-oz. caſes, filled with a proper charge, each about 6 inches in length. Now, to clothe the wheel with theſe caſes, get ſome whitiſh-brown paper, and cut it into ſlips 4 or 5 inches broad and 7 or 8 long: theſe ſlips being paſted all over on one ſide, take one of the caſes, and roll one of the ſlips of paper about 1½ inch on its end, ſo that there will remain about 2½ inches of the paper hollow from the end of the caſe: this caſe tie on one of the ſides of the wheel, near the corners of which muſt be holes bored, through which you put the packthread to tie the caſes: having tied on the firſt caſe at the neck and end, put a little meal-powder in the hollow paper; then paſte a ſlip of paper on the end of another caſe, the head of which put into the hollow paper on the firſt, allowing a ſufficient diſtance from the tail of one to the head of the other for the paſted paper to bend without tearing: the ſecond caſe tie on as you did the firſt: and ſo on with the reſt, except the laſt, which muſt be cloſed at the end, unleſs it is to communicate to any thing on the top of the wheel, ſuch as fire pumps or brilliant fires, fixed in holes cut in the wheel, and fired by the laſt or ſecond caſe, as the fancy directs: 6, 8, or any number, may be placed on the top of the wheel, provided they be not too heavy for the bowl.

Before you tie on the caſes, cut the upper part of all their ends, except the laſt, a little ſhelving, that the fire from one may play over the other, without being obſtructed by the caſe. Wheel-caſes have no clay drove in their ends, nor pinched, but are always left open; only the laſt, or thoſe which are not to lead fire, which muſt be well ſecured.

131. *Water Mines.*

For theſe mines you muſt have a bowl with a wheel on it, made in the ſame manner as the water-wheel; only in its middle there muſt be a hole, of the ſame diameter you deſign to have the mine. Theſe mines are tin pots, with ſtrong bottoms, and a little more than 2 diameters in length: your mine muſt be fixed in the hole in the wheel, with its bottom reſting on the bowl; then loaded with ſerpents, crackers, ſtars, ſmall water-rockets, &c. in the ſame manner as pots of aigrettes; but in their centre fix a caſe of Chineſe fire, or a ſmall gerbe, which muſt be lighted at the beginning of the laſt caſe on the wheel. Theſe wheels are to be clothed as uſual.

132. *Fire-globes for the Water.*

Bowls for water-globes muſt be very large, and the wheels on them of a decagonal form: on each ſide of which nail a piece of wood 4 inches long; and on the outſide of each piece cut a groove wide enough to receive about ¼ of the thickneſs of a 4-oz. caſe: theſe pieces of wood muſt be nailed in the middle of each face of the wheel, and fixed in an oblique direction, ſo that the fire from the caſes may incline upwards; the wheel being thus prepared, tie in each groove a 4-oz. caſe, filled with a gray charge; then carry a leader from the tail of one caſe to the mouth of the other.

Globes for theſe wheels are made of 2 tin hoops, with their edges outwards, fixed one within the other, at right angles. The diameter of theſe hoops muſt be ſomewhat leſs than that of the wheel. Having made a globe, drive in the centre of a wheel an iron ſpindle which muſt ſtand perpendicular, and its length 4 or 6 inches more than the diameter of the globe.

This ſpindle ſerves for an axis, on which the globe is fixed, which, when done, muſt ſtand 4 or 6 inches from the wheel: round one ſide of each hoop muſt be ſoldered little bits of tin, 2½ inches diſtant from each other; which pieces muſt be 2 inches in length each, and only faſtened at one end, the other ends being left looſe, to turn round the ſmall port-fires, and hold them on: theſe port-fires muſt be made of ſuch a length as will laſt out the caſes on the wheel. You are to obſerve, that there need not be any port-fires at the bottom of the globe within 4 inches of the ſpindle; for, if there were, they would have no effect, but only burn the wheel; all the port-fires muſt be placed perpendicular from the centre of the globe, with their mouths outwards; and muſt all be clothed with leaders, ſo as all to take fire with the ſecond caſe of the wheel; which caſes muſt burn two at a time, one oppoſite the other. When two caſes of a wheel begin together, two will end together; therefore the two oppoſite end caſes muſt have their ends pinched and ſecured from fire. The method of firing ſuch wheels is, by carrying a leader from the mouth of one of the firſt caſes to that of the other; which leader being burnt through the middle, will give fire to both at the ſame time.

133. *Odoriferous Water Balloons.*

Theſe balloons are made in the ſame manner as air-balloons, but very thin of paper, and in diameter 1¾ inch, with a vent of ½ inch diameter. The ſhells being made, and quite dry, fill them with any of the following compoſitions, which muſt be rammed in tight: theſe balloons muſt be fired at the vent, and put into a bowl of water. Odoriferous works are generally fired in rooms.

Compoſition I. Saltpetre 2 oz. flour of ſulphur 1 oz. camphor ½ oz. yellow amber ½ oz. charcoal-duſt ¾ oz. flour of benjamin or aſſa odorata ½ oz. all powdered very fine and well mixed.

II. Saltpetre 12 oz. meal-powder 3 oz. frankincenſe 1 oz. myrrh ½ oz. camphor ½ oz. charcoal 3 oz. all moiſtened with the oil of ſpike.

III. Saltpetre 2 oz. ſulphur ½ oz. antimony ½ oz. amber ½ oz. cedar raſpings ¼ oz. all mixed with the oil of roſes and a few drops of bergamot.

IV. Saltpetre 4 oz. ſulphur 1 oz. ſaw-duſt of juniper ½ oz. ſaw-duſt of cypreſs 1 oz. camphor ½ oz. myrrh 2 drams, dried roſemary ¼ oz. cortex elaterii ½ oz. all moiſtened a little with the oil of roſes.

N. B. Water rockets may be made with any of the above compoſitions, with a little alteration, to make them weaker or ſtronger, according to the ſize of the caſes.

134. *Water Balloons.*

Having made ſome thin paper ſhells, of what diameter you pleaſe, fill ſome with the compoſition for water balloons, and ſome after this manner: Having made the vent of the ſhells pretty large, fill them almoſt full with water rockets, marrons, ſquibs, &c. Then put in ſome blowing powder, ſufficient to burſt the ſhells; and afterwards fix in the vent a water rocket, long enough to reach the bottom of the ſhell, and its neck to project a little out of the vent; this rocket muſt be open at the end, to fire the powder in the ſhell, which will burſt the ſhell, and diſperſe the ſmall rockets, &c. in the water. When you have well ſecured the large rocket in the vent of the ſhell, take a cork float with a hole in its middle, which fit over the head of the rocket, and faſten it to the ſhell: this float muſt be large enough to keep the balloon above water.

135. *Water Squibs.*

Are generally made of 1-oz. ſerpent caſes ſeven or eight inches long, filled two thirds with charge, and the remainder bounced. The common method of firing them is thus: Take a water-wheel, with a tin mortar in its centre, which load with ſquibs after the uſual method; but the powder in the mortar muſt be no more than will juſt throw the ſquibs out eaſily into the water; you may place the caſes on the wheel either obliquely or horizontally: and on the top of the wheel, round the mortar, fix ſix caſes of brilliant fire perpendicular to the wheel: theſe caſes muſt be fired at the beginning of the laſt caſe of the wheel, and the mortar at the concluſion of the ſame.

136. *A Sea-fight with ſmall Ships, and to prepare a Fire-ſhip for it.*

Having procured four or five ſmall ſhips, of two or three feet in length, (or as many as you deſign to fight), make a number of ſmall reports, which are to ſerve for guns. Of theſe range as many as you pleaſe on each ſide of the upper decks; then at the head and ſtern of each ſhip fix a two-ounce caſe, eight inches long, filled with a ſlow port fire receipt; but take care to place it in ſuch a manner that the fire may fall in the water, and not burn the rigging: in theſe caſes bore holes at unequal diſtances from one another, but make as many in each caſe as half the number of reports, ſo that one caſe may fire the guns on one ſide, and the other thoſe on the oppoſite. The method of firing the guns is, by carrying a leader from the holes in the caſes to the reports on the decks; you muſt make theſe leaders very ſmall, and be careful in calculating the burning of the ſlow-fire in the regulating caſes, that more than two guns be not fired at a time. When you would have a broadſide given, let a leader be carried to a cracker, placed on the outſide of the ſhip; which cracker muſt be tied looſe, or the reports will be too ſlow: in all the ſhips put artificial guns at the port-holes.

Having filled and bored holes in two port fires for regulating the guns in one ſhip, make all the reſt exactly the ſame; then, when you begin the engagement, light one ſhip firſt, and ſet it a ſailing, and ſo on with the reſt, ſending them out ſingly, which will make them fire regularly, at different times, without confuſion; for the time between the firing of each gun will be equal to that of lighting the ſlow fires.

The fire ſhip may be of any ſize; and need not be very good, for it is always loſt in the action. To prepare a ſhip for this purpoſe, make a port-fire equal in ſize with thoſe in the other ſhips, and place it at the ſtern; in every port place a large port-fire, filled with a very ſtrong compoſition, and painted in imitation of a gun, and let them all be fired at once by a leader from the ſlow fire, within 2 or 3 diameters of its bottom; all along both ſides, on the top of the upper deck, lay ſtar-compoſition about half an inch thick and one broad, which muſt be wetted with thin ſize, then primed with meal-powder, and ſecured from fire by paſting paper over it; in the place where you lay this compoſition, drive ſome little tacks with flat heads, to hold it faſt to the deck: this muſt be fired juſt after the ſham guns, and when burning will ſhow a flame all round the ſhip: at the head take up the decks, and put in a tin mortar loaded with crackers, which mortar muſt be fired by a pipe from the end of the ſlow fire; the firing of this mortar will ſink the ſhip, and make a pretty concluſion. The regulating port-fire of this ſhip muſt be lighted at the ſame time with the firſt fighting ſhip.

Having prepared all the ſhips for fighting, we ſhall next proceed with the management of them when on the water. At one end of the pond, juſt under the ſurface of the water, fix two running blocks, at what diſtance you chooſe the ſhips ſhould fight; and at the other end of the pond, oppoſite to each of theſe blocks under the water, fix a double block: then on the land, by each of the double blocks, place two ſmall windlaſſes; round one of them turn one end of a ſmall cord, and the other end put through one of the blocks; then carry it through the ſingle one at the oppoſite end of the pond, and bring it back through the double block again, and round the other windlaſs: to this cord, near the double block, tie as many ſmall ſtrings as half the number of the ſhips, at what diſtance you think proper; but theſe ſtrings muſt not be more than two feet each: make faſt the looſe end of each to a ſhip, juſt under her bowſprit; but if tied to the keel, or too near the water, it will overſet the ſhip. Half the ſhips being thus prepared, near the other double block fix two more windlaſſes, to which faſten a cord, and to it tie the other half of the ſhips as before: when you fire the ſhips, pull in the cord with one of the windlaſſes, to get all the ſhips together; and when you have ſet fire to the firſt, turn that windlaſs which draws them out, and ſo on with the reſt, till they are all out in the middle of the pond; then, by turning the other windlaſs, you will draw them back again; by which method you may make them change ſides, and tack about backwards and forwards at pleaſure. For the fire-ſhip, fix the blocks and windlaſſes between the others; ſo that when ſhe ſails out, ſhe will be between the other ſhips: you muſt not let this ſhip advance till the guns at her ports take fire.

137. *To fire Sky-rockets under Water.*

You muſt have ſtands made as uſual, only the rails muſt be placed flat inſtead of edgewiſe, and have holes in them for the rocket-ſticks to go through; for if they were hung upon hooks the motion of the water would throw them off: the ſtands being made, if the pond is deep enough, ſink them at the ſides ſo deep, that, when the rockets are in, their heads may juſt appear above

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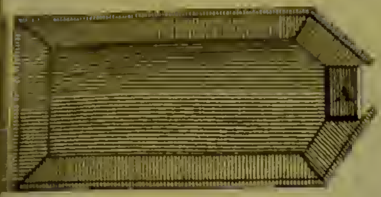

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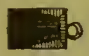

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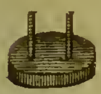

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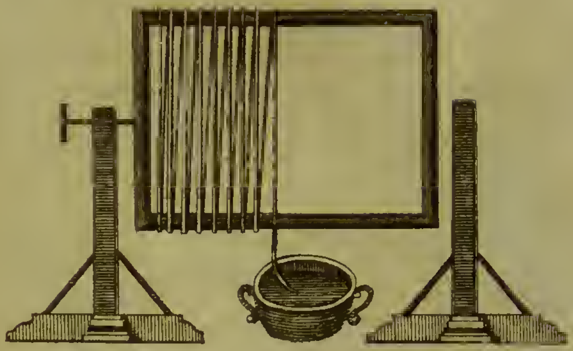

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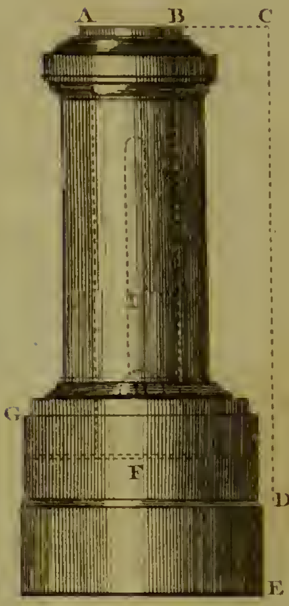

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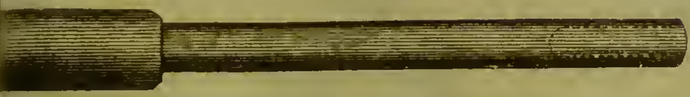

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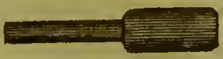

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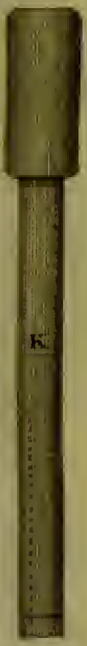

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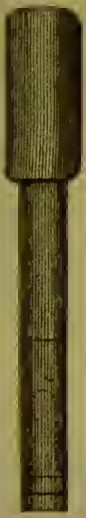

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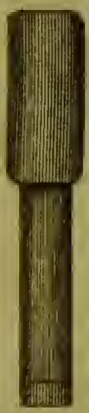

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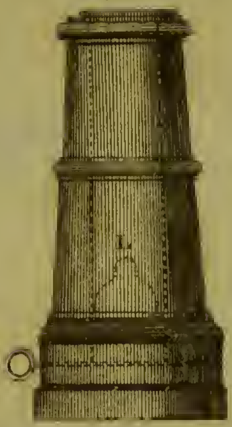

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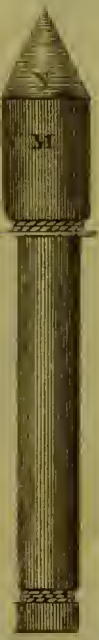

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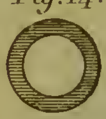

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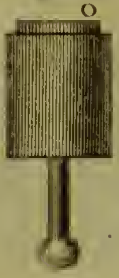

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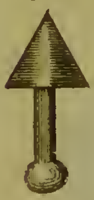

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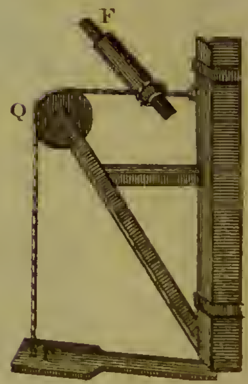

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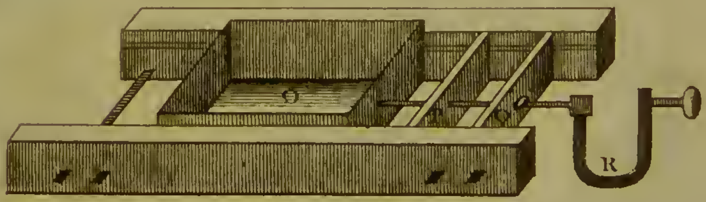

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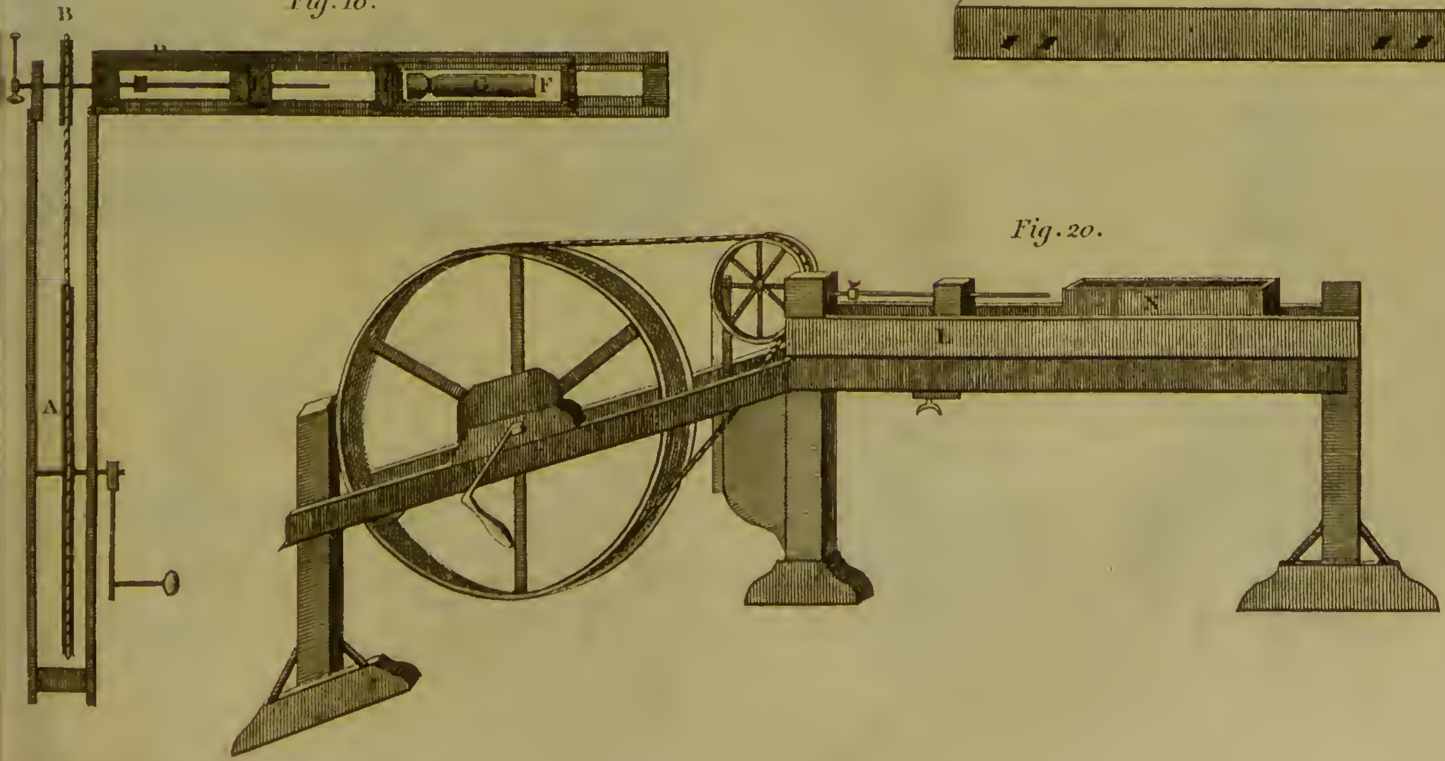

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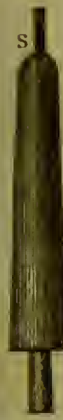

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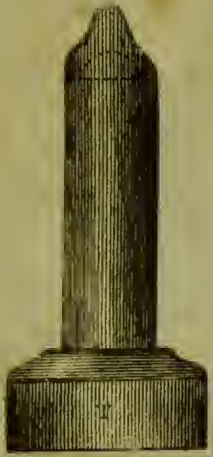

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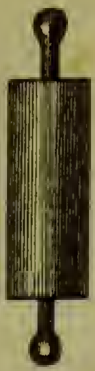

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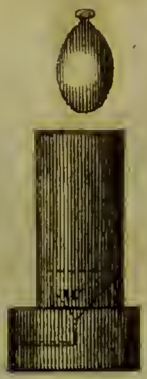

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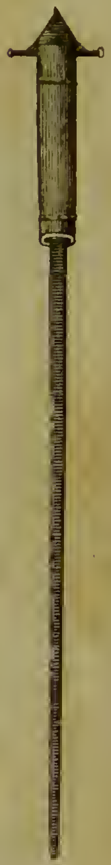

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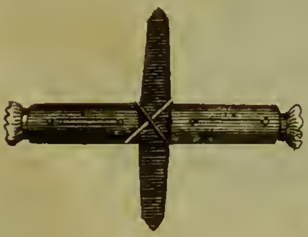

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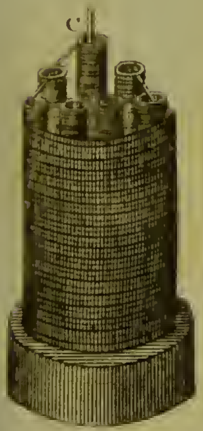

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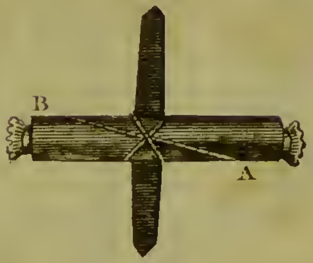

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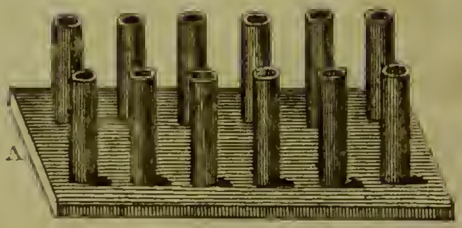

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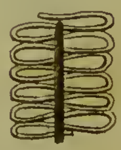

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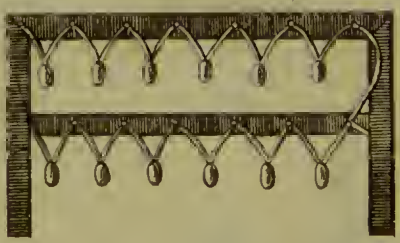

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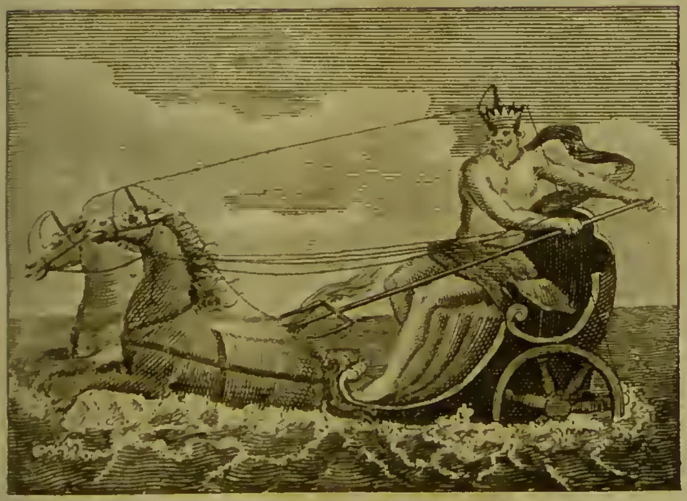

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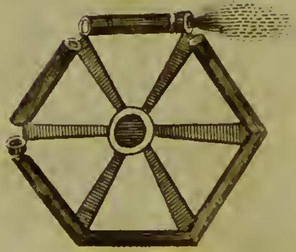

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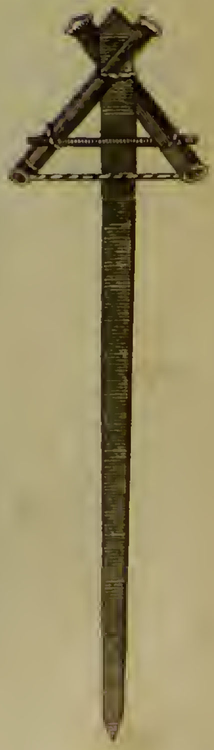

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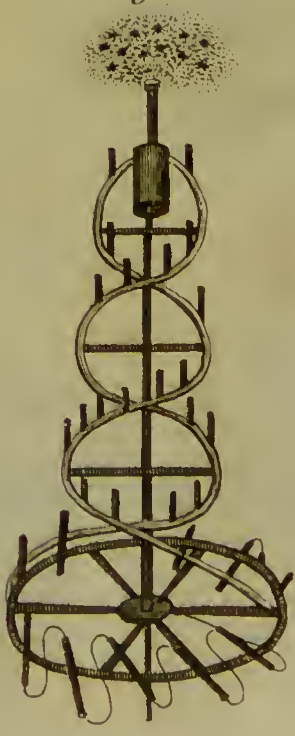

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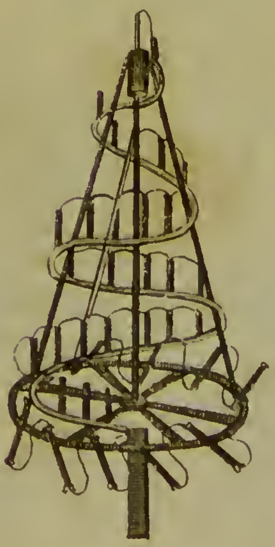

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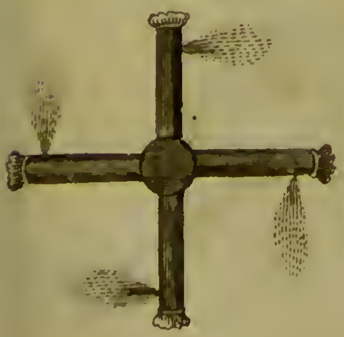

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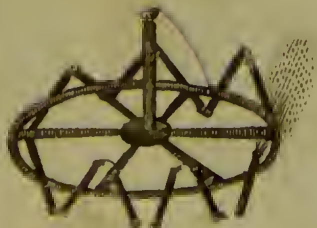

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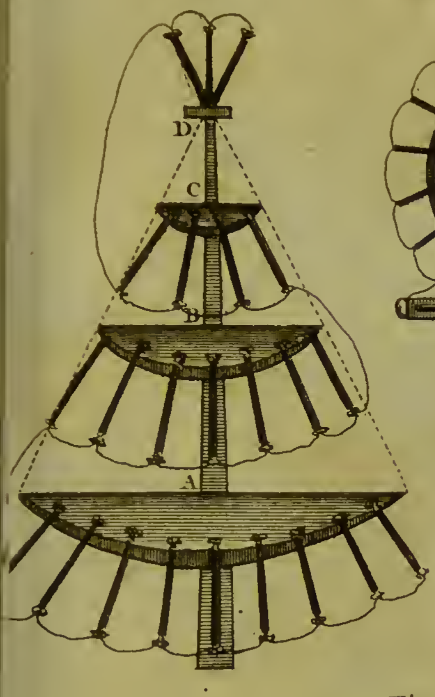

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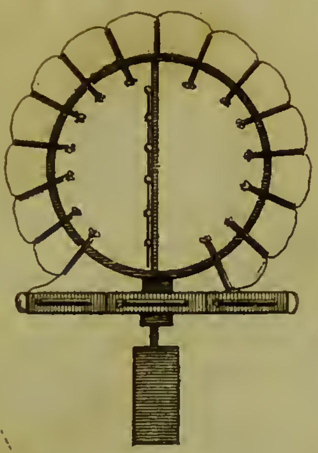

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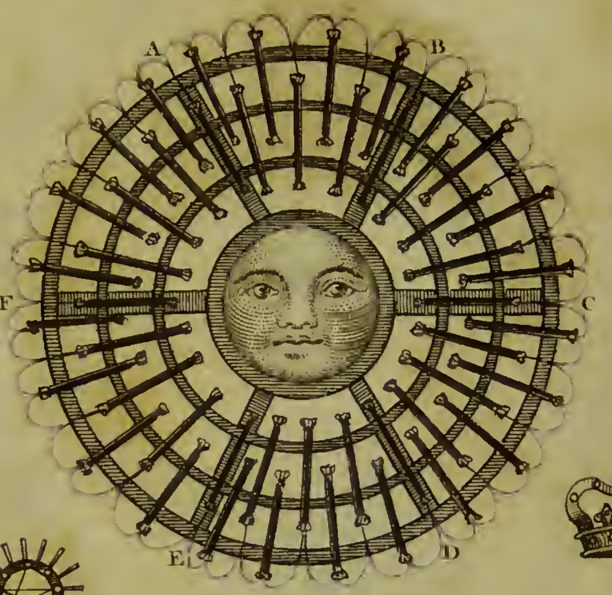

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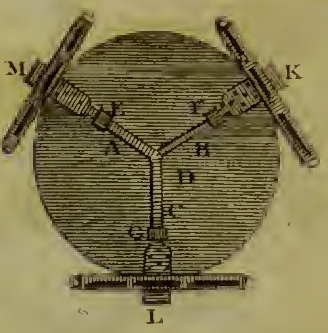

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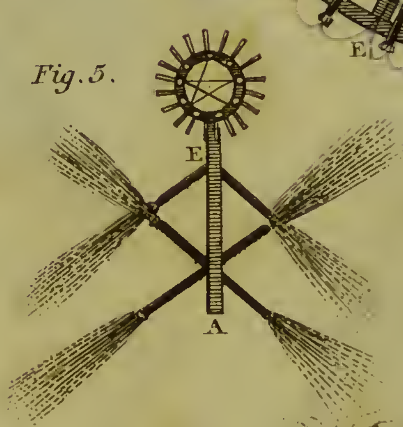

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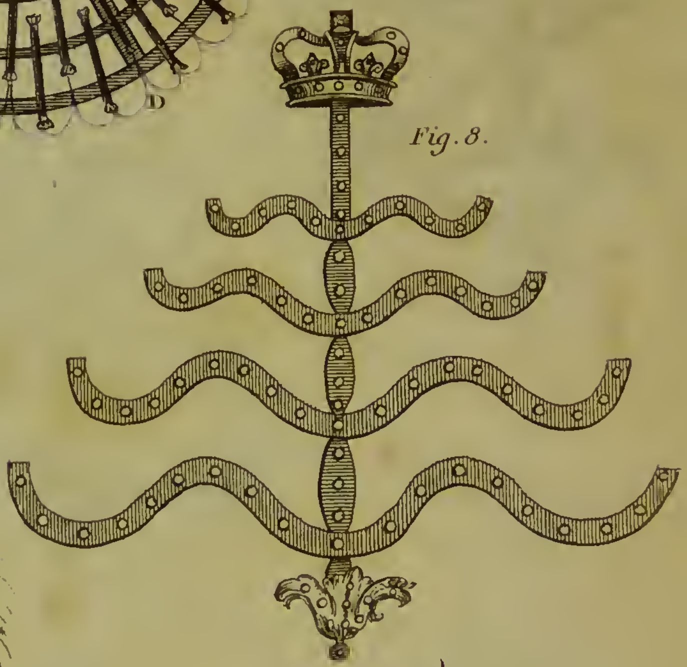

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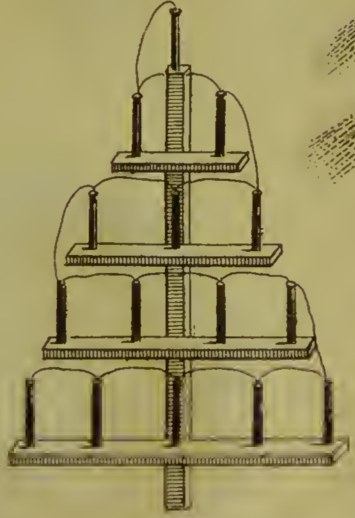
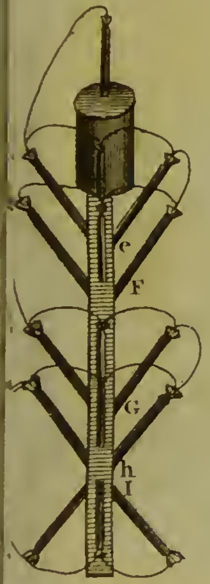


Fig. 2.



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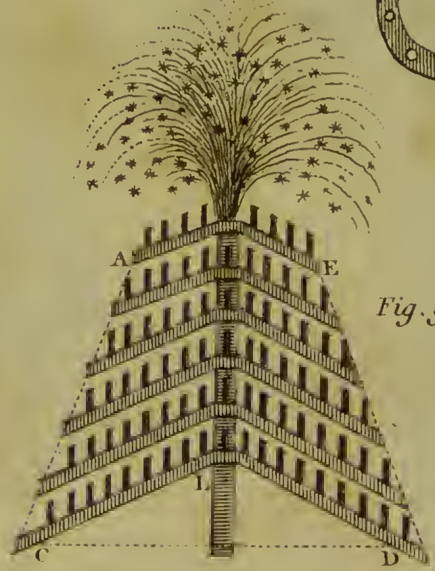

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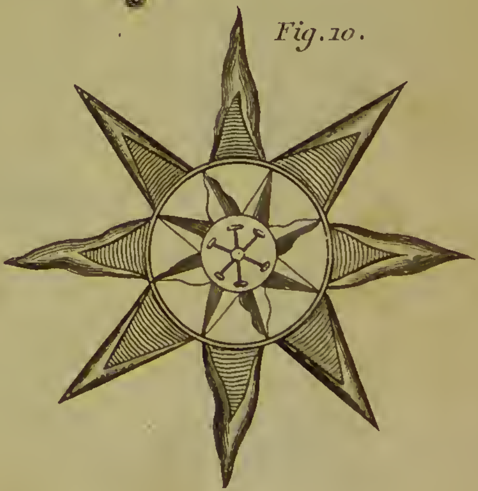

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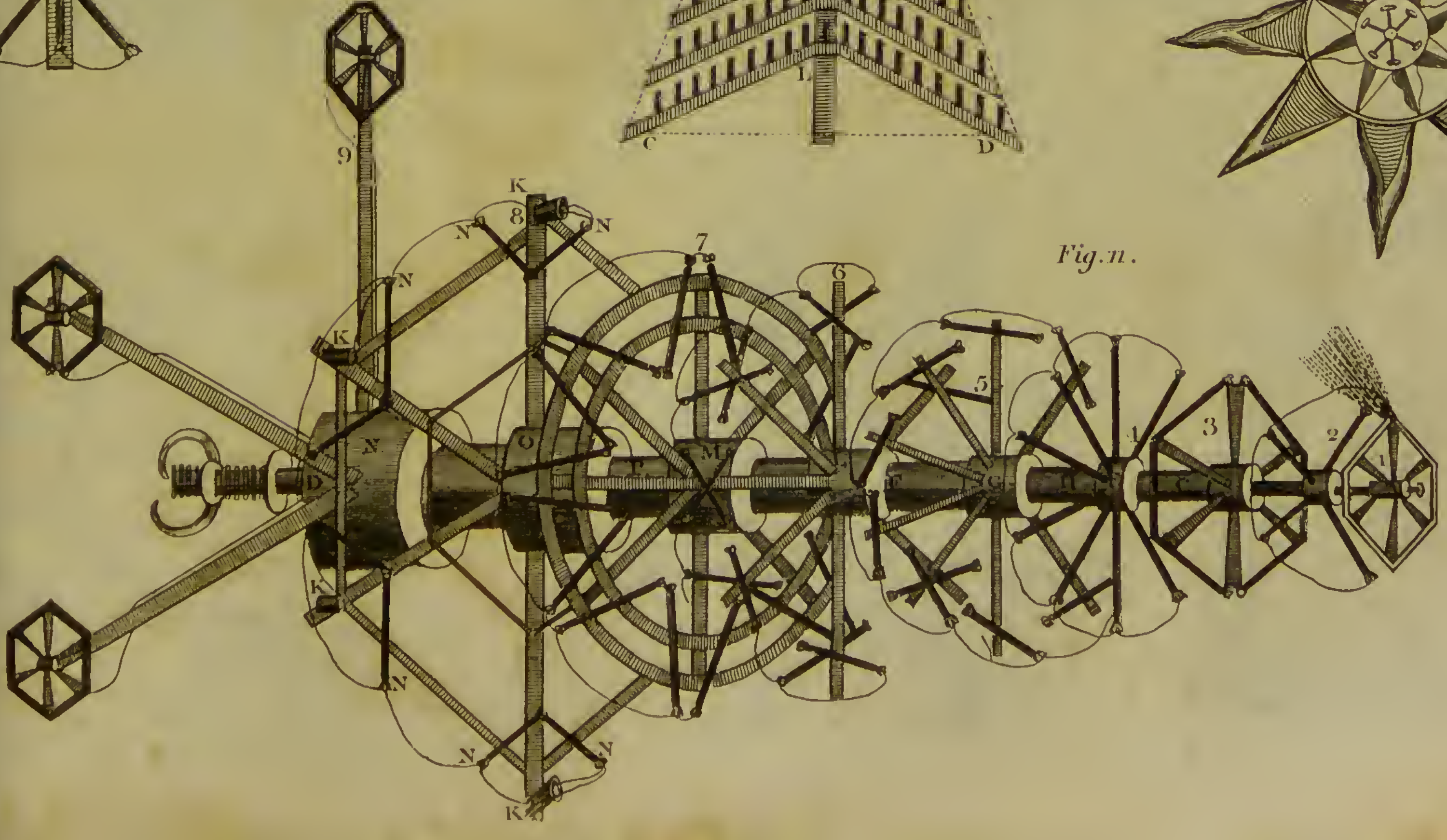
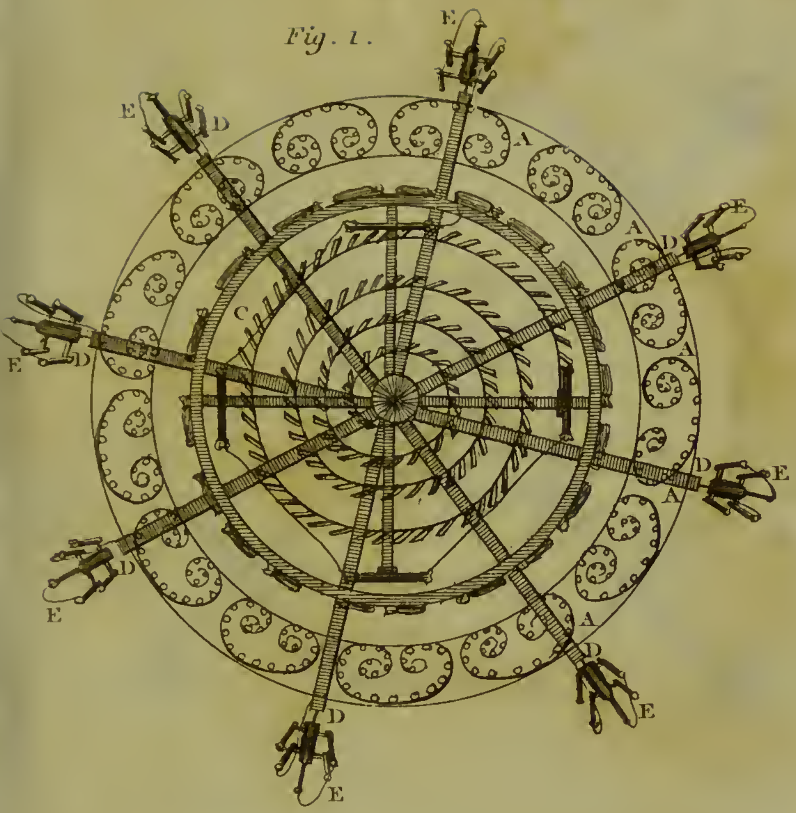


PYROTECHNY.

Fig. 1.



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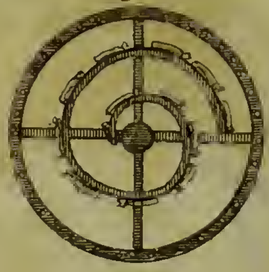

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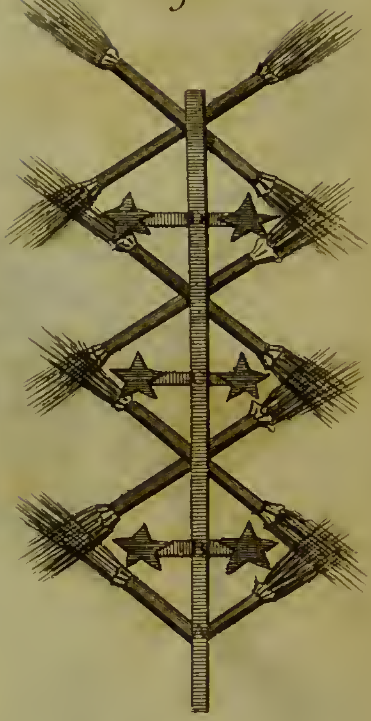

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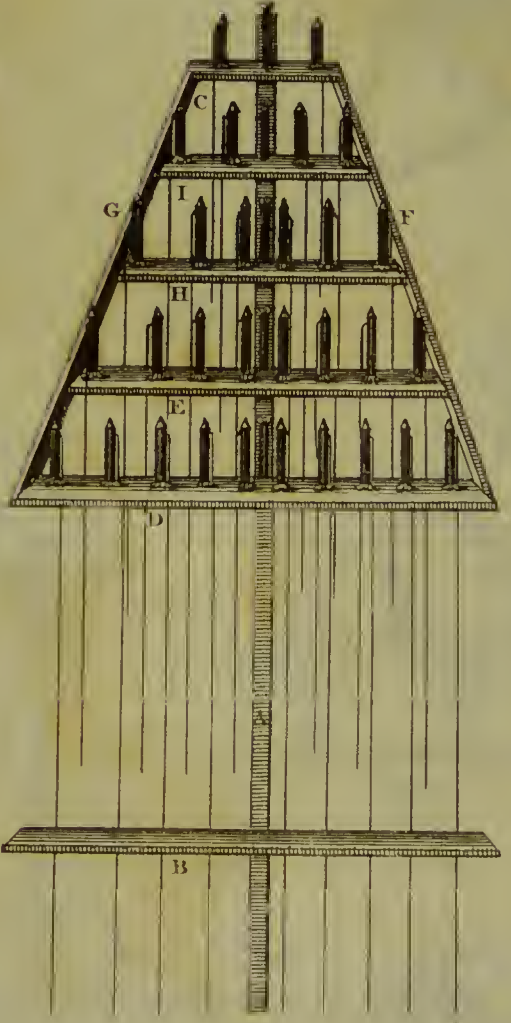

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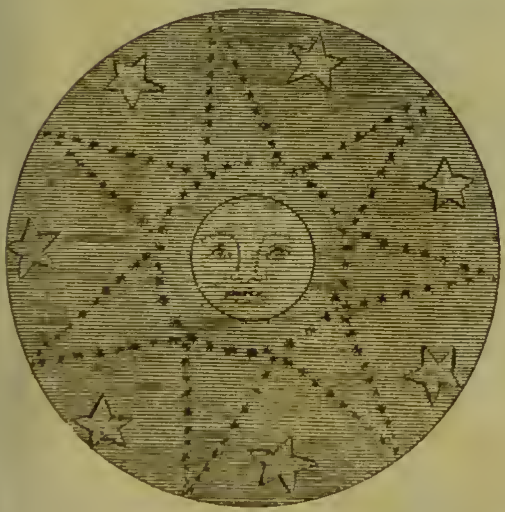

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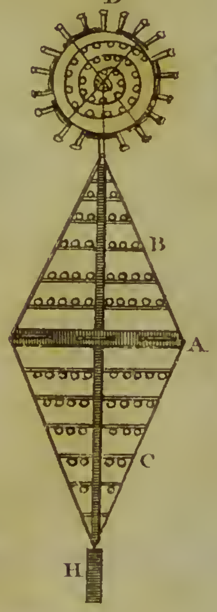

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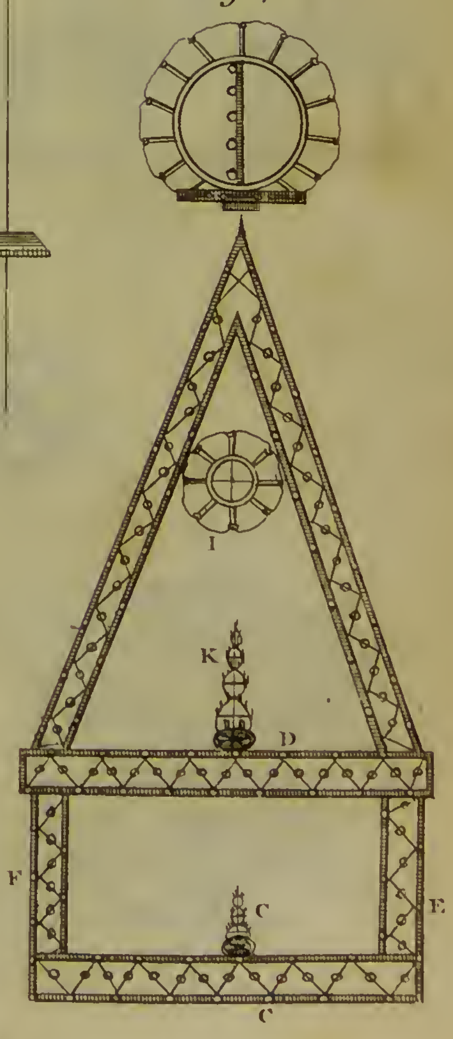

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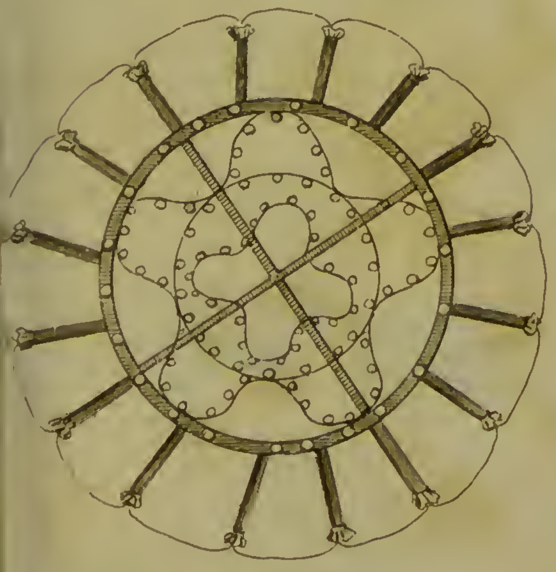

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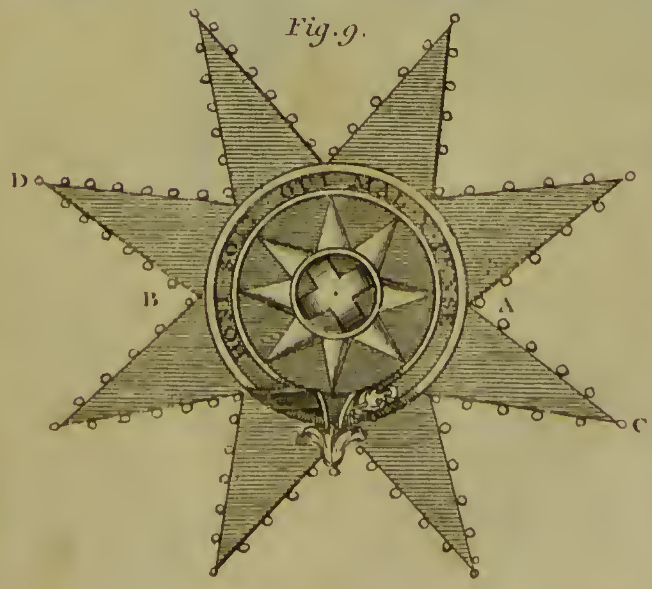


Mutlow Sculp.

PYROTECHNY.

Fig. 1.

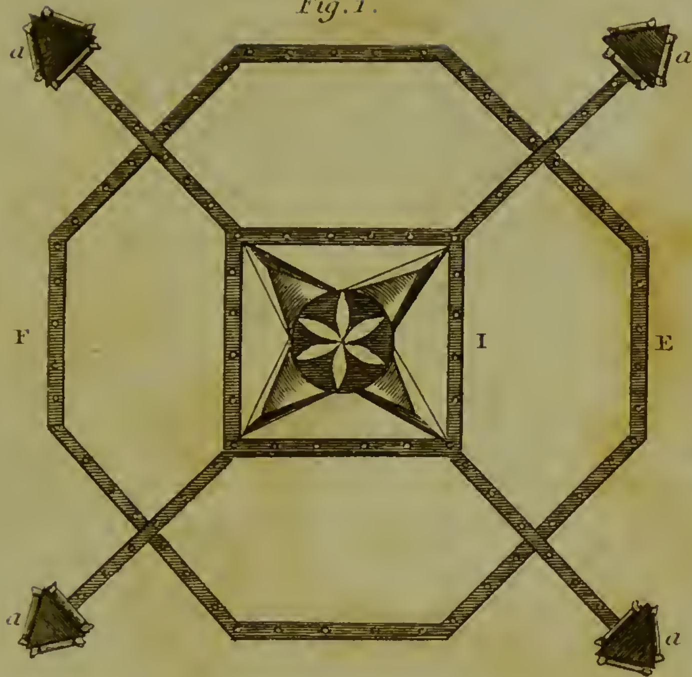
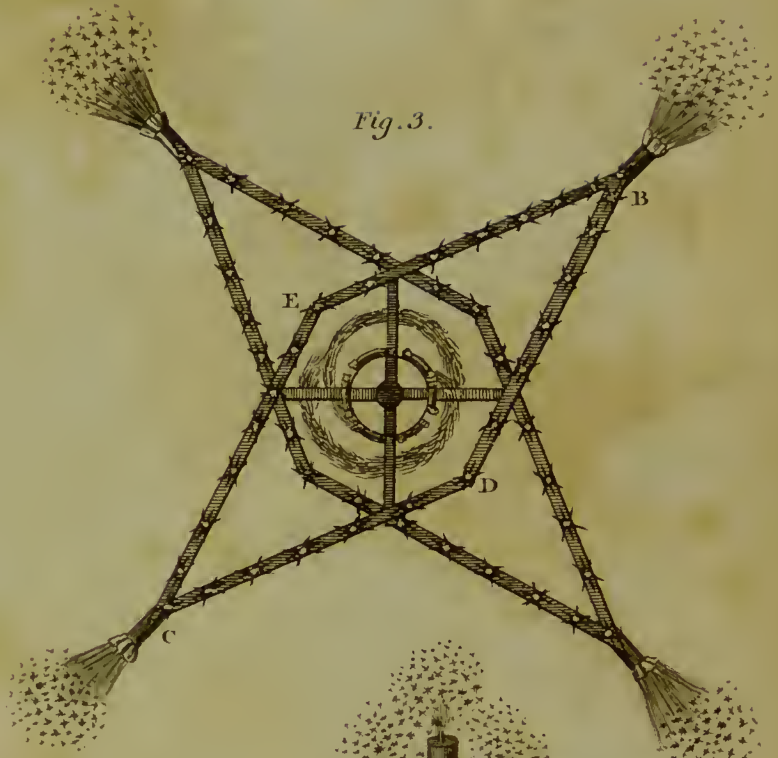


Fig. 3.



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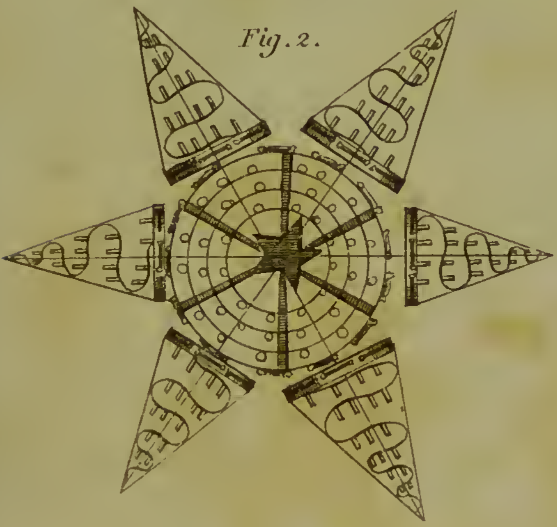
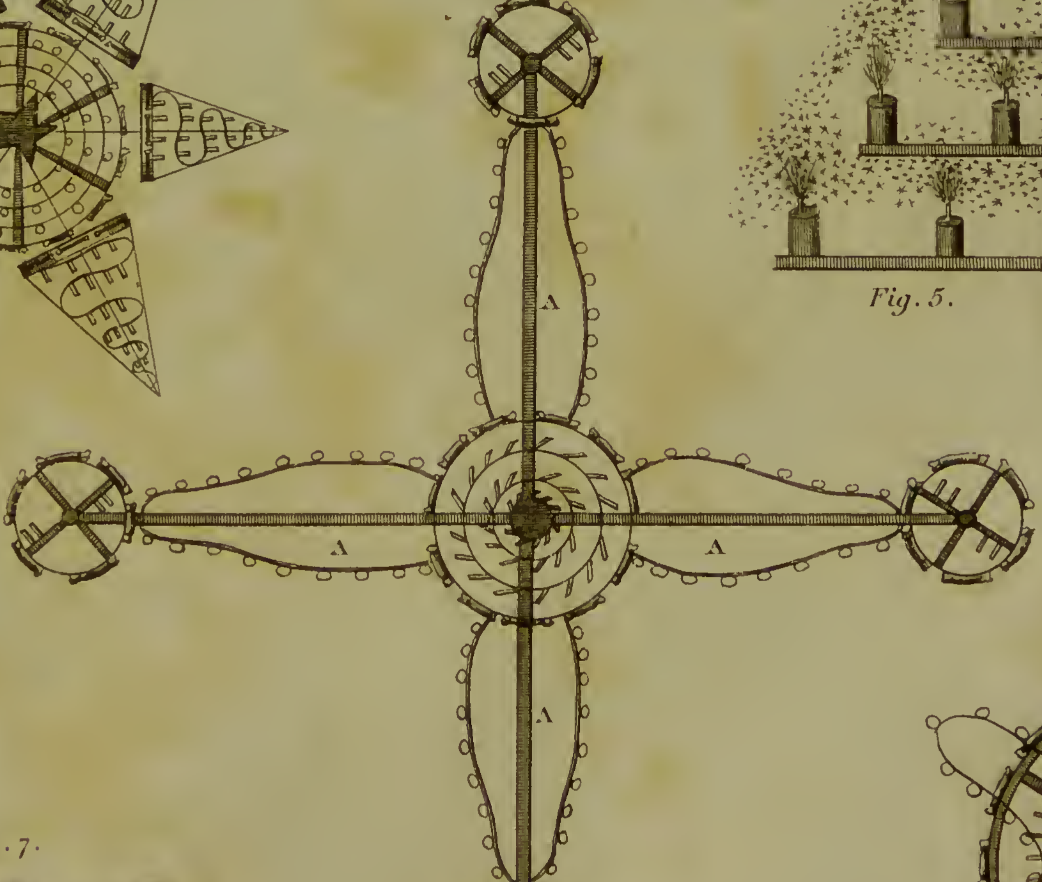


Fig. 6.



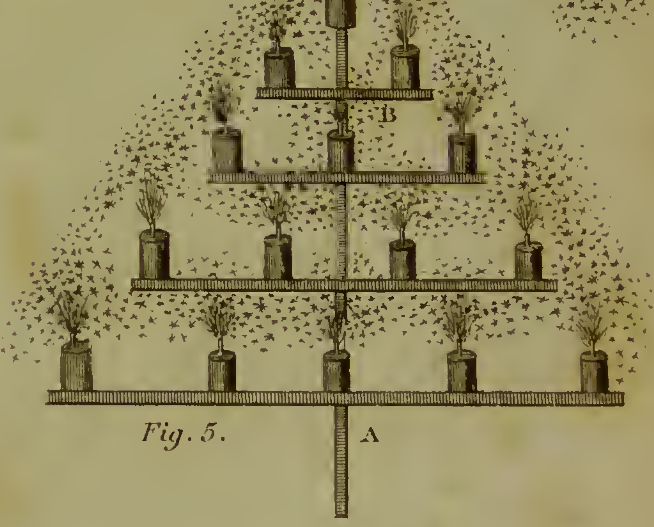


Fig. 5.

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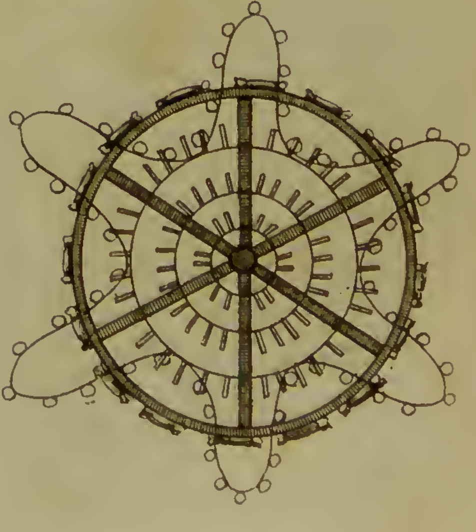

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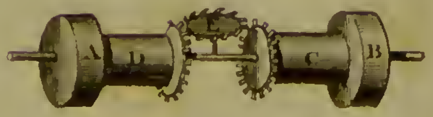


Mutlow Sculp.

the ſurface of the water; to the mouth of each rocket fix a leader, which put through the hole with the ſtick: then a little above the water muſt be a board, ſupported by the ſtand, and placed along one ſide of the rockets; then the ends of the leaders are turned up through holes made in this board, exactly oppoſite the rockets. By this means you may fire them ſingly or all at once. Rockets may be fired by this method in the middle of a pond, by a Neptune, a ſwan, a water-wheel, or any thing elſe you chooſe.

138. *To repreſent Neptune in his Chariot.*

To do this to perfection, you muſt have a Neptune (made of wood, or baſket work) as big as life, fixed on a float large enough to bear his weight; on which muſt be two horſes heads and necks, ſo as to ſeem ſwimming, as ſhown by fig. 11. For the wheels of the chariot, there muſt be two vertical wheels of black fire, and on Neptune's head a horizontal wheel of brilliant fire, with all its caſes, to play upwards. When this wheel is made, cover it with paper or paſteboard, cut and painted like Neptune's coronet; then let the trident be made without prongs, but inſtead of them, fix three caſes of a weak gray charge, and on each horſe's head put an eight-ounce caſe of brilliant fire, and on the mouth of each fix a ſhort caſe, of the ſame diameter, filled with the white-flame receipt, enough to laſt out all the caſes on the wheels: theſe ſhort caſes muſt be open at bottom, that they may light the brilliant fires; for the horſes eyes put ſmall port fires, and in each noſtril put a ſmall caſe filled half with gray charge, and the reſt with port-fire compoſition.

If Neptune is to give fire to any building on the water; at his firſt ſetting out, the wheels of the chariot, and that on his head, with the white flames on the horſes heads, and the port-fires in their eyes and noſtrils, muſt all be lighted at once: then from the bottom of the white flames carry a leader to the trident. As Neptune is to advance by the help of a block and cord, you muſt manage it ſo as not to let him turn about, till the brilliant fires on the horſes and the trident begin; for it is by the fire from the horſes (which plays almoſt upright) that the building, or work, is lighted; which muſt be thus prepared. From the mouth of the caſe which is to be firſt fired, hang ſome looſe quick-match to receive the fire from the horſes. When Neptune is only to be ſhown by himſelf, without ſetting fire to any other works, let the white flames on the horſes be very ſhort, and not to laſt longer than one caſe of each wheel, and let two caſes of each wheel burn at a time.

139. *Swans and Ducks in Water.*

If you would have the ſwans or ducks diſcharge rockets into the water, they muſt be made hollow, and of paper, and filled with ſmall water rockets, with ſome blowing powder to throw them out: but if this is not done, they may be made of wood, which will laſt many times. Having made and painted ſome ſwans, fix them on floats: then in the places where their eyes ſhould be, bore holes two inches deep, inclining downwards, and wide enough to receive a ſmall port-fire; the port-fire caſes for this purpoſe muſt be made of braſs, two inches long, and filled with a ſlow bright charge. In the middle of one of theſe caſes make a little hole; then put the port fire in the eye-hole of the ſwan, leaving about half an inch to project out; and in the other eye put another port-fire, with a hole made in it: then in the neck of the ſwan, within two inches of one of the eyes, bore a hole ſlantwiſe, to meet that in the port-fire; in this hole put a leader, and carry it to a water-rocket, that muſt be fixed under the tail with its mouth upwards. On the top of the head place two 1-oz. caſes, four inches long each, driven with brilliant fire; one of theſe caſes muſt incline forwards, and the other backwards: theſe muſt be lighted at the ſame time as the water-rocket; to do which, bore a hole between them in the top of the ſwan's head, down to the hole in the port-fire, to which carry a leader: if the ſwan is filled with rockets, they muſt be fired by a pipe from the end of the water-rocket under the tail. When you ſet the ſwan a ſwimming, light the two eyes.

140. *Water Fire-fountains.*

To make a fire fountain, you muſt firſt have a float made of wood, three feet diameter; then in the middle fix a round perpendicular poſt, four feet high, and two inches diameter; round this poſt fix three circular wheels made of thin wood, without any ſpokes. The largeſt of theſe wheels muſt be placed within two or three inches of the float, and muſt be nearly of the ſame diameter. The ſecond wheel muſt be 2 feet 2 inches in diameter, and fixed at two feet diſtance from the firſt. The third wheel muſt be 1 foot 4 inches in diameter, and fixed within ſix inches of the top of the poſt: the wheels being fixed, take 18 four or eight-oz. caſes of brilliant fire, and place them round the firſt wheel with their mouths outwards, and inclining downwards; on the ſecond wheel place 13 caſes of the ſame, and in the ſame manner as thoſe on the firſt; on the third, place 8 more of theſe caſes, in the ſame manner as before, and on the top of the poſt fix a gerbe; then clothe all the caſes with leaders, ſo that both they and the gerbe may take fire at the ſame time. Before you fire this work, try it in the water to ſee if the float is properly made, ſo as to keep the fountain upright.

PYROTICS, in medicine, cauſtics, or remedies either actually or potentially hot; and which accordingly will burn the fleſh, and raiſe an eſchar. See CAUSTICITY.

PYRRHICHA, in antiquity, a kind of exerciſe on horſeback, or a feigned combat, for the exerciſe of the cavalry. It was thus called from its inventor Pyrrhichus, or Pyrrhus of Cydonia, who firſt taught the Cretans to march in meaſure and cadence to battle, and to obſerve the pace of the Pyrrhic foot.—Others derive the name from Pyrrhus the ſon of Achilles, who inſtituted this exerciſe at the obſequies of his father.—Ariſtotle ſays, that it was Achilles himſelf who invented it. The Romans alſo called it *ludus Trojanus*, "the Trojan game;" and Aulus Gellius, *decurſus*.—It is doubtleſs this exerciſe that we ſee repreſented on medals by two cavaliers in front running with lancets, and the word *decurſio* in the exergum.

PYRRHICHIUS, in the Greek and Latin poetry, a foot conſiſting of two ſyllables, both ſhort;—as, *Deus*.—Among the ancients this foot is alſo called *periambus*; by others *hegemona*.

PYRRHO, a Greek philoſopher, born at Elis in Peloponneſus, flouriſhed about 300 B. C. He was the diſciple of Anaxarchus, whom he accompanied as far as India, where he converſed with the Brachmans and Gymnoſophiſts. He had made painting his profeſſion before he devoted himſelf to the ſtudy of philoſophy. He eſtabliſhed a ſect whoſe fundamental principle was, That there is nothing true or falſe, right or wrong, honeſt or diſhoneſt, juſt or unjuſt: or that there is no ſtandard of any thing beyond law or cuſtom, and that uncertainty or doubt belong to every thing. From this continual ſeeking after truth and never finding it, the ſect obtained the name of *Sceptics* or *Pyrrhonians* from the founder, who is ſaid to have acted upon his own principles, and to have carried his ſcepticiſm to ſuch a ridiculous extreme, that his friends were obliged to accompany him wherever he went, that he might not be run over by carriages, or fall down precipices. If this was true, it was not without reaſon that he was ranked among thoſe whoſe intellects were diſturbed by intenſe ſtudy. But it is treated by a modern writer as a mere calumny invented by the dogmatiſts; and we are ſtrongly inclined to be of his opinion (ſee Sceptics).—Pyrrho died about the 90th year of his age, when his memory was honoured with a ſtatue at Athens, and a monument erected to him in his own country.

PYRRHUS, the name of two kings of Epirus.

PYRUS, the pear-tree: A genus of the pentagynia order, belonging to the icoſandria claſs of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid; there are five petals; the fruit is an apple, inferior, quinquelocular, and polyſpermous. To this genus Linnæus has joined the apple and quince; but, on account of the remarkable difference between the fruits, the laſt is treated under the article Cydonia. The other ſpecies are,

1. The *communis*, or common pear-tree, riſes with an upright large trunk, branching 30 or 40 feet high, in ſome widely around, in others more erectly, and forming a conical head; oval, lanceolated, ſerrated leaves, and corymbous cluſters of white flowers from the ſides of the branches, ſucceeded by large fruit extended at the baſe. Under this ſpecies are comprehended almoſt endleſs varieties, all bearing the above deſcription. They bear their flowers and fruit upon ſpurs, ariſing from the ſides of the branches from two or three years old and upwards; the ſame branches and ſpurs continuing fruitful for a great number of years. The different varieties furniſh fruit for uſe from the beginning of July till the months of May and June, next year; which, according to their times of ripening may be divided into three claſſes, ſummer-pears, autumn pears, and winter-pears. The ſummer-pears ripen in different ſorts from the beginning of July until the middle or end of September, and are generally fit to eat from the tree, or at leaſt do not keep a week or two before they rot. The autumn pears come to their perfection in October, November, and December; ſome ripening nearly on the tree in October and the beginning of November, others requiring to lie ſome time in the fruitery, while ſome will keep two months: but all the winter-pears, though they attain their full growth on the tree by the end of October and in November, yet they do not acquire perfection for eating till from the end of November to April and May. Thoſe of each claſs have different properties; ſome being melting, others breaking, ſome mealy, and ſome hard and auſtere, fit only for kitchen uſes. As many of the fineſt ſorts were firſt obtained from France, they are ſtill continued in moſt catalogues by French names.

2. The *malus*, or common apple-tree, grows 20 or 30 feet high, having oval ſerrated leaves, and ſeſſile umbels of whitiſh red flowers, ſucceeded by large, roundiſh, and oblong fruit, concave at the baſe. The apple is compoſed of four diſtinct parts, viz. the pill, the parenchyma, the branchery, and the core. The pill or ſkin is only a dilatation of the outermoſt ſkin or rind of the bark of the branch on which it grew. The parenchyma or pulp, as tender and delicious as it is found, is only a dilatation, or, as Dr. Grew calls it, *a ſwelth* or ſuperbience of the inner part of the bark of the branch. This appears not only from the viſible continuation of the bark from the one through the pedicle or ſtalk to the other, but alſo from the ſtructure common to both. The branchery or veſſels are only ramifications of the woody part of the branch, ſent throughout all the parts of the parenchyma, the greater branches being made to communicate with each other by inoſculations of the leſs. The apple core is originally from the pith of the branch; the ſap of which finding room enough in the parenchyma through which to diffuſe itſelf, quits the pith, which by this means hardens into core. The varieties of this ſpecies are amazingly great with reſpect to the differences of the fruit. The botaniſts contend, that the wilding, or crab-apple of the woods and hedges is the original kind, and from the ſeeds of which the cultivated apple was firſt obtained. The varieties of this laſt no doubt are multiplied to ſome hundreds in different places, having been all firſt accidentally obtained from the ſeed or kernels of the fruit, and the approved ſorts continued and increaſed by grafting upon crabs or any kind of apple ſtocks: but although the number of varieties is very conſiderable, there are not above 40 or 50 ſorts retained in the nurſerymen's catalogue. Theſe varieties arrive at full growth in ſucceſſive order from July to the end of October, improve in perfection after being gathered; and ſeveral of the winter kinds, in particular, keep good for many months, even till the arrival of apples next ſummer.

Among theſe various kinds of apples ſome are uſed for the deſſert, ſome for the kitchen, and ſome for cyder-making. Thoſe uſed for the deſſert are the following, placed as they ſucceſſively ripen after one another: The white juncating, the margaret apple, the ſummer pearmain, the ſummer queening, the embroidered apple, the golden rennet, the ſummer white calville, the ſummer red calville, the ſilver pippen, the aromatic pippen, *la reinette griſe*, *la haute bonte*, the royal ruſſetting, Wheeler's-ruſſet, Sarp's ruſſet, the ſpine apple, the golden pippen, the nonpareil, the *l'api* or *pomme d'api*. Thoſe for the kitchen uſe, in the order of their ripening, are theſe: The codlin, the ſummer-marygold, the ſummer red pearmain, the Holland pippen, the Kentiſh pippen, the courpendu, Loan's pearmain, the French-rennet, the French pippen, the royal ruſſet, the monſtrous rennet, the winter pearmain, the *pome violette*, Spencer's pippen, the ſtone pippen, and the oaken pippen. Thoſe moſt eſteemed for cyder are, the Devonſhire royal wilding, the redſtreak apple, the whitſour, the Herefordſhire under-leaf, and the John apple, or *deux annes*, everlaſting hanger, and gennet moyle.

The juice of apples is a menſtruum for iron. A ſolution of iron in the juice of the apples called *golden rennets*, evaporated to a thick conſiſtence, proves an elegant chalybeate, which keeps well.

The beſt method of preſerving apples for winter uſe, is to let them hang upon the trees until there is danger of froſt, to gather them in dry weather, and then to lay them in large heaps to ſweat for a month or ſix weeks. They ought then to be carefully looked over, all which have the leaſt appearance of decay taken out, the ſound fruit wiped dry, and packed up in large oil jars, which have been thoroughly ſcalded and dry, and then ſtopped cloſe to exclude the air. If this plan is duly obſerved, the fruit will keep a long time ſound, and their fleſh remain plump; whereas, when expoſed to the air, their ſkins will ſhrivel, and their pulp ſoften.

3. The *coronaria*, or ſweet-ſcented crab of Virginia, grows 12 or 15 feet high, having angular, ſerrated leaves, pedunculated umbels of whitiſh-red, ſweet-ſcented flowers, ſucceeded by ſmall round crabs, remarkably ſour and auſtere. There is one variety called the *ever-green Virginian crab-tree*.

All the varieties of the pear-tree are hardy, and will ſucceed in any common ſoil of a garden or orchard. They are propagated by grafting and budding upon any kind of pear-ſtocks; alſo occaſionally upon quince-ſtocks, and ſometimes upon white-thorn ſtocks; but pear-ſtocks are generally preferable to all others for general uſe.—All kinds of apples are propagated in the ſame manner; uſing apple-ſtocks inſtead of pear-ſtocks. They will ſucceed in any common ſoil of a garden or orchard, and in any free ſituation, except in a low and very moiſt ſoil, in which they are apt to canker, and very ſoon go off. In a friable loam they are generally very ſucceſsful.

PYTHAGORAS, a celebrated philoſopher of antiquity, reſpecting the time and place of whoſe birth the learned are much divided. Eratoſthenes aſſerts that in the 48th Olympiad, when he was very young, he was a victor at the Olympic games. Hence Dr. Bentley determines the date of his birth to be the 4th year of the 43d Olympiad; whilſt Lloyd, who denies that the Olympic victor was the ſame perſon with the philoſopher, places it about the 3d year of the 48th Olympiad. Mr. Dodwell differs from both, and wiſhes to fix the birth of Pythagoras in the 4th year of the 52d Olympiad. Of the arguments of theſe learned writers, Le Clerc has given a ſummary in the *Bibliothèque Choiſie*, tom. x. p. 81. &c. and from a review of the whole, it would appear that he was not born earlier than the 4th year of the 43d Olympiad, nor later than the 4th year of the 52d; but in what particular year of that period his birth took place, cannot with any degree of certainty be aſcertained. It is generally believed that he was born in the iſland of Samos, and that he flouriſhed about 500 years before Chriſt, in the time of Tarquin the laſt king of Rome. (Tuſc. Queſt. lib. iv. cap. 1.) His father Mneſarchus, who is thought by ſome to have been a lapidary, and by others a merchant of Tyre, appears to have been a man of ſome diſtinction, and to have beſtowed upon his ſon the beſt education.

Jamblicus (Vit. Pythag. n. 6.) relates a number of wonderful ſtories reſpecting Pythagoras's deſcent from Jupiter, his birth, and early life; and repreſents him even in his youth as a prodigy of wiſdom and manly ſerioufneſs. But moſt of theſe idle tales confute themſelves, afford nothing of importance to be depended upon, and only prove the credulity, careleſſneſs, and prejudice of their author. Of his childhood and early education we know nothing, except that he was firſt inſtructed in his own country by Creophilus, and afterwards in Scyrus by Pherecydes (ſee Pherecydes). According to the cuſtom of the times he was made acquainted with poetry and muſic; eloquence and aſtronomy became his private ſtudies, and in gymnaſtic exerciſes he often bore the palm for ſtrength and dexterity. He firſt diſtinguiſhed himſelf in Greece at the Olympic games, where, beſides gaining the prize, he is ſaid to have excited the higheſt admiration by the elegance and dignity of his perſon, and the brilliancy of his underſtanding.

Soon after his appearance at theſe games Pythagoras commenced his travels in queſt of knowledge. He firſt viſited Egypt, where, through the intereſt of Polycrates, tyrant of Samos, he obtained the patronage of Amaſis king of Egypt, by whoſe influence, combined with his own aſſiduity, patience, and perſeverance, he at length gained the confidence of the prieſts; from whom he learned their ſacred myſteries, theology, and the whole ſyſtem of ſymbolical learning. In Egypt, too, he became acquainted with geometry and the true ſolar ſyſtem; and, before he left that country, made himſelf maſter of all the learning for which it was ſo famed among the nations of antiquity.

He afterwards viſited Perſia and Chaldea, where from the Magi he learnt divination, the interpreting of dreams, and aſtronomy. He is likewiſe ſaid to have travelled into India, to have converſed with the Gymnoſophiſts, and to have acquired from them a knowledge of the philoſophy and literature of the Eaſt; and ſuch was his ardour in the purſuit of ſcience, that in queſt of it, we are told by Cicero, (De Finibus, lib. iv. § 29.) he croſſed many ſeas, and travelled on foot through many barbarous nations.

After Pythagoras had ſpent many years in gathering information on every ſubject, eſpecially reſpecting the nature of the gods, the rites of religion, and the immortality of the human ſoul, he returned to his native iſland, and attempted to make his knowledge uſeful by inſtituting a ſchool for the inſtruction of his countrymen. Failing of ſucceſs in this laudable undertaking, he repaired to Delos, where he pretended to receive moral dogmas from the prieſteſs of Apollo. He alſo viſited Crete, where he was initiated into the moſt ſacred myſteries of Greece. He went likewiſe to Sparta and Elis, and again aſſiſted at the Olympic games; where in the public aſſembly he was ſaluted with the title of *ſophiſt* or *wiſe man*, which he declined for one more humble. See Philology and Philosophy.

He returned to Samos enriched with mythological learning and myſterious rites, and again inſtituted a ſchool. His myſterious ſymbols and oracular precepts made this attempt more ſucceſsful than the former had been; but meeting with ſome oppoſition, or being detected in ſome pious frauds, he ſuddenly left Samos, retired to Magna Grecia, and ſettled at Crotona.

Here he founded the Italic ſect (ſee Philosophy); and his mental and perſonal accompliſhments, the fame of his diſtant travels, and his Olympic crown, ſoon procured him numerous pupils. His bold and manly eloquence and graceful delivery attracted the moſt diſſolute, and produced a remarkable change in the morals of the people of Crotona. His influence was increaſed by the regularity of his own example, and its conformity to his precepts. He punctually attended the temples of the gods, and paid his devotions at an early hour: he lived upon the pureſt and moſt innocent food, clothed himſelf like the prieſts of Egypt, and by his continual purifications and regular offerings appeared to be ſuperior in ſanctity to the reſt of mankind. He endeavoured to aſſuage the paſſions of his ſcholars with verſes and numbers, and made a practice of compoſing his own mind every morning, by playing on his harp, and ſinging along with it the pæans of Thales. To avoid the temptations of eaſe and the ſeductions of idleneſs, bodily exerciſes alſo made a conſiderable part of his diſcipline.

At Crotona he had a public ſchool for the general benefit of the people, in which he taught them their duty, praiſing virtue and condemning vice; and particularly inſtructing them in the duties of ſocial life. Beſide this, he had a college in his own houſe, which he denominated κοινοβιον, in which there were two claſſes of ſtudents, viz. εξωτερικοι (who were alſo called *auſcultantes*) and εσωτερικοι. The former of theſe were probationers, and were kept under a long examen. A ſilence of five years was impoſed upon them; which Apuleius thinks was intended to teach them modeſty and attention; but Clemens Alexandrinus thinks it was for the purpoſe of abſtracting their minds from ſenſible objects, and inuring them to the pure contemplation of the Deity. The latter claſs of ſcholars were called *genuini*, *perfecti*, *mathematici*, and, by way of eminence, *Pythagoreans*. They alone were admitted to the knowledge of the arcana and depths of Pythagoric diſcipline, and were taught the uſe of ciphers and hieroglyphic writings.

Clemens obſerves, that theſe orders correſponded very exactly to thoſe among the Hebrews: for in the ſchools of the prophets there were two claſſes, viz. the ſons of the prophets, who were the ſcholars, and the doctors or maſters, who were alſo called *perfecti*; and among the Levites, the novices or tyros, who had their quinquennial exerciſes, by way of preparation. Laſtly, even among the proſelytes there were two orders; *exoterici*, or proſelytes of the gate; and *intrinſeci* or *perfecti*, proſelytes of the covenant. He adds, It is highly probable, that Pythagoras himſelf had been a proſelyte of the gate, if not of the covenant. Gale endeavours to prove that Pythagoras borrowed his philoſophy from that of the Jews; to this end producing the authorities of many of the fathers and ancient authors, and even pointing out the tracks and footſteps of Moſes in ſeveral parts of Pythagoras's doctrine. But we believe the learned author was miſled by the Chriſtian Platoniſts.

The authority of Pythagoras among his pupils was ſo great, that it was even deemed a crime to diſpute his word; and their arguments were conſidered as infallibly convincing, if they could enforce them by adding, that "the maſter ſaid ſo;" an expreſſion which afterwards became proverbial in *jurare in* *verba magiſtri.* This influence over his ſchool was ſoon extended to the world, and even his pupils themſelves divided the applauſe and approbation of the people with their maſter; and the rulers and legiſlators of all the principal towns of Greece, Sicily, and Italy, boaſted of being the diſciples of Pythagoras. To give more weight to his exhortations, as ſome writers mention, Pythagoras retired into a ſubterraneous cave, where his mother ſent him intelligence of every thing which happened during his abſence. After a certain number of months he again re-appeared on the earth with a grim and ghaſtly countenance, and declared in the aſſembly of the people that he was returned from hell. From ſimilar exaggerations it has been aſſerted that he appeared at the Olympic games with a golden thigh, and that he could write in letters of blood whatever he pleaſed on a looking-glaſs; and that by ſetting it oppoſite to the moon, when full, all the characters which were on the glaſs became legible on the moon's diſc. They alſo relate, that by ſome magical words he tamed a bear, ſtopped the flight of an eagle, and appeared on the ſame day and at the ſame inſtant in the cities of Crotona and Metapontum, &c.

At length his ſingular doctrines, and perhaps his ſtrenuouſly aſſerting the rights of the people againſt their tyrannical governors, excited a ſpirit of jealouſy, and raiſed a powerful party againſt him; which ſoon became ſo outrageous as to oblige him to fly for his life. His friends fled to Rhegium; and he himſelf, after being refuſed protection by the Locrians, fled to Metapontum, where he was obliged to take refuge in the temple of the muſes, and where it is ſaid he died of hunger about 497 years before Chriſt. Reſpecting the time, place, and manner of his death, however, there are various opinions, and many think it uncertain when, where, or in what manner, he ended his days. After his death his followers paid the ſame reſpect to him as was paid to the immortal gods; they erected ſtatues in honour of him, converted his houſe at Crotona into a temple of Ceres, appealed to him as a deity, and ſwore by his name.

Pythagoras married Theano of Crotona, or, according to others, of Crete, by whom he had two ſons, Telauges and Mneſarchus, who, after his death, took care of his ſchool. He is ſaid alſo to have had a daughter called *Damo.*

Whether he left any writings behind him is diſputed. It ſeems probable, however, that he left none, and that ſuch as went under his name were written by ſome of his followers. The *golden verſes* which Hierocles illuſtrated with a commentary, have been aſcribed to Epicharmus or Empedocles, and contain a brief ſummary of his popular doctrines. From this circumſtance, and from the myſterious ſecrecy with which he taught, our information concerning his doctrine and philoſophy is very uncertain, and cannot always be depended on.

The purpoſe of philoſophy, according to the ſyſtem of Pythagoras, is to free the mind from incumbrance, and to raiſe it to the contemplation of immutable truth and the knowledge of divine and ſpiritual objects. To bring the mind to this ſtate of perfection is a work of ſome difficulty, and requires a variety of intermediate ſteps. Mathematical ſcience was with him the firſt ſtep to wiſdom, becauſe it inures the mind to contemplation, and takes a middle courſe between corporeal and incorporeal beings. The whole ſcience he divided into two parts, *numbers* and *magnitude;* and each of theſe he ſubdivided into two others, the former into *arithmetic* and *muſic,* and the latter into *magnitude at reſt and in motion;* the former of which comprehends *geometry,* and the latter *aſtronomy.* Arithmetic he conſidered as the nobleſt ſcience; and an acquaintance with numbers as the higheſt good. He conſidered numbers as the principles of every thing; and divided them into ſcientific and intelligible. Scientific number is the production of the powers involved in unity, and its return to the ſame; number is not infinite, but is the ſource of that infinite diviſibility into equal parts which is the property of all bodies. Intelligible numbers are thoſe which exiſted in the divine mind before all things. They are the model or archetype of the world, and the cauſe of the eſſence of beings. Of the Monad, Duad, Triad, Tetrad, and Decad, various explanations have been given by various authors; but nothing certain or important is known of them. In all probability, numbers were uſed by Pythagoras as ſymbolical repreſentations of the firſt principles and forms of nature, and eſpecially of thoſe eternal and immutable eſſences which Plato denominated ideas; and in this caſe the Monad was the ſimple root from which he conceived numbers to proceed, and, as ſuch, analogous to the ſimple eſſence of deity; from whence, according to his ſyſtem, the various properties of nature proceed.

Muſic followed numbers, and was uſeful in raiſing the mind above the dominion of the paſſions. Pythagoras conſidered it as a ſcience to be reduced to mathematical principles and proportions, and is ſaid to have diſcovered the muſical chords from the circumſtance of ſeveral men ſucceſſively ſtriking with hammers a piece of heated iron upon an anvil. This ſtory Dr. Burney (Hiſtory of Muſic, vol. i. p. 441.) diſcredits; but allows, from the uniform teſtimony of writers ancient and modern, that he invented the *harmonical canon* or monochord, (ſee Monochord.) The muſic of the ſpheres, of which every one has heard, was a moſt fanciful doctrine of Pythagoras. It was produced, he imagined, by the planets ſtriking on the ether, through which in their motion they paſſed; and he conſidered their muſical proportions as exact, and their harmony perfect.

Pythagoras, as we have already ſeen, learned geometry in Egypt; but by inveſtigating many new theorems, and by digeſting its principles, he reduced it to a more regular ſcience. A geometrical point, which he defines to be a monad, or unity with poſition, he ſays, correſponds to unity in arithmetic, a line to two, a ſuperficies to three, and a ſolid to four. He diſcovered ſeveral of the propoſitions of Euclid; and on diſcovering the 47th of book 1ſt, he is ſaid to have offered a hecatomb to the gods; but as he was averſe to animal ſacrifices, this aſſertion is ſurely falſe. His great progreſs in aſtronomical ſcience has been mentioned under Astronomy and Philosophy.

Wiſdom, according to Pythagoras, is converſant with thoſe objects which are naturally immutable, eternal, and incorruptible: and its end is to aſſimilate the human mind to the divine, and to qualify us to join the aſſembly of the gods. Active and moral philoſophy preſcribes rules and precepts for the conduct of life, and leads us to the practice of public and private virtue.—On theſe heads many of his precepts were excellent, and ſome of them were whimſical and uſeleſs. Theoretical philoſophy treats of nature and its origin, and is, according to Pythagoras, the higheſt object of ſtudy. It included all the profound myſteries which he taught, of which but little is now known. God he conſiders as the univerſal mind, diffuſed through all things, and the ſelf-moving principle of all things (αυτοματισμος των παντων), and of whom every human ſoul is a portion. It is very probable, that he conceived of the Deity as a ſubtle fire, eternal, active, and intelligent; which is not inconſiſtent with the idea of incorporeality, as the ancients underſtood that term. This Deity was primarily combined with the chaotic maſs of paſſive matter, but he had the power of ſeparating himſelf, and ſince the ſeparation he has remained diſtinct. The learned Cudworth contends, that Pythagoras maintained a trinity of hypoſtaſes in the divine nature, ſimilar to the Platonic triad (ſee Pla-

TONISM). We cannot ſay that his arguments appear to have much force; but we think the concluſion which he wiſhes to eſtabliſh extremely probable, as Plato certainly drew his doctrine from ſome of the countries which Pythagoras had viſited before him.

Subordinate to the Deity there were in the Pythagorean creed three orders of intelligences, gods, demons, and heroes, of different degrees of excellence and dignity. Theſe, together with the human ſoul, were conſidered as emanations from the Deity, the particles of ſubtle ether aſſuming a groſſer clothing the further they receded from the fountain. Hierocles defines a hero to be a rational mind united with a luminous body. God himſelf was repreſented under the notion of monad, and the ſubordinate intelligences as numbers derived from and included in unity. Man is conſidered as conſiſting of an elementary nature and a divine or rational ſoul. His ſoul, a ſelf-moving principle, is compoſed of two parts; the rational, ſeated in the brain; and the irrational, including the paſſions, in the heart. In both theſe reſpects he participates with the brutes, whom the temperament of their body, &c. allows not to act rationally. The ſenſitive ſoul periſhes; the other aſſumes an ethereal vehicle, and paſſes to the regions of the dead, till ſent back to the earth to inhabit ſome other body, brutal or human. See METEMPSYCHOSIS. It was unqueſtionably this notion which led Pythagoras and his followers to deny themſelves the uſe of fleſh, and to be ſo peculiarly merciful to animals of every deſcription. Some authors, however, ſay, that fleſh and beans, the uſe of which he alſo forbad, were prohibited, becauſe he ſuppoſed them to have been produced from the ſame putrified matter, from which, at the creation of the world, man was formed.

Of the ſymbols of Pythagoras little is known. They have been religiouſly concealed; and though they have awakened much curioſity, and occaſioned many ingenious conjectures, they ſtill appear to us dark and trifling. As a ſpecimen we give the following: "Adore the ſound of the whiſpering wind. Stir not the fire with a ſword. Turn aſide from an edged tool. Paſs not over a balance. Setting out on a journey, turn not back, for the furies will return with you. Breed nothing that hath crooked talons. Receive not a ſwallow into your houſe. Look not in a mirror by the light of a candle. At a ſacrifice pare not your nails. Eat not the heart or brain. Taſte not that which hath fallen from the table. Break not bread. Sleep not at noon. When it thunders touch the earth. Pluck not a crown. Roaſt not that which has been boiled. Sail not on the ground. Plant not a palm. Breed a cock, but do not ſacrifice it, for it is ſacred to the ſun and moon. Plant mallows in thy garden, but eat them not. Abſtain from beans."

The following precepts are more important: "Diſcourſe not of Pythagorean doctrines without light. Above all things, govern your tongue. Engrave not the image of God in a ring. Quit not your ſtation without the command of your general. Remember that the paths of virtue and of vice reſemble the letter Y. To this ſymbol Perſius refers, when he ſays,

Et tibi quæ Samios diduxit litera ramos,
Surgentem dextro monſtravit limite collem.

There has the Samian Y's inſtructive make
Pointed the road thy doubtful foot ſhould take;
There warn'd thy raw and yet unpractis'd youth,
To tread the riſing right-hand path of truth.

The ſcantineſs and uncertainty of our information reſpecting Pythagoras, renders a regular and complete account of his life and doctrines impoſſible. A modern author of profound erudition, pronounces him to have been *unqueſtionably* the wiſeſt man that ever lived, if his maſters, the Egyptian prieſts, muſt not be excepted. This is ſaying a great deal too much; but that he was one of the moſt diſtinguiſhed philoſophers of antiquity, or, as Cicero expreſſes it, *vir præſtanti ſapientia*, appears very evident; and his moral character has never been impeached. The myſterious air which he threw over his doctrines, and the apparent inanity of ſome of his ſymbols, have indeed ſubjected him to the charge of impoſture and perhaps the charge is not wholly groundleſs: but when we conſider the age in which he lived, and the nature of the people with whom he had to deal, who would in all probability have reſiſted more open innovations, even this will not appear ſo blameable as at firſt ſight we are apt to think it; and it is worthy of notice, that the worſt ſtories of this kind have come down to us in a very queſtionable ſhape, and with much probability appear to be falſe.

PYTHAGOREANS, a ſect of ancient philoſophers, ſo called from being the followers of Pythagoras. See the preceding article.

PYTHIA, the prieſteſs of Apollo at Delphi by whom he delivered oracles. She was ſo called from Pythius, a name of that god, which is ſaid to have been given him on account of his victory over the ſerpent Python. The Pythia was at firſt required to be a young girl, but in later times ſhe was a woman of 50 years of age. The firſt and moſt famous Pythia was Phemonöe. Oracles were at firſt delivered by her in hexameter verſe. All the Pythias were to be pure virgins, and all of them delivered their oracles with great enthuſiaſm and violent agitations. See ORACLE and DELPHI.

PYTHIAN GAMES, in Grecian antiquity, ſports inſtituted near Delphos in honour of Apollo, on account of his ſlaying the ſerpent Python. See APOLLO.—Theſe games, at their firſt inſtitution, were celebrated only once in nine years; but afterwards every fifth year, from the number of the Parnaſſian nymphs who came to congratulate Apollo, and to make him preſents on his victory. The victor was crowned with garlands.

PYTHON, in fabulous hiſtory, a monſtrous ſerpent, produced by the earth after Deucalion's deluge. Juno being exaſperated at Latona, who was beloved by Jupiter, commanded this ſerpent to deſtroy her; but flying from the purſuit of the monſter, ſhe eſcaped to Delos, where ſhe was delivered of Diana and Apollo; the latter of whom at length deſtroyed Python with his arrows; in memory of which victory the Pythian games were inſtituted. See APOLLO.

Q.

Q, or *q*, the 16th letter and 12th conſonant of our alphabet; but is not to be found either in the Greek, old Latin, or Saxon alphabets; and indeed ſome would entirely exclude it, pretending that k ought to be uſed wherever this occurs. However, as it is formed in the voice in a different manner, it is undoubtedly a diſtinct letter: for, in expreſſing this ſound, the cheeks are contracted, and the lips, particularly the under one, are put into a canular form, for the paſſage of the breath.

The q is never ſounded alone, but in conjunction with u, as in *quality*, *queſtion*, *quite*, *quote*, &c. and never ends any Engliſh word.

As a numeral, Q ſtands for 500; and with a daſh over it, thus, Q, for 500,000.

Uſed as an abbreviature, *q* ſignifies *quantity*, *quantum*. Thus, among phyſicians, *q. pl.* is *quantum placet*, i. e. "as much as you pleaſe" of a thing; and *q. ſ.* is *quantum ſufficit*, i. e. "as much as is neceſſary." Q. E. D. among mathematicians, is *quod erat demonſtrandum*, i. e. "which was to be demonſtrated; and Q. E. F. is *quod erat faciendum*, i. e. "which was to be done." Q. D. among grammarians, is *quaſi dictum*, i. e. "as if it were ſaid;" or, "as who ſhould ſay." In the notes of the ancients, Q ſtands for *Quintus*, or *Quintius*; Q. B. V. for *quod bene vertat*; Q. S. S. S, for *quæ ſupra ſcripta ſunt*; Q. M. for *Quintus Mutius*, or *quomodo*; Quint. for *Quintilius*; and Quæſt. for *quæſtor*.

QUAB, in ichthyology, the name of a Ruſſian fiſh, which is ſaid to be firſt a tadpole, then a frog, and laſt a fiſh. Dr. Mounſey, who made many inquiries concerning theſe pretended changes, conſiders them all as fabulous. He had opportunity of ſeeing the fiſh itſelf, and found that they ſpawned like other fiſhes, and grew in ſize, without any appearances to juſtify the report. He adds, that they delight in very clear water, in rivers with ſandy or ſtony bottoms, and are never found in ſtanding lakes, or in rivers paſſing through marſhy or moſſy grounds, where frogs chooſe moſt to be.

QUABES, are a free people of Africa, inhabiting the ſouthern banks of the river Seſtos, and between that and Sierra Leona. They are under the protection of the emperor of Manow.

QUACHA, or QUAGGA. See BARB.

QUACHILTO, in ornithology, is the name of a very beautiful Braſilian bird, called alſo *yacazintli*, and *porphyrio Americanus*. It is of a fine blackiſh purple colour, variegated with white; its beak is white while young, but becomes red as it grows older, and has a naked ſpace at its baſis, reſembling in ſome ſort the coot; its legs are of a yellowiſh green; it lives about the waters, and feeds on fiſh, yet is a very well taſted bird. It imitates the crowing of a common cock, and makes its muſic early in the morning.

QUACK, among phyſicians, the ſame with empiric. See the article EMPIRIC.

QUADI, (Tacitus), a people of Germany, ſituated to the ſouth-eaſt of the mountains of Bohemia, on the banks of the Danube, and extending as far as the river Marus, or March, running by Moravia, which country they occupied.

QUADRAGESIMA, a denomination given to Lent, from its conſiſting of 40 days. See LENT.

QUADRANGLE, in geometry, the ſame with a quadrilateral figure, or one conſiſting of four ſides and four angles.

QUADRANS, the quarter or fourth part of any thing, particularly the *as*, or pound.

QUADRANS, in Engliſh money, the fourth part of a penny. Before the reign of Edward I. the ſmalleſt coin was a *ſterling*, or penny, marked with a croſs; by the guidance of which a penny might be cut into halves for a halfpenny, or into quarters or four parts for farthings; till, to avoid the fraud of unequal cuttings, that king coined halfpence and farthings in diſtinct round pieces.

QUADRANT, in geometry, the arch of a circle, containing 90°, or the fourth part of the entire periphery. Sometimes alſo the ſpace or area, included between this arch and two radii drawn from the centre to each extremity thereof, is called a *quadrant*, or, more properly, a *quadrantal ſpace*, as being a quarter of an entire circle.

QUADRANT alſo denotes a mathematical inſtrument of great uſe in aſtronomy and navigation, for taking the altitudes of the ſun and ſtars, as alſo for taking angles in ſurveying, &c. This inſtrument is variouſly contrived, and furniſhed with different apparatus, according to the various uſes it is intended for; but they all have this in common, that they conſiſt of a quarter of a circle, whoſe limb is divided into 90°. Some have a plummet ſuſpended from the centre, and are furniſhed with ſights to look through. The principal and moſt uſeful quadrants are the common ſurveying quadrant, aſtronomical quadrant, Adams's quadrant, Cole's quadrant, Gunter's quadrant, Hadley's quadrant, horodictical quadrant, Sutton's or Collins's quadrant, and the ſinical quadrant, &c. Of each of which in order.

1. The common *ſurveying quadrant* is made of braſs, wood, or any other ſolid ſubſtance; the limb of which is divided into 90°, and each of theſe further divided into as many equal parts as the ſpace will allow, either diagonally or otherwiſe. On one of the ſemidiameters are fitted two moveable ſights; and to the centre is ſometimes alſo fixed a label or moveable index, bearing two other ſights; but in lieu of theſe laſt ſights there is ſometimes fitted a teleſcope: alſo from the centre there is hung a thread with a plummet; and on the under ſide or face of the inſtrument is fitted a ball and ſocket, by means of which it may be put into any poſition. The general uſe of it is for taking angles in a vertical plane, comprehended under right lines going from the centre of the inſtrument, one of which is horizontal, and the other is directed to ſome viſible point. But beſides the parts already deſcribed, there is frequently added on the face, near the centre, a kind of compartment, called the *quadrat*, or *geometrical ſquare*. See QUADRAT. This quadrant may be uſed in different ſituations: for obſerving heights or depths, its plane muſt be diſpoſed perpendicularly to the horizon; but to take horizontal diſtances, its plane is diſpoſed parallel thereto. Again, heights and diſtances may be taken two ways, viz. by means of the fixed ſights and plummet, or by the label: as to which, and the manner of meaſuring angles, ſee GEOMETRY.

2. The *aſtronomical quadrant* is a large one, uſually made of braſs, or wooden bars faced with iron plates; having its limb nicely divided, either diagonally or otherwiſe, into degrees, minutes, and ſeconds; and furniſhed with two teleſcopes, one fixed on the ſide of the quadrant, and the other moveable about the centre, by means of the ſcrew. There are alſo dented wheels which ſerve to direct the inſtrument to any object or phenomenon.—The uſe of this curious inſtrument, in taking obſervations of the ſun, planets, and fixed ſtars, is obvious; for, being turned horizontally upon its axis, by means of the teleſcope, till the object is ſeen through the moveable teleſcope, then the degrees, &c. cut by the index give the altitude required. See ASTRONOMY.

3. *Cole's quadrant* is a very uſeful inſtrument invented by Mr. Benjamin Cole. It conſiſts of 6 parts, *viz.* the ſtaff AB (pl. 38. fig. 1.); the quadrantal arch DE; three vanes A. B, C; and the vernier FG. The ſtaff is a bar of wood about two feet long, an inch and a quarter broad, and of a ſufficient thickneſs to prevent it from bending or warping. The quadrantal arch is alſo of wood; and is divided into degrees, and third-parts of a degree, to a radius of about nine inches; to its extremities are fitted two radii, which meet in the centre of the quadrant by a pin, round which it eaſily moves. The ſight-vane A is a thin piece of braſs, almoſt two inches in height and one broad, placed perpendicularly on the end of the ſtaff A, by the help of two ſcrews paſſing through its foot. Through the middle of this vane is drilled a ſmall hole, through which the coincidence or meeting of the horizon and ſolar ſpot is to be viewed. The horizon vane B is about an inch broad, and two inches and a half high, having a ſlit cut through it of near an inch long and a quarter of an inch broad; this vane is fixed in the centre pin of the inſtrument, in a perpendicular poſition, by the help of two ſcrews paſſing through its foot, whereby its poſition with reſpect to the ſight-vane is always the ſame, their angles of inclination being equal to 45 degrees. The ſhade-vane C is compoſed of two braſs plates. The one, which ſerves as an arm, is about four inches and a half long, and three quarters of an

inch broad, being pinned at one end to the upper limb of the quadrant by a ſcrew, about which it has a ſmall motion; the other end lies in the arch; and the lower edge of the arm is directed to the middle of the centre-pin; the other plate, which is properly the vane, is about two inches long, being fixed perpendicularly to the other plate, at about half an inch diſtance from that end next the arch; this vane may be uſed either by its ſhade or by the ſolar ſpot caſt by a convex lens placed therein. And becauſe the wood-work is often apt to warp or twiſt, therefore this vane may be rectified by the help of a ſcrew, ſo that the warping of the inſtrument may occaſion no error in the obſervation, which is performed in the following manner: Set the line G on the vernier againſt a degree on the upper limb of the quadrant, and turn the ſcrew on the backſide of the limb forward or backward, till the hole in the ſight-vane, the centre of the glaſs, and the ſunk ſpot in the horizon-vane, lie in a right line.

To find the ſun's altitude by this inſtrument: Turn your back to the ſun, holding the inſtrument by the ſtaff with your right hand, ſo that it be in a vertical plane paſſing through the ſun; apply your eye to the ſight-vane, looking through that and the horizon-vane till you ſee the horizon; with the left hand ſlide the quadrantal arch upwards, until the ſolar ſpot or ſhade, caſt by the ſhade-vane, fall directly on the ſpot or ſlit in the horizon-vane; then will that part of the quadrantal arch which is raiſed above G or S (according as the obſervation reſpected either the ſolar ſpot or ſhade) ſhow the altitude of the ſun at that time. But if the meridian altitude be required, the obſervation muſt be continued; and as the ſun approaches the meridian, the ſea will appear through the horizon-vane, and then is the obſervation finiſhed; and the degrees and minutes, counted as before, will give the ſun's meridian altitude: or the degrees counted from the lower limb upwards will give the zenith-diſtance.

4. *Adams's quadrant* differs from Cole's quadrant only in having an horizontal vane, with the upper part of the limb lengthened; ſo that the glaſs, which caſts the ſolar ſpot on the horizon-vane, is at the ſame diſtance from the horizon vane as the ſight-vane at the end of the index.

5 *Gunter's quadrant*, ſo called from its inventor Edmund Gunter, beſides the uſual apparatus of other quadrants, has a ſtereographical projection of the ſphere on the plane of the equinoctial. It has alſo a kalendar of the months, next to the diviſions of the limb. It is uſed in the following way:—1. To find the ſun's meridian altitude for any given day, or the day of the month for any given meridian altitude. Lay the thread to the day of the month in the ſcale next the limb; and the degree it cuts in the limb is the ſun's meridian altitude. Thus, the thread being laid on the 15th of May, cuts 59° 30′, the altitude ſought; and, contrarily, the thread, being ſet to the meridian altitude, ſhows the day of the month. 2. To find the hour of the day. Having put the bead, which ſlides on the thread, to the ſun's place in the ecliptic, obſerve the ſun's altitude by the quadrant; then, if the thread be laid over the ſame in the limb, the bead will fall upon the hour required. Thus, ſuppoſe on the 10th of April, the ſun being then in the beginning of Taurus, I obſerve the ſun's altitude by the quadrant to be 36°; I place the bead to the beginning of Taurus in the ecliptic, and lay the thread over 36° of the limb; and find the bead to fall on the hour-line marked 3 and 9; accordingly the hour is either 9 in the morning or 3 in the afternoon. Again, laying the bead on the hour given, having firſt rectified or put it to the ſun's place, the degree cut by the thread on the limb gives the altitude. Note, the bead may be rectified otherwiſe, by bringing the thread to the day of the month, and the bead to the hour-line of 12. 3. To find the ſun's declination from his place given, and contrariwiſe. Set the bead to the ſun's place in the ecliptic, move the thread to the line of declination, and the bead will cut the degree of declination required. Contrarily, the bead being adjuſted to a given declination, and the thread moved to the ecliptic, the bead will cut the ſun's place. 4. The ſun's place being given, to find his right aſcenſion, or contrarily. Lay the thread on the ſun's place in the ecliptic, and the degree it cuts on the limb is the right aſcenſion ſought. Contrarily, laying the thread on the right aſcenſion, it cuts the ſun's place in the ecliptic. 5. The ſun's altitude being given, to find his azimuth, and contrariwiſe. Rectify the bead for the time, as in the ſecond article, and obſerve the ſun's altitude: bring the thread to the complement of that altitude; thus the bead will give the azimuth ſought among the azimuth lines. 6. To find the hour of the night from ſome of the five ſtars laid down on the quadrant. (1.) Put the bead to the ſtar you would obſerve, and find how many hours it is off the meridian, by article 2. (2.) Then from the right aſcenſion of the ſtar, ſubtract the ſun's right aſcenſion converted into hours, and mark the difference; which difference, added to the obſerved hour of the ſtar from the meridian, ſhows how many hours the ſun is gone from the meridian, which is the hour of the night. Suppoſe on the 15th of May the ſun is in the 4th degree of Gemini, I ſet the bead to Arcturus; and, obſerving his altitude, find him to be in the weſt about 52° high, and the bead to fall on the hour-line of 2 in the afternoon; then will the hour be 11 hours 50 minutes paſt noon, or 10 minutes ſhort of midnight; for 62°, the ſun's right aſcenſion, converted into time, makes 4 hours 8 minutes; which, ſubtracted from 13 hours 58 minutes, the right aſcenſion of Arcturus, the remainder will be 9 hours 50 minutes; which added to 2 hours, the obſerved diſtance of Arcturus from the meridian, ſhows the hour of the night to be 11 hours 50 minutes.

The *mural quadrant* has already been deſcribed under the article ASTRONOMY, p. 414. It is a moſt important inſtrument, and has of late been much improved by Mr. Ramſden, who has diſtinguiſhed himſelf by the accuracy of his diviſions, and by the manner in which he finiſhes the planes by working them in a vertical poſition. He places the plumb-line behind the inſtrument, that there may be no neceſſity for removing it when we take an obſervation near the zenith. His manner of ſuſpending the glaſs, and that of throwing light on the object-glaſs and on the diviſions at the ſame time, are new, and improvements that deſerve to be noticed. Thoſe of eight feet, which he has made for the obſervatories of Padua and Vilna, have been examined by Dr. Maſkelyne; and the greateſt error does not exceed two ſeconds and a half. That of the ſame ſize for the obſervatory of Milan is in a very advanced ſtate. The mural quadrant of ſix feet, at Blenheim, is a moſt admirable inſtrument. It is fixed to four pillars, which turn on two pivots, ſo that it may be put to the north and to the ſouth in one minute. It was for this inſtrument Mr. Ramſden invented a method of rectifying the arc of 90 degrees, on which an able aſtronomer had ſtarted ſome difficulties; but by means of an horizontal line and plumb-line, forming a kind of croſs, without touching the circle, he ſhowed him that there was not an error of a ſingle ſecond in the 90 degrees; and that the difference was occaſioned by a mural quadrant of Bird, in which the arc of 90 degrees was too great by ſeveral ſeconds, and which had never been rectified by ſo nice a method as that of Mr. Ramſden.

But the quadrant is not the inſtrument which ſtands higheſt in Mr. Ramſden's opinion: it is the complete circle: and he has demonſtrated to M. de la Lande, that the former muſt be laid aſide, if we would arrive at the utmoſt exactneſs of which an obſervation is capable. His principal reaſons are: 1. The leaſt variation in the centre is perceived by the two diametrically oppoſite points. 2. The circle being worked on the turn, the ſurface is always of the greateſt accuracy, which it is impoſſible to obtain in the quadrant. 3. We may always have two meaſures of the ſame arc, which will ſerve for the verification of each other. 4. The firſt point of the diviſion may be verified every day with the utmoſt facility. 5. The dilatation of the metal is uniform, and cannot produce any error. 6. This inſtrument is a meridian glaſs at the ſame time. 7. It alſo becomes a moveable azimuth circle by adding an horizontal circle beneath its axis, and then gives the refractions independent of the menſuration of time.

6. *Hadley's quadrant* is an inſtrument of vaſt utility both in navigation and practical aſtronomy. It derives its name from Mr. Hadley, who firſt publiſhed an account of it, though the firſt thought originated with the celebrated Dr. Hooke, and was completed by Sir Iſaac Newton (ſee Astronomy). The utility of this quadrant ariſes fom the accuracy and preciſion with which it enables us to determine the latitude and longitude; and to it is navigation much indebted for the very great and rapid advances it has made of late years. It is eaſy to manage, and of extenſive uſe, requiring no peculiar ſteadineſs of hand, nor any ſuch fixed baſis as is neceſſary to other aſtronomical inſtruments. It is uſed as an inſtrument for taking angles in maritime ſurveying, and with equal facility at the maſt-head as upon the deck, by which its ſphere of obſervation is much extended: for, ſuppoſing many iſlands to be viſible from the maſt-head, and only one from deck, no uſeful obſervation can be made by any other inſtrument. But by this, angles may be taken at the maſt-head from the one viſible object with great exactneſs; and further, taking angles from heights, as hills, or a ſhip's maſt head, is almoſt the only way of exactly deſcribing the figure and extent of ſhoals.

It has been objected to the uſe of this inſtrument for ſurveying, that it does not meaſure the horizontal angles, by which alone a plan can be laid down. This objection, however true in theory, may be reduced in practice by a little caution; and Mr. Adams has given very good directions for doing ſo.

Notwithſtanding, however, the manifeſt ſuperiority of this inſtrument over thoſe that were in uſe at the time of its publication, it was many years before the ſailors could be perſuaded to adopt it, and lay aſide their imperfect and inaccurate inſtruments; ſo great is the difficulty to remove prejudice, and emancipate the mind from the ſlavery of opinion. No inſtrument has undergone, ſince the original invention, more changes than the quadrant of Hadley; of the various alterations, many had no better foundation than the caprice of the makers, who by theſe attempts have often rendered the inſtrument more complicated in conſtruction, and more difficult in uſe, than it was in its original ſtate

It is an eſſential property of this inſtrument, derived from the laws of reflection, that half degrees on the arch anſwer to whole ones in angles meaſured: hence an octant, or the eighth part of a circle, or 45 degrees on the arch, ſerves to meaſure 90 degrees; and ſextants will meaſure an angular diſtance of 120 degrees, though the arch of the inſtrument is no more than 60 degrees. It is from this property that foreigners term that inſtrument an *octant*, which we uſually call a *quadrant*, and which in effect it is. This property reduces indeed conſiderably the bulk of the inſtrument: but at the ſame time it calls for the utmoſt accuracy in the diviſions, as every error on the arch is doubled in the obſervation.

Another eſſential, and indeed an invaluable, property of this inſtrument, whereby it is rendered peculiarly advantageous in marine obſervations, is, that it is not liable to be diſturbed by the ſhip's motion; for, provided the mariner can ſee diſtinctly the two objects in the field of his inſtrument, no motion nor vacillation of the ſhip will injure his obſervation.

Thirdly, the errors to which it is liable are eaſily diſcovered and readily rectified, while the application and uſe of it is facile and plain.

To find whether the two ſurfaces of any one of the reflecting glaſſes be parallel, apply your eye at one end of it, and obſerve the image of ſome object reflected very obliquely from it; if that image appears ſingle, and well defined about the edges, it is a proof that the ſurfaces are parallel: on the contrary, if the edge of the reflected images appear miſted, as if it threw a ſhadow from it, or ſeparated like two edges, it is a proof that the two ſurfaces of the glaſs are inclined to each other: if the image in the ſpeculum, particularly if that image be the ſun, be viewed through a ſmall teleſcope, the examination will be more perfect.

To find whether the ſurface of a reflecting glaſs be plane. Chooſe two diſtant objects, nearly on a level with each other; hold the inſtrument in an horizontal poſition, view the left hand object directly through the tranſparent part of the horizon-glaſs, and move the index till the reflected image of the other is ſeen below it in the ſilvered part; make the two images unite juſt at the line of ſeparation, then turn the inſtrument round ſlowly on its own plane, ſo as to make the united images move along the line of ſeparation of the horizon-glaſs. If the images continue united without receding from each other, or varying their reſpective poſition, the reflecting ſurface is a good plane.

To find if the two ſurfaces of a red or darkening glaſs are parallel and perfectly plane. This muſt be done by means of the ſun when it is near the meridian, in the following manner: Hold the ſextant vertically, and direct the ſight to ſome object in the horizon, or between you and the ſky, under the ſun; turn down the red glaſs and move the index till the reflected image of the ſun is in contact with the object ſeen directly: fix then the index, and turn the red glaſs round in its ſquare frame; view the ſun's image and object immediately, and if the ſun's image is neither raiſed nor depreſſed, but continues in contact with the object below, as before, then the ſurfaces of the darkening glaſs are true.

For a more particular deſcription of Hadley's quadrant, and the mode of uſing it, ſee Navigation, p. 710.

This inſtrument has undergone ſeveral improvements ſince its firſt invention, and among theſe improvers muſt be ranked Mr. Ramſden. He found that the eſſential parts of the quadrant had not a ſufficient degree of ſolidity; the friction at the centre was too great, and in general the alidada might be moved ſeveral minutes without any change in the poſition of the mirror; the diviſions were commonly very inaccurate, and Mr. Ramſden found, that Abbé de la Caille did not exceed the truth in eſtimating at five minutes the error to which an obſerver was liable in taking the diſtance between the moon and a ſtar; an error capable of producing a miſtake of 50 leagues in the longitude. On this account Mr. Ramſden changed the principle of conſtruction of the centre, and made the inſtrument in ſuch a manner as never to give an error of more than half a minute; and he has now brought them to ſuch a degree of perfection as to warrant it not more than ſix ſeconds in a quadrant of fifteen inches. Since the time of having improved them, Mr. Ramſden has conſtructed an immenſe number; and in ſeveral which have been carried to the Eaſt Indies and America, the deficiency has been found no greater at their return than it had been determined by examinations before their being taken out. Mr. Ramſden has made them from 15 inches to an inch and a half, in the latter of which the minutes are eaſily diſtinguiſhable; but he prefers for general uſe thoſe of 10 inches, as being more eaſily handled than the greater, and at the ſame time capable of equal accuracy. See Sextant.

A great improvement was alſo made in the conſtruction of this quadrant by Mr. Peter Dollond, famous for his invention of achromatic teleſcopes. The glaſſes of the quadrants ſhould be perfect planes, and have their ſurfaces perfectly parallel to one another. By a practice of ſeveral years, Mr. Dollond found out methods of grinding them of this form to great exactneſs; but the advantage which ſhould have ariſen from the goodneſs of the glaſſes was often defeated by the index-glaſs being bent by the frame which contains it. To prevent this, Mr. Dollond contrived the frame ſo that the glaſs lies on three points, and the part that preſſes on the front of the glaſs has alſo three points oppoſite to the former. Theſe points are made to confine the glaſs by three ſcrews at the back, acting directly oppoſite to the points between which the glaſs is placed. The principal improvements, however, are in the methods of adjuſting the glaſſes, particularly for the back-obſervation. The method formerly practiſed for adjuſting that part of the inſtrument by means of the oppoſite horizons at ſea, was attended with ſo many difficulties that it was ſcarce ever uſed: for, ſo little dependence could be placed on the obſervations taken this way, that the beſt Hadley's ſextants made for the purpoſe of obſerving the diſtances of the moon from the ſun or fixed ſtars, have been always made without the horizon-glaſs for the back-obſervation; for want of which, many valuable obſervations of the ſun and moon have been loſt when their diſtance exceeded 120 degrees. To make the adjuſtment of the back-obſervation eaſy and exact, he applied an index to the back horizon-glaſs, by which it may be moved in a parallel poſition to the index-glaſs, in order to give it the two adjuſtments in the ſame manner as the fore-horizon-glaſs is adjuſted. Then, by moving the index to which the back horizon-glaſs is fixed exactly 90 degrees (which is known by the diviſions made for that purpoſe), the glaſs will thereby be ſet at right angles to the index-glaſs, and will be properly adjuſted for uſe; and the obſervations may be made with the ſame accuracy by this as by the fore-obſervation. To adjuſt the horizon-glaſſes in the perpendicular poſition to the plane of the inſtrument, he contrived to move each of them by a ſingle ſcrew, which goes through the frame of the quadrant, and is turned by means of a milled head at the back; which may be done by the obſerver while he is looking at the object. To theſe improvements alſo he added a method invented by Mr. Maſkelyne, of placing darkening glaſſes behind the horizon-glaſſes. Theſe, which ſerve for darkening the object ſeen by direct viſion, in adjuſting the inſtrument by the ſun or moon, he placed in ſuch a manner as to be turned behind the fore horizon-glaſs, or behind the back horizon-glaſs: there are three of theſe glaſſes of different degrees of darkneſs.

We have been the more particular in our deſcription and uſe of Hadley's quadrant, as it is undoubtedly the beſt hitherto invented.

7. *Horodictical quadrant*, a pretty commodious inſtrument, ſo called from its uſe in telling the hour of the day.—Its conſtruction is this: From the centre of the quadrant, C, pl. 38. fig. 3. whoſe limb AB is divided into 90°, deſcribe ſeven concentric circles at intervals at pleaſure; and to theſe add the ſigns of the zodiac, in the order repreſented in the figure. Then applying a ruler to the centre C and the limb AB, mark upon the ſeveral parallels the degrees correſponding to the altitude of the ſun when therein, for the given hours: connect the points belonging to the ſame hour with a curve line, to which add the number of the hour. To the radius CA fit a couple of ſights, and to the centre of the quadrant C tie a thread with a plummet, and upon the thread a bead to ſlide. If now the thread be brought to the parallel wherein the ſun is, and the quadrant directed to the ſun, till a viſual ray paſs through the ſights, the bead will ſhow the hour; for the plummet, in this ſituation, cuts all the parallels in the degrees correſponding to the ſun's altitude. Since the bead is in the parallel which the ſun deſcribes, and through the degrees of altitude to which the ſun is elevated every hour there paſs hour-lines the bead muſt ſhow the preſent hour. Some repreſent the hour-lines by arches of circles, or even by ſtraight lines, and that without any ſenſible error.

8. *Sutton's* or *Collins's quadrant* (fig. 4.) is a ſtereographic projection of one quarter of the ſphere between the tropics, upon the plane of the ecliptic, the eye being in its north pole: it is fitted to the latitude of London. The lines running from the right hand to the left are parallels of altitude; and thoſe croſſing them are azimuths. The leſſer of the two circles, bounding the projection, is one-fourth of the tropic of Capricorn; the greater is one fourth of that of Cancer. The two ecliptics are drawn from a point on the left edge of the quadrant, with the characters of the ſigns upon them; and the two horizons are drawn from the ſame point. The limb is divided both into degrees and time; and, by having the ſun's altitude, the hour of the day may be found here to a minute. The quadrantal arches next the centre contain the kalendar of months; and under them, in another arch, is the ſun's declination. On the projection are placed ſeveral of the moſt noted fixed ſtars between the tropics; and the next below the projection is the quadrant and line of ſhadows.—To find the time of the ſun's riſing or ſetting, his amplitude, his azimuth, hour of the day, &c. by this quadrant: lay the thread over the day and the month, and bring the bead to the proper ecliptic, either of ſummer or winter, according to the ſeaſon, which is called *rectifying*; then, moving the thread, bring the bead to the horizon, in which caſe the thread will cut the limb in the time of the ſun's riſing or ſetting before or after ſix; and at the ſame time the bead will cut the horizon in the degrees of the ſun's amplitude.—Again, obſerving the ſun's altitude with the quadrant, and ſuppoſing it found 45° on the 5th of May, lay the thread over the 5th of May, bring the bead to the ſummer ecliptic, and carry it to the parallel of altitude 45°; in which caſe the thread will cut the limb at 55° 15′, and the hour will be ſeen among the hour-lines to be either 41′ paſt nine in the morning, or 19′ paſt two in the afternoon. Laſtly, the bead among the azimuths ſhows the ſun's diſtance from the ſouth 50° 41′. But note, that if the ſun's altitude be leſs than what it is at ſix o'clock, the operation muſt be performed among thoſe parallels above the upper horizon; the bead being rectified to the winter ecliptic.

9. *Sinical quadrant* (fig. 5.) conſiſts of ſeveral concentric quadrantal arches, divided into eight equal parts by radii, with parallel right lines croſſing each other at right angles. Now any one of the arches, as BC, may repreſent a quadrant of any great circle of the ſphere, but is chiefly uſed for the horizon or meridian. If then BC be taken for a quadrant of the horizon, either of the ſides, as AB, may repreſent the meridian; and the other ſide, AC, will repreſent a parallel, or line of eaſt and weſt: and all the other lines parallel to AB will be alſo meridians; and all thoſe parallel to AC, eaſt and weſt lines, or parallels. Again, the eight ſpaces into which the arches are divided by the radii, repreſent the eight points of the compaſs in a quarter of the horizon; each containing 11° 15′. The arch BC is likewiſe divided into 90°, and each degree ſubdivided into 12′, diagonal-wiſe. To the centre is fixed a thread, which being laid over any degree of the quadrant, ſerves to divide the horizon.

If the ſinical quadrant be taken for a fourth part of the meridian, one ſide thereof, AB, may be taken for the common radius of the meridian and equator: and then the other, AC, will be half the axis of the world. The degrees of the circumference, BC, will repreſent degrees of latitude: and the parallels to the ſide AB, aſſumed from every point of latitude to the axis AC, will be radii of the parallels of latitude, as likewiſe the ſine complement of thoſe latitudes.

Suppoſe, then, it be required to find the degrees of longitude contained in 83 of the leſſer leagues in the parallel of 48°; lay the thread over 48° of latitude on the circumference, and count thence the 83 leagues on AB, beginning at A; this will terminate in H, allowing every ſmall interval four leagues, Then tracing out the parallel HE, from the point H to the thread; the part AE of the thread ſhows that 125 greater or equinoctial leagues make 6° 15′; and therefore that the 83 leſſer leagues AH, which make the difference of longitude of the courſe, and are equal to the radius of the parallel HE, make 6° 15′ of the ſaid parallel.

If the ſhip ſails an oblique courſe, ſuch courſe, beſides the north and ſouth greater leagues, gives leſſer leagues eaſterly and weſterly, to be reduced to degrees of longitude of the equator. But theſe leagues being made neither on the parallel of departure, nor on that of arrival, but in all the intermediate ones, we muſt find a mean proportional parallel between them. To find this, we have on the inſtrument a ſcale of croſs latitudes. Suppoſe then it were required to find a mean parallel between the parallels of 40° and 60°; with your compaſſes take the middle between the 40th and 60th degree on this ſcale: the middle point will terminate againſt the 51ſt degree, which is the mean parallel required.

The principal uſe of the ſinical quadrant is to form triangles upon, ſimilar to thoſe made by a ſhip's way with the meridians and parallels; the ſides of which triangles are meaſured by the equal intervals between the concentric quadrants and the lines N and S, E and W: and every fifth line and arch is made deeper than the reſt. Now, ſuppoſe a ſhip to have ſailed 150 leagues north-eaſt, one-fourth north, which is the third point, and makes an angle of 33° 44′ with the north part of the meridian: here are given the courſe and diſtance ſailed, by which a triangle may be formed on the inſtrument ſimilar to that made by the ſhip's courſe; and hence the unknown parts of the triangle may be found. Thus, ſuppoſing the centre A to repreſent the place of departure; count, by means of the concentric circles along the point the ſhip ſailed on, viz. AD, 150 leagues: then in the triangle AED, ſimilar to that of the ſhip's courſe, find AE = difference of latitude, and DE = difference of longitude, which muſt be reduced according to the parallel of latitude come to.

10. *Gunner's quadrant* (fig. 6.), ſometimes called *gunner's ſquare*, is that uſed for elevating and pointing cannon, mortars, &c. and conſiſts of two branches either of braſs or wood, between which is a quadrantal arch divided into 90 degrees, beginning from the ſhorter branch, and furniſhed with a thread and plummet, as repreſented in the figure. The uſe of the gunner's quadrant is extremely eaſy; for, if the longeſt branch be placed in the mouth of the piece, and it be elevated till the plummet cut the degree neceſſary to hit a propoſed object, the thing is done. Sometimes on one of the ſurfaces of the long branch are noted the diviſion of diameters and weights of iron bullets, as alſo the bores of pieces.

QUADRANT *of Altitude*, is an appendage of the artificial globe, conſiſting of a lamina, or ſlip of braſs, the length of a quadrant of one of the great circles of the globe, and graduated. At the end, where the diviſion terminates, is a nut riveted on, and furniſhed with a ſcrew, by means whereof the inſtrument is fitted on the meridian, and moveable round upon the rivet to all points of the horizon. Its uſe is to ſerve as a ſcale in meaſuring altitudes, amplitudes, azimuths, &c. See ASTRONOMY.

QUADRANTAL, in antiquity, the name of a veſſel in uſe among the Romans for the meaſuring of liquids. It was at firſt called *amphora*; and afterwards *quadrantal*, from its form, which was ſquare every way like a die. Its capacity was 80 libræ or pounds of water, which made 48 ſextaries, two urnæ, or eight congii.

QUADRAT, a mathematical inſtrument, called alſo a *Geometrical Square*, and *Line of Shadows*: it is frequently an additional member on the face of the common quadrant, as alſo on thoſe of Gunter's and Sutton's quadrants. See GEOMETRY, p. 754. and plate 42. Vol. III.

QUADRAT, in printing, a piece of metal uſed to fill up the void ſpaces between words, &c. There are quadrats of different ſizes; as m-quadrats, n-quadrats, which are reſpectively of the dimenſions of theſe letters, only lower, that they may not receive the ink.

QUADRATIC EQUATIONS, in algebra, thoſe wherein the unknown quantity is of two dimenſions, or raiſed to the ſecond power. See ALGEBRA.

QUADRATRIX, in geometry, a mechanical line, by means whereof we can find right lines equal to the circumference of circles, or other curves, and their ſeveral parts.

QUADRATURE, in geometry, denotes the ſquaring, or reducing a figure to a ſquare. Thus, the finding of a ſquare, which ſhall contain juſt as much ſurface or area as a circle, an ellipſis, a triangle, &c. is the quadrature of a circle, ellipſis, &c. The quadrature, eſpecially among the ancient mathematicians, was a great poſtulatum. The quadrature of rectilineal figures is eaſily found, for it is merely the finding their areas or ſurfaces, *i. e.* their ſquares: for the ſquares of equal areas are eaſily found by only extracting the roots of the areas thus found. See GEOMETRY. The quadrature of curvilinear ſpaces is of more difficult inveſtigation; and in this reſpect extremely little was done by the ancients. except the quadrature of the parabola by Archimedes. In 1657, Sir Paul Neil, Lord Brouncker, and Sir Chriſtopher Wren, geometrically demonſtrated the equality of ſome curvilinear ſpaces to rectilinear ſpaces; and ſoon after the like was proved both at home and abroad of other curves, and it was afterwards brought under an analytical calculus; the firſt ſpecimen of which was given to the public in 1688 by Mercator, in a demonſtration of Lord Brouncker's quadrature of the hyperbola, by Dr. Wallis's reduction of a fraction into an infinite ſeries of diviſion. Sir Iſaac Newton, however, had before diſcovered a method of attaining the quantity of all quadruple curves analytically by his fluxions before 1668. It is diſputed between Sir Chriſtopher Wren and Mr. Huygens which of them firſt diſcovered the quadrature of any determinate cycloidal ſpace. Mr. Leibnitz afterwards found that of another ſpace; and in 1699 Bernoulli diſcovered the quadrature of an infinity of cycloidal ſpaces, both ſegments and ſectors, &c. See GEOMETRY and FLUXIONS.

QUADRATURE, in aſtronomy, that aſpect of the moon when ſhe is 90° diſtant from the ſun; or when ſhe is in a middle point of her orbit, between the points of conjunction and oppoſition, namely, in the firſt and third quarters. See ASTRONOMY.

QUADRATUS, in anatomy, a name given to ſeveral muſcles on account of their ſquare figure. See ANATOMY, *Table of the Muſcles*.

QUADREL, in building, a kind of artificial ſtone, ſo called from its being perfectly ſquare. The quadrels are made of a chalky earth, &c. and dried in the ſhade for two years. Theſe were formerly in great requeſt among the Italian architects.

QUADRIGA, in antiquity, a car or chariot drawn by four horſes. On the reverſes of medals we frequently ſee the emperor or Victory in a quadriga, holding the reins of the horſes; whence theſe coins are, among the curious, called *nummi quadrigati*, and *victoriati*.

QUADRILATERAL, in geometry, a figure whoſe perimeter conſiſts of four ſides and four angles; whence it is alſo called a *quadrangular figure*.

QUADRILLE, a little troop or company of cavaliers, pompouſly dreſſed and mounted for the performance of carouſals, juſts, tournaments, runnings at the ring, and other gallant divertiſements.

QUADRILLE, a game played by four perſons, with 40 cards;

QUADRANT.

Fig. 1.
Cole's Quadrant

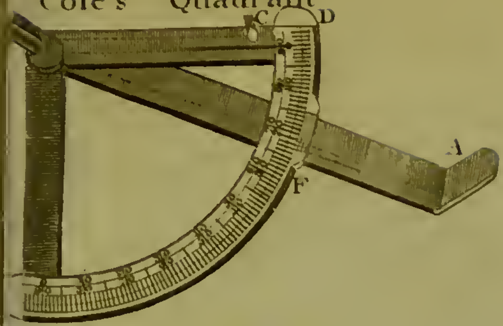


Fig. 3.
Horodetical Quadrant

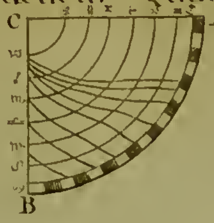


Fig. 4.
Sutton's Quadrant

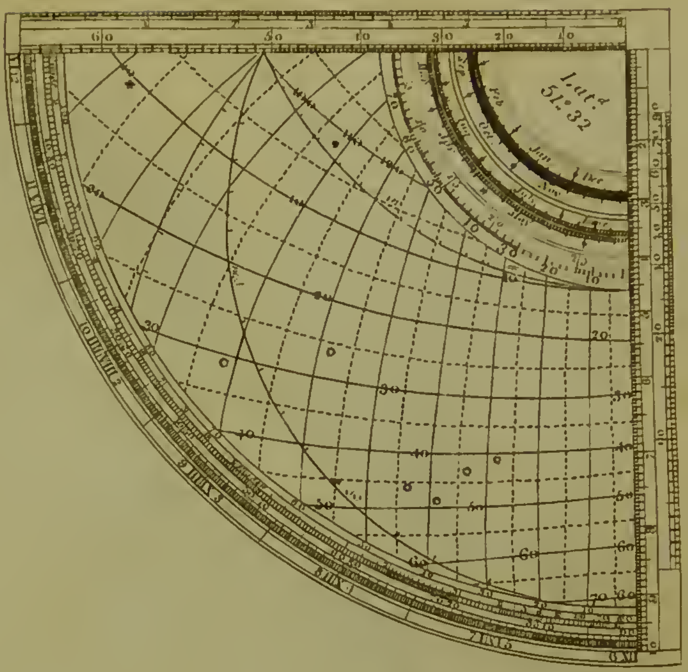


Fig. 5.
Smical Quadrant

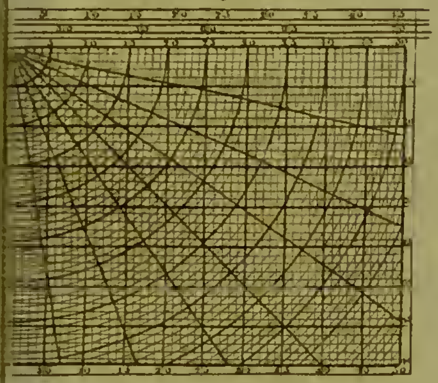
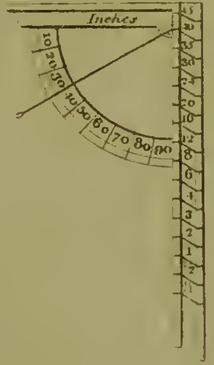


Fig. 6.
Gunner's Quadrant



QUARTER.

Fig. 1.

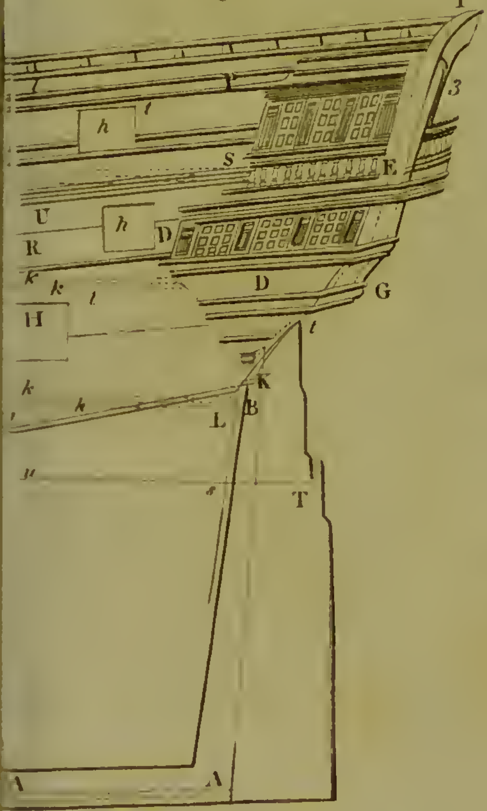


Fig. 2.

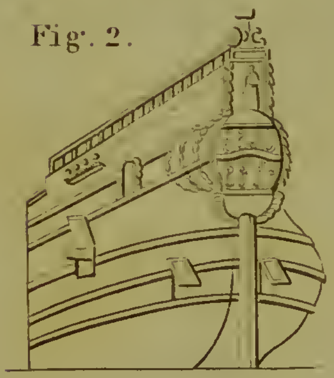


Fig. 3.

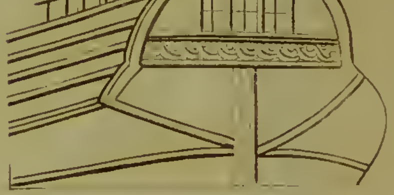


Fig. 4.

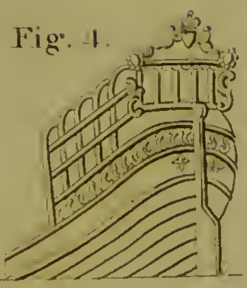


Fig. 7.

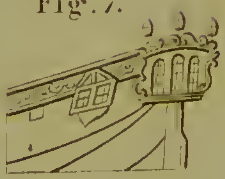


Fig. 5.

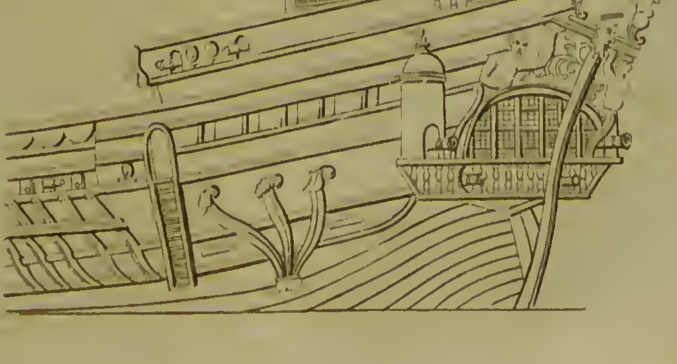
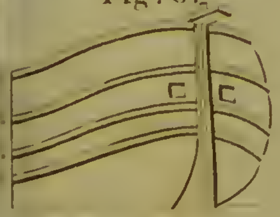
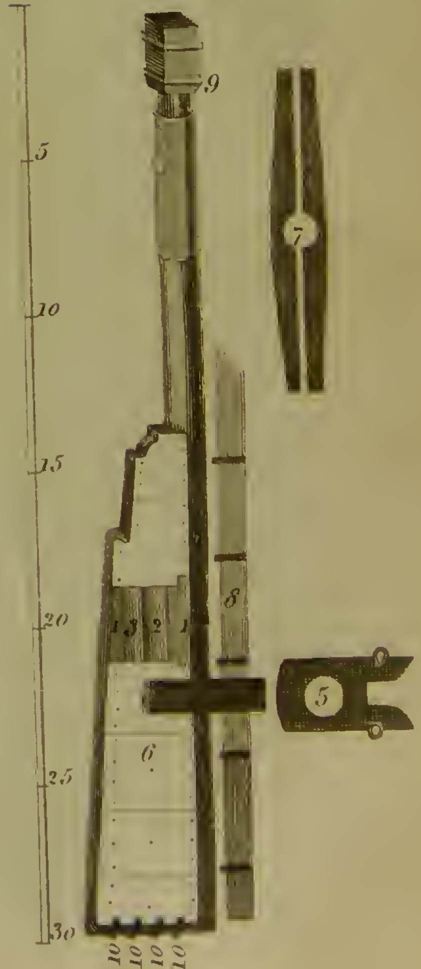


Fig. 6.



Subſtitute for a Rudder



which are the remains of a pack, after the four tens, nines, and eights are diſcarded; theſe are dealt three and three, and one round four, to the right hand player; and the trump is made by him that plays with or without calling, by naming ſpades, clubs, diamonds, or hearts, and the ſuit named is trumps. If the perſon who names the trump ſhould miſtake, and ſay ſpades inſtead of clubs, or if he name two ſuits, the firſt-named is the trump.

In this game the order of the cards, according to their natural value, is as follows: of hearts and diamonds, *king, queen, knave, ace, deuce, three, four, five, ſix, ſeven*; in all 10; of ſpades and clubs, *king, queen, knave, ſeven, ſix, five, four, three, deuce*; in all 9. The reaſon why the ace of ſpades and ace of clubs are not mentioned, is, becauſe they are always trumps, in whatever ſuit that is played. The ace of ſpades being always the firſt, and the ace of clubs the third trump, for the cards ranked according to their value when *trumps* ſtand in the following order.

Hearts and diamonds SPADILL, or the *ace of ſpades*; MANILL, the *ſeventh* of the two *red ſuits*; BASTO, the *ace of clubs*; PONTO, the *ace of hearts* and *diamonds*; *king, queen, knave, deuce, three, four, five, ſix*; in all 12. Spades and clubs, SPADILL the ace of ſpades, MANILL the *deuce* of ſpades and clubs, BASTO the ace of clubs; *king, queen, knave, ſeven, ſix, five, four, three*; in all 11. It is here to be obſerved, that the card which is *manill* and the ſecond trump, is always the loweſt in its ſuit when not trumps; and that the ace of hearts or diamonds, which when trump is above the king, is below the knave when not trump.

There are three matadores; ſpadill, manill, and baſto; the privilege of which is, that when the player has no other trumps but them, and trumps are led, he is not obliged to play them, but may play what card he thinks proper, provided, however, that the trump led is of an inferior rank; but if ſpadill ſhould be led, he that has manill or baſto only, is obliged to play it; it is the ſame of manill baſto, with reſpect to the ſuperior matadore always forcing the inferior. Though there are properly but three matadores, nevertheleſs, all thoſe trumps which follow the three firſt without interruption, are likewiſe called matadores; but the three firſt only enjoy the privilege above mentioned.

Each perſon is to play as he judges moſt convenient for his own game. He is not to encourage his friend to play; but each perſon ought to know what to do when it is his turn to play. The ſtakes conſiſt of ſeven equal mils or *contrats*, as they are ſometimes called, compriſing the ten counters and fiſhes, which are given to each player. A mil is equal to ten fiſh, and each fiſh to ten counters: the value of the fiſh is according to the players agreement, as alſo the number of tours, which are generally fixed at ten, and marked by turning the corners of a card.

If the cards ſhould happen not to be dealt right, or that there ſhould be two cards of the ſame ſort, as two deuces of ſpades, for example, there muſt be a new deal; provided it is diſcovered before the cards are all played. The cards muſt likewiſe be dealt over again in caſe a card is turned in dealing, as it might be of prejudice to him who ſhould have it; and of courſe if there ſhould be ſeveral cards turned. There is no penalty for dealing wrong, he who does ſo muſt only deal again.

When each player has got his ten cards, he that is on the right hand of the dealer, after examining his game, and finding his hand fit to play, aſks if they play; or, if he has not a good hand, he paſſes, and ſo the ſecond, third, and fourth. All the four may paſs; but he that has ſpadill, after having ſhown or named it, is obliged to play by calling a king. Whether the deal is played in this manner, or that one of the players has aſked leave, nobody chooſing to play without calling, the eldeſt hand muſt begin the play, firſt naming his ſuit, and the king which he calls; he who wins the trick plays another card, and ſo of the reſt till the game is finiſhed. The tricks then are counted; and if the ombre, that is, he who ſtands the game, has, together with him who is the king called, ſix tricks, they have won and are paid the game, the conſolation, and the matadores, if they have them, and divide what is upon the game, and the beaſts if there are any. But if they make only five tricks, it is a remiſe, and they are beaſted what goes upon the game, paying to the other players the conſolation and the matadores. If the tricks are equally divided betwixt them, they are likewiſe beaſted; and if they make only four tricks between them, it is a remiſe; if they make leſs they loſe codill*, and in that caſe they pay to their adverſaries what they ſhould have received if they had won; that is, the game, the conſolation, and the matadores, if they have them, and are beaſted what is upon the game: they who win codill divide the ſtakes. The beaſt, and every thing elſe that is paid, is paid equally betwixt the two loſers; one half by him that calls, and the other half by him that is called, as well in caſe of codill as a remiſe; unleſs the ombre does not make three tricks, in which caſe he that is called is not only exempted from paying half the beaſt, but alſo the game, the conſolation, and the matadores if there are any; which the ombre in that caſe pays alone; and as well in caſe of a codill as a remiſe. This is done in order to oblige players not to play games that are unreaſonable. There is, nevertheleſs, one caſe in which, if the ombre makes only one trick, he is not beaſted alone, and that is, when not having a good hand he paſſes, and all the other players have paſſed likewiſe; he having ſpadill is obliged to play. Here it would be unjuſt to oblige him to make three or four tricks: in this caſe, therefore, he that is called pays one half of the loſings. For which reaſon he that has ſpadill with a bad hand, ſhould paſs, that, if he is afterwards obliged to play by calling a king (which is called *forced ſpadill*), he may not be beaſted alone. He that has once paſſed cannot be admitted to play; and he that has aſked leave cannot refuſe to play, unleſs any one ſhould offer to play without calling.

He that has four kings may call a queen to one of his kings, except that which is trump. He that wants one or more kings may call one of thoſe kings; but in that caſe he muſt make ſix tricks alone, and conſequently he wins or loſes alone. The king of that ſuit in which he plays cannot be called. No one ſhould play out of his turn, although he is not beaſted for ſo doing. If he who is not the eldeſt hand has the king called, and plays ſpadill, manill, or baſto, or even the king called in order to ſhow that he is the friend, having other kings that he fears the ombre ſhould trump, he is not to be allowed to go for the vole; he is even beaſted, if it appears to be done with that intent. It is not permitted to ſhow a hand though codill may already be won; that it may be ſeen whether the ombre is beaſted alone. If the ombre or his friend ſhow their cards before they have made ſix tricks, thinking that they have made them, and there appears a poſſibility of preventing their making them, the other players can oblige them to play their cards as they think proper.

A player need only name his ſuit when he plays, without calling a king. He who plays without calling muſt make ſix tricks alone to win; for all the other players are united against him, and they are to do what they can to prevent his winning. He who plays without calling, is admitted to play in preference to him who would play with calling; however, if he that has aſked leave will play without calling, he has the preference of the other who would force him. Theſe are the two methods of play without calling that are called forced.

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* Codill is when thoſe who defend the pool make more tricks than they who ſtand the game; which is called *winning the codill*.

As he who plays without calling does not divide the winnings with any perſon, he conſequently, when he loſes, pays all by himſelf; if he loſes by remiſe he is beaſted, and pays each of the other players the conſolation, the *ſans appeller* (which is commonly, but improperly, called the *ſans prendre*), and the matadores if there are any; if he loſes codill he is likewiſe beaſted, and pays to each player what he would have received from each if he had won. They who win codill divide what there is; and if there are any counters remaining, they belong to him of the three who ſhall have ſpadill or the higheſt trump the next deal. It is the ſame with regard to him who calls one of his own kings: he wins alone or loſes alone as in the other caſe, except the ſans appeller, which he does not pay if he loſes, or receive if he wins, although he plays alone.

If he plays ſans appeller, though he may have a ſure game, he is obliged to name his ſuit; which if he neglects to do, and ſhows his cards, and ſays "I play ſans appeller;" in that caſe either of the other players can oblige him to play in what ſuit he pleaſes, although he ſhould not have one trump in that ſuit.

He who has aſked leave is not permitted to play ſans appeller unleſs he is forced; in which caſe, as was ſaid before, he has the preference of the other that forces him.

A player is not obliged to trump when he has none of the ſuit led, nor play a higher card in that ſuit if he has it, being at his option although he is the laſt player, and the trick ſhould belong to the ombre; but he is obliged to play in the ſuit led if he can, otherwiſe he renounces. If he ſeparates a card from his game and ſhows it, he is obliged to play it, if by not doing it the game may be prejudiced, or if it can give any intelligence to his friend; but eſpecially if it ſhould be a matadore.—He that plays ſans appeller, or by calling himſelf, is not ſubject to this law. He may turn the tricks made by the other players, and count what has been played as often as it his turn to play, but not otherwiſe. If, inſtead of turning a player's tricks, he turns and ſees his game, or ſhows it to the other players, he is beaſted, together with him whoſe cards he turned; and each of them muſt pay one half of the beaſt.

If any one renounces, he is beaſted as often as he has renounced and it is detected; but a renounce is not made till the trick is turned. If the renounce is diſcovered before the deal is finiſhed, and has been detrimental to the game, the cards muſt be taken up again, and the game replayed from that trick where the renounce was made; but if the cards are all played, the beaſt is ſtill made, and the cards muſt not be replayed, except there ſhould be ſeveral renounces in the ſame deal: then they are to be played again, unleſs the cards ſhould be mixed. If ſeveral beaſts are made in the ſame deal, they all go together, unleſs it is otherwiſe agreed at the beginning of the party; and when there are ſeveral beaſts, the greateſt always goes firſt.

A great advantage accrues from being eldeſt hand at quadrille, which often renders it very diſagreeable to the reſt of the players, being obliged to paſs with a good hand unleſs they chooſe to play alone; and when it happens that, the eldeſt hand having aſked leave, the ſecond player has three matadores, ſeveral trumps in back, and all ſmall cards, he cannot then even play alone; and having no chance of being called, he muſt paſs with this good hand. On account of which, this method has been thought expedient to remedy this defect of the game; each player having an opportunity of availing himſelf of the goodneſs of his game, by adding to the uſual method of playing the game that of the mediateur and the favourite ſuit.

The firſt thing to be obſerved is that of drawing for places, which is done in this manner: One of the players takes four cards; a king, a queen, a knave, and an ace; each player draws one of theſe cards; and commonly he who comes in laſt, draws firſt. The perſon who draws the king ſits where he pleaſes, the queen at his right hand, the knave next the queen, and the ace on the left of the king. The king draws the favourite ſuit. The number of cards and perſons is the ſame at this game as the other, and is played in the ſame manner.

The favourite ſuit is determined by drawing a card out of the pack, and is of the ſame ſuit, during the whole party, of the card ſo drawn.

A king is the mediateur, which is demanded of the others by one of the players who has a hand he expects to make five tricks of; and through the aſſiſtance of this king he can play alone and make ſix tricks.

In return for the king received, he gives what card he thinks proper with a fiſh; but muſt give two fiſh if it is in the favourite ſuit. He who aſks by calling in the favourite ſuit, has the preference to him who aſks by calling in any other; he who aſks with the mediateur, has the preference to him who aſks by calling in the favourite ſuit, and by playing alone is obliged to make ſix tricks to win. He who aſks with the mediateur in the favourite ſuit, has the preference to him who aſks with the mediateur in any other ſuit, and is obliged to play alone, and to make ſix tricks.

If ſans prendre is played in any other ſuit than the favourite, he who plays it has the preference to him who aſks only, or with the mediateur, or even he who plays in the favourite ſuit with the mediateur; and the ſans prendre in the favourite ſuit has the preference to all other players whatever.

The only difference between this method of playing the game and the other is, that when one of the players demands the mediateur he is obliged to play alone, and to make ſix tricks, as if he played ſans prendre. In this caſe he ſhould judge from the ſtrength of his hand, whether the aid of the king will enable him to play alone or not.

With the mediateur and without the favourite ſuit it is played in this manner: The game is marked and played the ſame as in common, except that a fiſh extraordinary is given to him who plays the mediateur, and to him who plays ſans prendre; that is, he who wins the mediateur receives 13 counters from each; and if he loſes by remiſe he pays 12 to each; and 13 if by codill. The winner of ſans prendre receives 17 counters from each; and if by remiſe he loſes, he pays 16 to each, and 17 if by codill.

The vole with the mediateur receives one fiſh only, as at common quadrille. The beaſts are alſo the ſame as the common game. The laſt game is generally played double, and is called *paulans*; but for thoſe who chooſe to play a higher game, they may play the double colour, which is called the *Turk*, and is double of the favourite ſuit. There is alſo a higher game than this called the *mode*, which is paying whatever is agreed to him who happens to hold the two aces in his hand.

We have omitted many things reſpecting the mode of marking the game, and playing the vole, becauſe theſe are different in different caſes, and are to be learned only by practice. The game itſelf is a very inferior one; but he who wiſhes to know more of it, may conſult Hoyle's games improved by James Beaufort, Eſq. from which we have, with very little alteration, taken this article.

QUADRUPEDS, in zoology; thoſe animals which have four limbs or legs proceeding from the trunk of their body. See ZOOLOGY; in which article notice will be taken of the method of preſerving ſpecimens of theſe and other animals.

QUÆSTOR, ſee QUESTOR.

QUAGGA, or QUACHA. See BARB.

QUAIL, in zoology. See TETRAO.

Quails are to be taken by means of the call during their whole wooing time, which laſts from April to Auguſt. The proper times for uſing the call are at ſun-riſing, at nine o'clock in the morning, at three in the afternoon, and at ſun-ſet; for theſe are the natural times of the quail's calling. The notes of the cock and hen quail are very different; and the ſportſman who expects to ſucceed in the taking them muſt be expert in both: for, when the cock calls, the anſwer is to be made in the hen's note; and, when the hen calls, the anſwer is to be made in the cock's. By this means they will come up to the perſon, ſo that he may, with great eaſe, throw the net over them and take them. If a cock quail be ſingle, on hearing the hen's note he will immediately come; but if he has a hen already with him, he will not forſake her. Sometimes, though only one quail anſwers to the call, there will three or four come up; and then it is beſt to have patience, and not run to take up the firſt, but ſtay till they are all entangled, as they will ſoon be.

The quail is a neat cleanly bird, and will not run much into dirty or wet places: in dewy mornings, they will often fly inſtead of running to the call; and in this caſe, it is beſt to let them go over the net, if it ſo happens that they fly higher than its top; and the ſportſman then changing ſides, and calling again, the bird will come back, and then will probably be taken in the net.

The calls are to be made of a ſmall leather purſe, about two fingers wide, and four fingers long, and made in the ſhape of a pear; this is to be ſtuffed half full of horſe-hair, and at the end of it is to be placed a ſmall whiſtle, made of the bone of a rabbit's leg, or ſome ſuch other bone: this is to be about two inches long, and the end formed like a flageolet, with a little ſoft wax. This is to be the end faſtened into the purſe; the other is to be cloſed up with the ſame wax, only that a hole is to be opened with a pin, to make it give a diſtinct and clear ſound. To make this ſound, it is to be held full in the palm of the hand, with one of the fingers placed over the top of the wax; then the purſe is to be preſſed, and the finger is to ſhake over the middle of it, to modulate the ſound it gives into a ſort of ſhake. This is the moſt uſeful call; for it imitates the note of the hen-quail, and ſeldom fails to bring a cock to the net if there be one near the place.

The call that imitates the note of the cock, and is uſed to bring the hen to him, is to be about four inches long, and above an inch thick; it is to be made of a piece of wire turned round and curled, and covered with leather; and one end of it muſt be cloſed up with a piece of flat wood, about the middle of which there muſt be a ſmall thread or ſtrap of leather, and at the other end is to be placed the ſame ſort of pipe, made of bone, as is uſed in the other call. The noiſe is made by opening and cloſing the ſpiral, and gives the ſame ſound that the cock does when he gives the hen a ſignal that he is near her.

QUAKERS, a religious ſociety, which took its riſe in England about the middle of the laſt century, and rapidly found its way into other countries in Europe, and into the Engliſh ſettlements in North America.—Their founder, George Fox, an illiterate ſhoemaker, made his firſt appearance as a preacher about the year 1648 The nation was then greatly agitated by religious controverſies, and numerous errors aroſe on the demolition of the eccleſiaſtical and civil conſtitution. The character of Fox was harmleſs, and he appears to have been an honeſt viſionary, though ſome writers accuſe him of making himſelf equal with Chriſt. He acquired ſeveral followers; and in the year 1650, being brought before two juſtices in Derbyſhire for oppoſing a miniſter in the exerciſe of his duty, one of the magiſtrates, by way of jeer, gave to them the name of *quakers*; an appellation which has ſtuck to them ever ſince, though they themſelves adopted, and ſtill retain, the term of *friends*. Robert Barclay and William Penn are the greateſt names which this ſociety can boaſt; the former wrote a maſterly apology for the quakers, to which was prefixed a remarkable dedication to king Charles II. Penn wrote ſeveral books in an excellent ſtyle, the principal of which is that entitled *No Croſs, no Crown*. Theſe writers were men of conſiderable learning and abilities. It muſt be admitted, however, that the quakers, as a body, have produced few learned or ſcientific men: and the reaſon ſeems to be this, they avoid ſending their children to public ſchools; they profeſs to ſlight profane learning; and being principally engaged in mechanical employments, or commercial concerns, they rather chooſe to acquire what is uſeful than what is ornamental in education. It is ſomewhat difficult to give an accurate view of their tenets, as they have no ſtandard confeſſion, and reject with abhorrence all creeds and formularies. They have, indeed, publiſhed a "Summary View of their Doctrines and Diſcipline;" but even this performance can hardly be ſaid to give a clear idea of their ſentiments, as many points are looſely worded, and others ſo obſcurely expreſſed, and that too upon doctrines of conſiderable importance, as to render the whole very unſatisfactory to the inquirer.

From this ſummary we learn, in brief, that the Friends believe in one eternal God, and in Jeſus Chriſt, his ſon, the Meſſiah, and Mediator of the new covenant. They acknowledge the divinity of Chriſt, who is the wiſdom and power of God unto ſalvation. To Chriſt alone they give the title of the *Word of God*, and not to the ſcriptures. They reverence the excellent precepts of the goſpel; and believe that, to enable mankind to put in practice theſe ſacred precepts, every man is endued with a meaſure of the light, grace, or good ſpirit of Chriſt, by which he is enabled to diſtinguiſh good from evil, and to correct the diſorderly paſſions and corrupt propenſities of his nature, which mere *reaſon* is inſufficient to overcome. They believe that the influence of the ſpirit of Chriſt is neceſſary to enable them acceptably to worſhip the Father of Light, and of Spirits, in ſpirit and in truth; and are of opinion that to wait in ſilence is moſt favourable to their having a true ſight of their condition beſtowed upon them.

They believe that all true miniſtry is derived from the ſame ſource, and that it ſprings from the influence of the holy ſpirit. They reject the ceremonies of baptiſm and the Lord's ſupper; the firſt as belonging, according to St. John, to an inferior and decreaſing diſpenſation, it being merely typical of true ſpiritual baptiſm; the latter rite they do not conſider as maintaining the communion between Chriſt and his church, which is only done by a real participation of the divine nature through faith; one is the ſubſtance, the other the ſhadow.

With reſpect to the divinity of Chriſt, and the perſonality of the Holy Ghoſt, the Friends ſeem to have very indiſtinct notions, and to differ much among themſelves. Some of them, if not indeed a great number, maintain that the names of Father, Son, and Holy Ghoſt, deſignate the ſame divine being under different relations to man, as the creator, as the redeemer, and as the comforter and inſtructor of the human race. This is evidently Sabellianiſm. There are others again who hold a diſtinction of perſon between the Father and the Son, but deny the perſonality of the Holy Ghoſt, ſo that they may truly be called Binarians. The ſociety at large, however, do not cenſure any of their brethren for taking up either of theſe explications, or for adopting any other. Perhaps many are Arians, and it may be that ſome of them are Socinians in fact, though not in name. But theſe points of difference make no breach in their friendſhip, provided all adopt the leading features of the ſect, and conform themſelves to its rules and peculiarities of diſcipline. In their public worſhip, if worſhip it may be called, where all is done in ſilence except any brother or ſiſter is moved to ſpeak a mere word of exhortation, the congregation ſit covered without ceremony. Oftentimes they break up the meeting without any thing having been ſaid. Theſe are properly called ſilent meetings. Their marriages are celebrated in the meeting in the manner of a civil contract; to which all who are preſent are deſired to become ſubſcribing witneſſes. Their funerals are equally plain; but ſometimes one of the attending friends feels an impulſe to ſpeak upon the occaſion. The moral ſyſtem of the quakers may be reduced to the following heads:—1. That it is not lawful to give to men ſuch flattering titles as your grace, your lordſhip, your honour, ſir, &c. or to uſe any of thoſe flattering words commonly called compliments, or even to make uſe of the plural *you*, inſtead of the ſingular *thee*. 2. That it is not lawful for chriſtians to kneel or proſtrate themſelves to any man, or to bow the body, or to uncover the head out of reſpect to any perſons. 3. That it is not lawful for a chriſtian to uſe ſuch ſuperfluities of apparel as are of no uſe except for ornament and vanity. 4. That it is not lawful to uſe games, ſports, or plays among chriſtians, under the notion of recreations, which do not agree with chriſtian gravity and ſobriety; for laughing, ſporting, gaming, mocking, jeſting, vain talking, &c. are not chriſtian liberty, nor harmleſs mirth. 5. That it is not lawful for chriſtians to ſwear at all under the goſpel, not only vainly and in their common diſcourſe, which was alſo forbidden under the law, but even to the truth before a magiſtrate. 6. That it is not lawful for chriſtians to reſiſt evil, or to war or to fight in any caſe whatever. The ſociety alſo, from its firſt appearance, has uniformly diſuſed thoſe names of the months and days which, having been given in honour of the heroes or falſe gods of the heathens, originated in their flattery or ſuperſtition.

In many reſpects this ſect are highly commendable. The ſobriety of their dreſs is well contraſted with the vain frippery and ever-varying modes of a degenerate age. Their guarded and decent language, and regularity of deportment, however uncouth and formal to light and ſuperficial minds, cannot but excite the admiration of the liberal and intelligent obſerver. The excellent manner in which they govern their families, and bring up their children to a cheerful obedience of, and ready acquieſcence to, their peculiar cuſtoms and reſtraints, may be recommended as highly deſerving of imitation. The quakers have exerted themſelves with unremitted activity to procure an abolition of the ſlave trade; and though they are adverſe to war and bloodſhed, yet their loyalty has never been called in queſtion. Perhaps the extraordinary acts of indulgence which they have experienced from the legiſlature, and above all their commercial ſpirit and connections, may have powerfully contributed towards fixing this part of their character. It is rather ſingular, that though they have, during the preſent conteſt, diſmiſſed from their communion ſome members who were engaged in the manufacture of arms, yet a great part of them do not ſcruple to engage in contracts and loans, which are juſtly conſidered as the very ſinews of war. This may be called ſtraining at a gnat and ſwallowing a camel.

It is no want of charity to ſay that an attachment to *worldly intereſt* is a diſtinguiſhing characteriſtic of this ſect. Perhaps the Jews themſelves have not ſo many moneyed men among them as the quakers.

A religious ſpirit can hardly be expected to conſort with this diſpoſition. A concern about the affairs of the world, when carried out to a great and active extent, tends naturally to leſſen the influence of religious opinion and the feeling of devotional ſentiment. The religion of the quakers appears now to be different, at leaſt in its effects, from that which diſtinguiſhed their forefathers. The enthuſiaſm of the primitive quakers agreed well with their leading principle, of being actuated by a divine afflatus; but that enthuſiaſm is now done away. Yet the preſent quakers pretend to the enjoyment of the ſame heavenly viſitation, and the effuſions they deliver in the meeting are attributed to the operation of the holy ſpirit. This, however, is evidently the effect of mechanical habit, and the conſequence of education. The number of the ſociety is great in Britain, and alſo in America. The care which they take of their indigent, and the ſupport which they miniſter to their unfortunate brethren, muſt of courſe cement the ſociety; and in many places occaſion its increaſe. It does not, however, appear that they take pains, or are even ſolicitous, to gain proſelytes.

There are ſeven yearly meetings among them, viz. 1. London, to which come repreſentatives from Ireland. 2. New England. 3. New York. 4. Pennſylvania and New Jerſey. 5. Maryland. 6. Virginia. 7. Carolina and Georgia.

At theſe meetings, which are held at the feaſt of pentecoſt, or Whitſuntide, deputies come from all parts convenient, and the general buſineſs of the ſociety is tranſacted. The reports of country members are received; accounts of ſufferings, for ſuch they account poors' rates and church dues, as tithes, &c. are ſtated, and the aggrieved brethren redreſſed from the fund of the ſociety. Contributions are alſo made for the poor. At the cloſe, a circular letter is drawn up, addreſſed to all the Friends, and printed.

The quakers have a reſpectable ſchool at Ackworth in Yorkſhire, to which Dr. Fothergill left conſiderable legacies, and where about two hundred boys, and one hundred and forty girls, are educated. They have beſides charity ſchools in London and ſome other parts of the kingdom.

QUALITY is a word which, as uſed in philoſophical diſquiſitions, cannot be explained by any periphraſis. That which is expreſſed by it muſt be brought into the immediate view of the ſenſes or intellect, and the name properly applied, or he who is a ſtranger to the word will never be made to comprehend its meaning. Ariſtotle, who treated it as a general conception ſecond in order among the ten *predicaments* or *categories* (ſee CATEGORY), gives ſeveral characters of it; but though they are all in ſome reſpects juſt, no man could from them, without other aſſiſtance, learn what *quality* is. Thus he tells us, Ὑπαρχει δε εναντιοτης κατα το ποιον: Επιδεχεται δε το μαλλον και το ἡττον τα ποια. And again, Ὁμοια δε η ανομοια κατα μονας τας ποιοτητας λεγεται· ὁμοιον γαρ ἑτερον ἑτερῳ ουκ εστι κατ' αλλο ουδεν, η καθ' ὁ ποιον εστιν.

When a man comprehends, by means of his ſenſes and intellect, what it is which the word *quality* denotes, he will indeed perceive that the firſt of theſe characters is applicable to ſome qualities and not to others: that the ſecond is more applicable to *quantity* than to quality; and that it is only the third which can with propriety be conſidered as the general characteriſtic of this predicament. Thus, when we have learned by our ſenſe of ſight that *whiteneſs* is a quality of ſnow, and *blackneſs* of coal; and by means of obſervation and reflection, that *wiſdom* is a quality of one man and *folly* of another—we muſt admit that the ſenſible quality of the ſnow is *contrary* to that of the coal, and the intellectual quality of wiſdom contrary to that of folly. There is, however, no contrariety between *wiſdom* and *whiteneſs* or *blackneſs*, nor between *hardneſs* or *ſoftneſs* and *any particular colour*; for ſenſible and intellectual qualities can never be compared; and it is not eaſy, if poſſible, to make a compariſon between qualities perceptible only by different ſenſes: Nay, among qualities perceptible by the ſame ſenſe, we often meet with a difference where there is no contrariety; for though the *figure* of a *cube* is *different* from that of a *ſphere*, and the figure of a *ſquare* from that of a *circle*, the ſphere is not *contrary* to the cube, nor the circle to the ſquare.

His ſecond characteriſtic of this genus is ſtill leſs proper than the firſt. It is indeed true that ſome qualities admit of *intenſion* and *remiſſion*; for ſnow is whiter than paper, and one woman is handſomer than another; but of the ſpecies of quality called *figure* we cannot predicate either *more* or *leſs*. A crown-piece may have as much of the *circular quality* in it as the plane of the equator, and a muſket-bullet as much of the *ſpherical quality* as the orb of the ſun. It is indeed a property of all *quantity* to admit of *intenſion* and *remiſſion*; and therefore this ought to have been given as the character not of the ſecond but of the third category. See QUANTITY.

That it is only from a *compariſon of their qualities that things are denominated like or unlike*, or that *one thing cannot reſemble another but in ſome quality*, is indeed a juſt obſervation. We know nothing directly but qualities ſenſible and intellectual (ſee METAPHYSICS); and as theſe have no reſemblance to each other, we conclude that body or matter, the ſubject of the former, is a being unlike mind, the ſubject of the latter. Even of bodies themſelves we can ſay, that one is like or unlike another only by virtue of their qualities. A ball of ivory reſembles a ball of ſnow in its *figure* and *colour*, but not in its *coldneſs* or *hardneſs*; a ball of lead may reſemble a ball of ſnow in its *figure* and *coldneſs*, but not in its *colour*; and a cube of ivory reſembles not a ball of lead either in *figure*, *colour*, or *coldneſs*. The mind of a brute reſembles that of a man in its powers of *ſenſation* and *perception*, but does not reſemble it in the powers of *volition* and *reaſoning*; or at leaſt the reſemblance in this latter inſtance is very ſlight. All bodies reſemble one another in being ſolid and extended, and all minds in being more or leſs active. *Likeneſs* or *unlikeneſs* therefore is the univerſal characteriſtic of the category *quality*.

Ariſtotle has other ſpeculations reſpecting quality, which are worthy of notice. He diſtinguiſhes between qualities which are *eſſential*, and thoſe which are *accidental*; between qualities which are *natural*, and thoſe which are *acquired*; and he ſpeaks of the qualities of *capacity*, and thoſe of *completion*. *Extenſion* and *figure*, in *general*, are qualities eſſential to all bodies; but a *particular* extenſion, ſuch as an *inch* or an *ell*, and a *particular* figure, ſuch as a *cube* or a *ſphere*, are qualities accidental to bodies. Among the *natural* qualities of glaſs it is one to tranſmit objects of viſion; but to enlarge theſe objects is an *adventitious* or *acquired* quality. The ſame quality may be *natural* in one ſubſtance, as attraction in the magnet; and *acquired* in another, as the ſame attraction in the magnetic bar. *Docility* may be called a quality *natural* to the mind of man, ſcience an *acquired* one. To underſtand what he means by qualities of *capacity* and *completion*, it may be ſufficient to obſerve that every piece of iron has the qualities of a razor in *capacity*, becauſe it may be converted into ſteel, and formed into a razor: when it is ſo formed, it has, in the language of this ſage, the quality of a razor in *completion*. Among the qualities of *capacity* and *completion*, the moſt important, and what may lead to intereſting ſpeculations, is the reaſoning faculty of man. A *capacity* of reaſoning is eſſential to the human mind; but the *completion* of this capacity or *actual reaſoning* is not, otherwiſe *infants* and perſons *aſleep* would be excluded from the human ſpecies.

Mr. Locke has puzzled his readers, and perhaps himſelf, with a queſtion reſpecting the ſpecies of an idiot or changeling, whom he pronounces to be ſomething between a man and a brute. It is not often that we feel ourſelves inclined to regret Locke's ignorance of Ariſtotle's diſtinctions: but we cannot help thinking, that had the Britiſh philoſopher attended to the Stagyrite's account of qualities in *capacity* and qualities in *completion*, this perplexing queſtion would never have been ſtarted. It is juſtly obſerved in the *Eſſay on Human Underſtanding*, that of *real eſſences* we know nothing: but that every man ſelects a certain number of qualities which he has always perceived united in certain beings; and forming theſe into one complex conception, gives to this conception a *ſpecific* name, which he applies to every being in which he finds thoſe qualities united. This is undoubtedly the proceſs of the mind in forming genera and ſpecies; and as the excellent author refuſes the name of *man* to the changeling, it is obvious that the complex conception, to which he gives that name, muſt imply *rationality* or the *actual exerciſe* of reaſon. But this limitation will exclude many beings from the ſpecies *man*, whom Mr. Locke certainly conſidered as men and women. Not to mention infants and perſons in ſound ſleep, how ſhall we claſs thoſe who, after having lived 30 or 40 years in the full exerciſe of reaſon, have been ſuddenly or by degrees deprived of it by ſome diſorder in the brain?

> From Marlb'rough's eyes the ſtreams of dotage flow;
> And Swift expires a driveller and a ſhow.
>
> JOHNSON.

But were the hero and the wit in thoſe deplorable circumſtances excluded from the human ſpecies, and claſſed between men and brutes? No ſurely; they were both acknowledged to be men, becauſe they were known to have the quality of reaſon in what Ariſtotle would have called *capacity*. Their dotage and drivelling originated from ſome diſorder in their bodies, probably in the region of the brain; and Locke himſelf contends that no defect in body is ſufficient to degrade a perſon from the rank of manhood. Again, lunatics have the exerciſe of reaſon, except at new and full moon. Are theſe unhappy beings ſometimes men and ſometimes a ſpecies by themſelves between men and brutes?

It appears, therefore, that *not* the *actual exerciſe* of reaſon, but reaſon in *capacity*, ought to be included in the complex conception to which we give the ſpecific name of *man*, as ſome of the greateſt men that ever lived have been during parts of their lives deprived of the power of *actual reaſoning*. This, however, it will be ſaid, does not remove the difficulty; for the occaſional exerciſe of reaſon in lunatics, and the great exertions of it in ſuch men as Swift and Marlborough, ſhow that they had it in *capacity* at all times; whereas we have no evidence that changelings have even a *capacity* of reaſoning at any time, ſince they never do a rational action, nor ever utter a ſentence to the purpoſe. That we have no *direct* and *poſitive* evidence of the minds of changelings being capable of reaſoning, were they ſupplied with proper organs, muſt be granted; but the probabilities of their being ſo are many and great. We know by experience that the actual exerciſe of reaſon may be interrupted by an occaſional and accidental preſſure on the brain: and therefore we cannot doubt but that if this preſſure were rendered permanent by any wrong configuration of the ſkull given to it in the womb, or in the act of being born into the world, an infant, with a mind capable of reaſoning by means of proper organs, would by this accident be rendered, through the whole of life, an idiot or changeling. That idiotiſm is cauſed by ſuch accidents, and is not the quality of an inferior mind occaſionally given to a human body, will at leaſt ſeem probable from the following conſiderations.

It does not appear that an animal body can live and move but while it is actuated by ſome mind. Whence then does the unborn infant derive its mind? It muſt be either immediately from God, or *ex traduce* from its parents; but if the mind of man be immaterial, it cannot be *ex traduce*. Now, as idiots are very few in number when compared with the rational part of the human ſpecies, and as God in the government of this world acts not by partial but by general laws; we muſt conclude that the law which he has eſtabliſhed reſpecting the union of mind and matter, is, that human bodies ſhall be animated with minds endowed with a capacity of reaſoning, and that thoſe who never exert this capacity are prevented by ſome ſuch accident as we have aſſigned. See a further account of qualities under METAPHYSICS.

Chemical QUALITIES, thoſe qualities principally introduced by means of chemical experiments, as fumigation, amalgamation, cupellation, volatilization, precipitation, &c.

QUALITY, is alſo uſed for a kind of title given to certain perſons in regard of their territories, ſigniories, or other pretenſions.

QUANGA. See CAPRA.

QUANG PING-FOU, a city in China, is ſituated in the northern part of the province of Pe-tcheli, between the provinces of Chang-tong and Ho nan, and has nine cities of the third claſs dependent on it; all its plains are well watered by rivers. Among its temples there is one dedicated to thoſe men who, as the Chineſe pretend, diſcovered the ſecret of rendering themſelves immortal.

QUANGSI, a province of China, bounded on the north by Koe-Tcheau and Hu-Quang; on the eaſt, by Yunan and Quantong: on the ſouth, by the ſame and Tonquin; and on the weſt, by Yun-nan. It produces great plenty of rice, being watered by ſeveral large rivers. The ſouthern part is a flat country, and well cultivated; but the northern is full of mountains covered with trees. It contains mines of all ſorts; and there is a gold-mine lately opened. The capital town is Quie-ling. A very ſingular tree, ſays Groſier, grows in this province; inſtead of pith, it contains a ſoft pulp, which yields a kind of flour: the bread made of it is ſaid to be exceedingly good. Beſides paroquets, hedgehogs, porcupines, and rhinoceroſes, a prodigious number of wild animals, curious birds, and uncommon inſects, are found here. This province contains 12 villages of the firſt claſs, and 80 of the ſecond and third.

QUANG-TONG, a province of China, bounded on the eaſt by Kiang-ſi and Fokien; on the ſouth, by the ocean; and on the weſt, by Tonquin. This province is diverſified by valleys and mountains; and yields two crops of corn in a year. It abounds in gold, jewels, ſilk, pearls, tin, quickſilver, ſugar, braſs, iron, ſteel, ſalt-petre, ebony, and ſeveral ſorts of odoriferous wood; beſides fruits of all ſorts proper to the climate. They have a prodigious number of ducks, whoſe eggs they hatch in ovens; and a tree, whoſe wood is remarkably hard and heavy, and thence called *iron wood*. The mountains are covered with a ſort of oſiers which creep along the ground, and of which they make baſkets, hurdles, matts, and ropes. Although the climate of this province is warm, the air is pure, and the people are robuſt and healthy. They are very induſtrious; and it muſt be allowed that they poſſeſs in an eminent degree the talent of imitation; if they are only ſhown any of our European works, they execute others like them with the moſt ſurpriſing exactneſs. This province ſuffered much during the civil wars; but at preſent it is one of the moſt flouriſhing in the empire; and, as it is at a great diſtance from court, its government is one of the moſt important. This province is divided into ten diſtricts, which contain 10 cities of the firſt claſs, and [illegible]4 of the ſecond and third. Canton is the capital town.

QUANTITY, as explained by the great Engliſh lexicographer, is that property of any thing which may be increaſed or diminiſhed. This interpretation of the *word* is certainly juſt, and for the purpoſes of common converſation it is ſufficiently determinate; but the man of ſcience may expect to find in a work like ours a definition of the *thing* ſignified. This, however, cannot be given him. A logical definition conſiſts of the *genus* under which the thing defined is ranked, and the *ſpecific* difference (ſee LOGIC); but quantity is ranked under no genus. In that ſchool where ſuch definitions were moſt valued, it was conſidered as one of the ten *categories*, or general conceptions, under which all the objects of human apprehenſion were muſtered, like ſoldiers in an army (ſee CATEGORY and PHILOSOPHY). On this account, even Ariſtotle himſelf, who delighted in definitions, and was not eaſily deterred from a favourite purſuit, could not conſiſtently with his own rules attempt to define *quantity*. He characterizes it, however, in ſeveral parts of his works; and particularly in the 15th chapter of the 4th book of his Metaphyſics, where he gives the following account of the three firſt *categories*: Ταυτα μεν γαρ, ων μια ἡ ουσια· ὁμοια δ' ων ἡ ποιοτης μια· ισα δε, ων το ποσον εν. "Things are the *ſame*, of which the SUBSTANCE is one; *ſimilar*, of which the QUALITY is one; *equal*, of which the QUANTITY is one. Again, he tells us that the chief characteriſtic of quantity is, that it may be denominated *equal* and *unequal*

That any man can become wiſer by reading ſuch deſcriptions as theſe, none but an idolater of Ariſtotle will ſuppoſe. There is, indeed, no periphraſis by which we can explain what is meant by quantity to thoſe who have not previouſly formed ſuch a notion.—All that can be done by making the attempt is only to ſettle language, by ſtating exactly the caſes in which we uſe this word in the greateſt conformity to general cuſtom; for there is a laxneſs or careleſſneſs of expreſſion in the language of moſt men, and our notions are frequently communicated by ſpeech in a way by no means preciſe; ſo that it is often a great chance that the notions excited in the mind of the hearer are not exact counterparts of thoſe in the mind of the ſpeaker.

The underſtandings of men differ in nothing more remarkably than in their power of abſtraction, and of rapidly forming conceptions ſo general and ſimple as not to be clogged with diſtinguiſhing circumſtances, which may be different in different minds while uttering and hearing the ſame words: and it is of great conſequence to a man of ſcientific habits, either to cultivate, if poſſible, this talent, or to ſuperſede its uſe, by ſtudiouſly forming to himſelf notions of the moſt important *univerſals* in his own courſe of contemplation, by careful abſtraction of every thing extraneous His language by this means becomes doubly inſtructive by its extreme preciſion; and he will even judge with greater certainty of notions intended to be communicated by the more ſlovenly language of another perſon.

We cannot ſay that there is much ambiguity in the general uſe of the term *quantity*: But here, as in all other caſes, a love of refinement, of novelty, and frequently of vanity, and the wiſh of appearing ingenious and original, have made men take advantage of even the ſmall latitude with which the careleſs uſe of the word will furniſh them, to amuſe themſelves and the public by giving the appearance of ſcience to empty ſounds.

Mathematics is undoubtedly employed in diſcovering and ſtating many relations of quantity; and it is in this category alone that any thing is contemplated by the mathematician, whether in geometry, arithmetic, or algebra. Hence mathematics has been called the ſcience of quantity. The ſimplicity of the object of the mathematician's contemplation, and unparalleled diſtinctneſs with which he can perceive its modifications, have enabled him to erect a body of ſcience, eminent not only for its certainty, but alſo for the great length to which he can carry his reaſonings without danger of error; and the intimate connection which this ſcience has with the arts of life, and the important ſervices which it has performed, have procured it a moſt reſpectable place in the circle of the ſciences. Ingenious men have availed themſelves of this pre-eminence of mathematics, and have endeavoured to procure reſpect for their diſquiſitions on other ſubjects, by preſenting them to the public as branches of mathematical ſcience, and therefore ſuſceptible of that accuracy and certainty, which are its peculiar boaſt. Our moral affections, our ſenſations, our intellectual powers, are all ſuſceptible of augmentation and diminution, are conceivable as greater and leſs when ſtated together, and are familiarly ſpoken of as admitting of degrees of compariſon. We are perfectly well underſtood when we ſay that one pain, heat, grief, kindneſs, is greater than another; and as this is the diſtinguiſhing characteriſtic of quantity, and as quantity is the ſubject of mathematical diſcuſſion, we ſuppoſe that theſe ſubjects may be treated mathematically. Accordingly, a very celebrated and excellent philoſopher (Dr. F. Hutchinſon), has ſaid, among many things of the ſame kind, that the greatneſs of a favour is in the direct compound ratio of the ſervice performed and the dignity of the performer, and the inverſe ratio of the merit and rank of the receiver; that the value of a character is in the compound ratio of the talents and virtue, &c.; and he has delivered a number of formal propoſitions on the moſt intereſting queſtions in morals, couched in this mathematical language, and even expreſſed by algebraic formulæ. But this is mere play, and conveys no inſtruction. We underſtand the words; they convey no abſurdity; and in as far as they have a ſenſe, we believe the propoſitions to be true. But they give no greater preciſion to our ſentiments than the more uſual expreſſions would do. If we attend cloſely to the meaning of any one of ſuch propoſitions, we ſhall find that it only expreſſes ſome vague and indiſtinct notions of degrees of thoſe emotions, ſentiments, or qualities, which would be juſt as well conceived by means of the expreſſions of ordinary language; and that it is only by a ſort of analogy or reſemblance that this mathematical language conveys any notions whatever of the ſubjects.

The object of contemplation to the mathematician is not whatever is ſuſceptible of greater and leſs, but what is meaſurable; and mathematics is not the ſcience of magnitude, in its moſt abſtracted and general acceptation, but of magnitude which can be meaſured. It is, indeed, the SCIENCE of MEASURE, and whatever is treated in the way of menſuration is treated mathematically. Now, in the diſcourſe of ordinary life and ordinary men, many things are called quantities which we cannot or *do not* meaſure. This is the caſe in the inſtances already given of the affections of the mind, pleaſure, pain, beauty, wiſdom, honour, &c. We do not ſay that they are incapable of meaſure; but we have not yet been able to meaſure them, nor do we think of meaſuring them when we ſpeak rationally and uſefully about them. We therefore do not conſider them mathematically; nor can we introduce mathematical preciſion into our diſcuſſions of theſe ſubjects till we can, and actually do, meaſure them. Perſons who are preciſe in their expreſſion will even avoid ſuch phraſes on theſe ſubjects as ſuppoſe, or ſtrictly expreſs, ſuch meaſurement. We ſhould be much embarraſſed how to anſwer the queſtion, How much pain does the tooth ache give you juſt now; and how much is it eaſier ſince yeſterday? Yet the anſwer (if we had a meaſure) would be as eaſy as to the queſtion, How many guineas did you win at cards? or how much land have you bought? Nay, though we ſay familiarly, "I know well how much ſuch a misfortune would affect you," and are underſtood when we ſay it, it would be awkward language to ſay, "I know well the quantity of your grief." It is vain, therefore, to expect mathematical preciſion in our diſcourſe or conceptions of quantities in the moſt abſtracted ſenſe. Such preciſion is confined to quantity which may be and is meaſured*. It is only trifling with the imagination when we employ mathematical language on ſubjects which have not this property.

It will therefore be of ſome ſervice in ſcience to diſcriminate quantities in this view; to point out what are ſuſceptible of meaſure, and what are not.

What is meaſuring? It is one of theſe two things: It is either finding out ſome known magnitude of the thing meaſured, which we can demonſtrate to be equal to it; or to find a known magnitude of it, which being taken ſo many times ſhall be equal to it. The geometer meaſures the contents of a parabolic ſpace when he exhibits a parallelogram of known dimenſions, and demonſtrates that this parallelogram is equal to the parabolic ſpace. In like manner, he meaſures the ſolid contents of an infinitely extended hyperbolic ſpindle, when he exhibits a cone of known dimenſions, and demonſtrates that three of theſe cones are equal to the ſpindle.

In this proceſs it will be found that he actually ſubdivides the quantity to be meaſured into parts of which it conſiſts, and ſtates theſe parts as actually making up the quantity, ſpecifying each, and aſſigning its boundaries. He goes on with it, piece by piece, demonſtrating the reſpective equalities as he goes along, till he has exhauſted the figure, or conſidered all its parts.—When he meaſures by means of a ſubmultiple, as when he ſhows the ſurface of a ſphere to be equal to four of its great circles, he ſtops, after having demonſtrated the equality of one of theſe circles to one part of the ſurface: then he demonſtrates that there are other three parts, each of which is preciſely equal to the one he has minutely conſidered. In this part of the proceſs he expreſſly aſſigns the whole ſurface into its diſtinct portions, of which he demonſtrates the equality.

But there is another kind of geometrical meaſurement which proceeds on a very different principle. The geometer conceives a certain individual portion of his figure, whether line, angle, ſurface, or ſolid, as known in reſpect to its dimenſions. He conceives this to be lifted from its place, and again laid down on the *adjoining* part of the figure, and that it is equal to the part which it now covers; and therefore that this part together with the firſt is double of the firſt: he lifts it again, and lays it down on the next adjoining part, and affirms that this, added to the two former, make up a quantity triple of the firſt. He goes on in this way, making ſimilar inferences, till he can demonſtrate that he has in this manner covered the whole figure by twenty applications, and that his moveable figure will cover no more; and he affirms that the figure is twenty times the part employed.

This mode is preciſely ſimilar to the manner of practical meaſurement in common life: we apply a foot-rule ſucceſſively to two lines, and find that 30 applications exhauſt the one, while it requires 35 to exhauſt the other. We ſay, therefore, that the one line is 30 and the other 35 feet long: and that theſe two lines are to each other in the ratio of 30 to 35. Having meaſured two ſhorter lines by a ſimilar application of a ſtick of an inch long 30 times to the one and 35 times to the other, we ſay that the ratio of the two firſt lines is the ſame with that of the two laſt. Euclid has taken this method of demonſtrating the fourth propoſition of the firſt book of his celebrated elements.

But all this proceſs is a fiction of the mind, and it is the fiction of an impoſſibility. It is even *inconceivable*, that is, we cannot in imagination make this application of one figure to another; and we preſume to ſay, that, if the elements of geometry cannot be demonſtrated in ſome other way, the ſcience has not that title to pure, abſtract, and infallible knowledge, which is uſually allowed it. We cannot *ſuppoſe* one of the triangles lifted and laid on the other, without ſuppoſing it ſomething different from a triangle *in abſtracto*. The *individuality* of ſuch a triangle conſiſts ſolely in its being in the preciſe place where it is, and in occupying *that* portion of ſpace. If we could diſtinctly conceive otherwiſe, we ſhould perceive that, when we have lifted the triangle from its place, and applied it to the other, it is gone from its former place, and that there is no longer a triangle *there*. This is inconceivable, and ſpace has always been acknowledged to be immoveable. There is therefore ſome logical defect in Euclid's demonſtration. We apprehend that he is labouring to demonſtrate, or rather illuſtrate, a ſimple apprehenſion. This indeed is the utmoſt that can be done in any demonſtration (ſee METAPHYSICS): but the mode by which he guides the mind to the apprehenſion of the truth of his fourth propoſition is not conſiſtent either with pure mathematics or with the laws of corporeal nature. The real proceſs as laid down by him, ſeems to be this. We ſuppoſe ſomething different from the abſtract triangle; ſome *thing* that, in conjunction with other properties, has the property of being triangular, with certain dimenſions of two of its ſides and the included angle. It has avowedly another property, not eſſential to, and not contained in, the abſtract notion of a triangle, viz. mobility. We alſo ſuppoſe it permanent in ſhape and dimenſions, or that although, *during* its motion, it does not occupy *the ſame ſpace*, it continues, and all its parts, to occupy *an equal ſpace*. In ſhort, our conception is very mixed, and does not perceptibly differ from our conception of a triangular piece of matter, where the triangle is not the ſubject, but an adjunct, a quality. And when we ſuppoſe the application made, we are not in fact ſuppoſing two abſtract triangles to coincide. This we cannot do with any thing like diſtinctneſs; for our diſtinct conception now is, not that of two triangles coinciding, but of one triangle being now exactly occupied by that moveable thing which formerly occupied the other. In ſhort, it is a vulgar meaſurement, reſtricted by ſuppoſitions which are inadmiſſible in all *actual* meaſurements in the preſent univerſe, in which no moveable material thing is *known* to be permanent, either in ſhape or magnitude.

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* To talk intelligibly of the quantity of a pain, we ſhould have ſome ſtandard by which to meaſure it; ſome known degree of it ſo well aſcertained, that all men, when talking of it, ſhould mean the ſame thing.—And we ſhould be able to compare other degrees of pain with this, ſo as to perceive diſtinctly, not only whether they exceed or fall ſhort of it, but alſo how much, or in what proportion; whether by a half, or a fifth, or a tenth. *Reid.*

This is an undeniable conſequence of the principle of univerſal gravitation, and the compreſſibility of every kind of tangible matter with which we are acquainted. Remove the braſs rule but one inch from its place; its gravitation to the earth and to the reſt of the univerſe is immediately changed, and its dimenſions change of conſequence. A change of temperature will produce a ſimilar effect; and this is attended to and conſidered in all nice menſurations. We do the beſt we can to aſſure ourſelves that our rule always occupies a ſenſibly equal ſpace; and we muſt be contented with chances of error which we can neither perceive nor remove.

We might (were this a proper place) take notice of ſome other logical defects in the reaſoning of this celebrated propoſition: but they are beſide our preſent purpoſe of explaining the different modes of mathematical meaſurement, with the view of diſcovering that circumſtance in which they all agree, and which (if the only one) muſt therefore be the characteriſtic of menſuration.

We think that the only circumſtance in which all modes of menſuration agree, or the only notion that is found in them all, is, that the quantity is conceived as conſiſting of parts, diſtinguiſhable from each other, and ſeparated by aſſignable boundaries; ſo that they are at once conceived ſeparately and jointly. We venture to aſſert that no quantity is directly meaſured which we cannot conceive in this way, and that ſuch quantities only are the immediate objects of mathematical contemplation, and ſhould be diſtinguiſhed by a generic name. Let them be called MATHEMATICAL QUANTITIES. EXTENSION, DURATION, NUMBER, and PROPORTION, have this characteriſtic, and they are the only quantities which have it. Any perſon will be convinced of the firſt aſſertion by attending to his own thoughts when contemplating theſe notions. He will find that he conceives every one of them as made up of its own parts, which are diſtinguiſhable from each other, and have aſſignable boundaries, and that it is only in conſequence of involving this conception that they can be added to or ſubtracted from each other; that they can be multiplied, divided, and conceived in any proportion to each other.

He may perhaps find conſiderable difficulty in acquiring perfectly diſtinct notions of the menſurability, and the accuracy of the modes of menſuration. He will find that the way in which he meaſures duration is very ſimilar to that in which he meaſures ſpace or extenſion. He does not know, or does not attend to, any thing which hinders the braſs foot-rule in his hand from continuing to occupy equal ſpaces during his uſe of it, in meaſuring the diſtance of two bodies. In like manner he ſelects an event which nature or art can repeat continually, and in which the circumſtances which contribute to its accompliſhment are invariably the ſame, or their variations and their effects are inſenſible. He concludes that it will always occupy an equal portion of time for its accompliſhment, or always laſt an equal time. Then, obſerving that, during the event whoſe duration he wiſhes to meaſure, this ſtandard event is accompliſhed $29\frac{1}{2}$ times, and that it is repeated $365\frac{1}{4}$ times during the accompliſhment of another event, he affirms that the durations of theſe are in the ratio of 29^{1} to $365\frac{1}{4}$. It is thus (and with the ſame logical defect as in the meaſuring a line by a braſs rod) that the aſtronomer meaſures the celeſtial revolutions by means of the rotation of the earth round its axis, or by the vibrations of a pendulum.

We are indebted for moſt of the preceding obſervations to Dr. Reid, the celebrated author of the Inquiry into the Human Mind on the Principles of Common Senſe, and of the Eſſays on the intellectual and active Powers of Man. He has publiſhed a diſſertation on this ſubject in the 45th volume of the Philoſophical Tranſactions, No. 489, which we recommend to our philoſophical readers as a performance eminent for preciſion and acuteneſs. If we preſume to differ from him in any trivial circumſtance, it is with that deference and reſpect which is due to his talents and his worth.

Dr. Reid juſtly obſerves, that as nothing has proportion which has not either extenſion, duration, or number, the characters of mathematical quantity may be reſtricted to theſe three. He calls them PROPER quantities, and all others he calls IMPROPER. We believe that in the utmoſt preciſion of the Engliſh language, this denomination is very appoſite, and that the word *quantity*, derived from *quantum*, always ſuppoſes meaſurement: But the word is frequently uſed in caſes where its originial is not kept in view, and we uſe other words as ſynonymous with it, when all menſuration, whether poſſible or not, is out of our thoughts. According to practice, therefore, the *jus et norma loquendi*, there ſeems to be no impropriety in giving this name, in our language at leaſt, to whatever can be conceived as great or little. There is no impropriety in ſaying that the pain occaſioned by the ſtone is greater than that of the tooth ache; and when we ſearch for the category to which the aſſertion may be referred, we cannot find any other than quantity. We may be allowed therefore to ſay, with almoſt all our ſcientific countrymen, that every thing is conceivable in reſpect of quantity which we can think or ſpeak of as greater and leſs; and that this notion is the characteriſtic of quantity as a genus, while meaſurableneſs is the characteriſtic of mathematical quantity as a ſpecies.

But do we not meaſure many quantities, and conſider them mathematically, which have not this characteriſtic of being made up of their own diſtinguiſhable parts? What elſe is the employment of the mechanician, when ſpeaking of velocities, forces, attractions, repulſions, magnetic influence, chemical affinity, &c. &c.? Are not theſe mathematical ſciences? And if the preciſion and certainty of mathematics ariſe from the nature of their ſpecific object, are not all the claims of the mechanician and phyſical aſtronomer ill founded pretenſions? Theſe queſtions require and deſerve a ſerious anſwer.

It is moſt certain that we conſider the notions which are expreſſed by theſe terms, velocity, force, denſity, and the like, as ſuſceptible of meaſure, and we conſider them mathematically.

Some of theſe terms are nothing but names for relations of meaſurable quantity, and only require a little reflection to ſhow themſelves ſuch. VELOCITY is one of theſe. It is only a name expreſſing a relation between the ſpace deſcribed by a moving body and the time which elapſes during its deſcription. Certain moderate rates of motion are familiar to us. What greatly exceeds this, ſuch as the flight of a bird when compared with our walking, excites our attention, and this exceſs gets a name. A motion not ſo rapid as we are familiar with, or as we wiſh, alſo gets a name; becauſe in this the exceſs or defect may intereſt us. We wiſh for the flight of the hawk: we chide the tardy pace of our meſſenger: but it is ſcientific curioſity which firſt conſiders this relation as a *ſeparate* object of contemplation, and the philoſopher muſt have a name for it. He has not formed a new one, but makes uſe of a word of common language, whoſe natural meaning is the combination of a great ſpace with a ſhort time. Having once appropriated it, in his ſcientific vocabulary, to this very general uſe, it loſes with him its true ſignification. Tardity would have done juſt as well, though its true meaning is diametrically oppoſite: and there is no greater impropriety in ſaying the tardity of a cannon bullet than in ſaying the velocity of the hour-hand of a watch. Velocity is a quality or affection of motion, the notion of which includes the notions of ſpace and duration (two mathematical quantities), and no other. It does not therefore expreſs a mathematical quantity itſelf, but a relation, a combination of two mathematical quantities of different kinds; and as it is meaſurable in the quantities ſo combined, its meaſure muſt be a unit of its own kind, that is, an unit of ſpace *as combined* with an unit of time.

DENSITY is another word of the ſame kind, expreſſing a combination of ſpace with number. *Denſæ arbores* means trees ſtanding at a ſmall diſtance from each other; and the word is uſed in the ſame ſenſe when we ſay that quickſilver is denſer than water. The expreſſion always ſuggeſts to the reflecting mind the notions of particles and their diſtances. We are indeed ſo habituated to complicated views of things, that we can ſee remote connections with aſtoniſhing rapidity; and a very few circumſtances are ſufficient for leading forward the mind in a train of inveſtigation. Common diſcourſe is a moſt wonderful inſtance of this. It is in this way that we ſay, that we found by weighing them that inflammable air had not the ſixth part of the denſity of common air. Suppoſing all matter to conſiſt of equal atoms equally heavy, and knowing that the weight of a bladder of air is the ſum of the weights of all the atoms, and alſo knowing that the *vicinity* of the atoms is in a certain proportion of the *number* contained in a given bulk, we affirm that common air is more than ſix times denſer than inflammable air; but this rapid deciſion is entirely the effect of habit, which makes us familiar with certain groups of conceptions, and we inſtantaneouſly diſtinguiſh them from others, and thus think and diſcourſe rationally. The Latin language employs the word *frequens* to expreſs both the combination of ſpace and number, and that of time and number.

There are perhaps a few more words which expreſs combinations of mathematical quantities of different kinds; and the correſponding ideas or notions are therefore proper and immediate ſubjects of mathematical diſcuſſion: But there are many words which are expreſſive of things, or at leaſt of notions, to which this way of conſidering them will not apply. All thoſe affections or qualities of external bodies, by which they are conceived to act on each other, are of this kind: IMPULSIVE FORCE, WEIGHT, CENTRIPETAL AND CENTRIFUGAL FORCE, MAGNETICAL, ELECTRICAL, CHEMICAL ATTRACTIONS AND REPULSIONS; in ſhort, all that we conſider as the immediate cauſes of natural phenomena. Theſe we familiarly meaſure, and conſider mathematically.

What was ſaid on this ſubject in the article PHYSICS will give us clear conceptions of this proceſs of the mind. Theſe forces or cauſes are not immediate objects of contemplation, and are known only *by* and *in* the phenomena which we conſider as their effects. The phenomenon is not only the indication of the agency of any cauſe, and the characteriſtic of its kind, but the meaſure of its degree. The neceſſary circumſtances in this *train of human thought* are, 1ſt, The notion of the force as ſomething ſuſceptible of augmentation and diminution. 2d, The notion of an inſeparable connection of the force with the effect produced, and of every degree of the one with a correſponding degree of the other. From theſe is formed the notion that the phenomenon or effect is the proper meaſure of the force or cauſe. All this is ſtrictly logical.

But when we are conſidering theſe ſubjects mathematically, the immediate objects of our contemplation are not the forces which we are thus treating. It is not their relations which we perceive, and which we combine with ſuch complication of circumſtances and certainty of inference as are unknown in all other ſciences: by no means; they are the phenomena only, which are ſubjects of purely mathematical diſcuſſion. They are motions which involve only the notions of ſpace and time; and when we have finiſhed an accurate mathematical inveſtigation, and make our affirmation concerning the forces, we are certain of its truth, becauſe we *ſuppoſe* the forces to have the proportions and relations, and no other, which we obſerve in the phenomena. Thus, after having demonſtrated, by the geometrical compariſon of the lines and angles and ſurfaces of an ellipſe, that the momentary deflection of the moon from the tangent of her orbit is the 3600th part of the ſimultaneous deflection of a ſtone from the tangent of its parabolic path, Newton affirms, that the force by which a particle of the moon is retained in her orbit is the 3600th part of the weight of a particle of the ſtone; and having further ſhown, from fact and obſervation, that theſe momentary deflections are inverſely as the ſquares of the diſtances from the centre of the earth, he affirms, that all this is produced by a force which varies its intenſity in this manner.

Now all this inveſtigation proceeds on the two ſuppoſitions mentioned above, and the meaſures of the forces are in fact the meaſures of the phenomena. The whole of phyſical aſtronomy, and indeed the whole of mechanical philoſophy, might be taught and underſtood, without ever introducing the word force, or the notion which it is ſuppoſed to expreſs; for our mathematical reaſonings are really about the phenomena, which are ſubjects purely mathematical.

The preciſion, therefore, that we preſume to affirm to attend theſe inveſtigations, ariſes entirely from the meaſurable nature of the quantities which are the real objects of our contemplation, and the ſuitableneſs and propriety of the meaſures which we adopt in our compariſons.

Since, then, the phenomena are the *immediate* ſubjects of our diſcuſſion, and the operating powers are only inferences from the phenomena conſidered as effects, the quantity aſcribed to them muſt alſo be an inference from the quantity of the effect, or of ſome circumſtance in the effect. The meaſure, therefore, of the cauſe, or natural power or force, cannot be one of its own parts; for the whole and the part are equally unperceived by us. Our meaſure, therefore, muſt be a meaſure of ſome intereſting part, or of the only intereſting part of the phenomenon. It is therefore in a manner arbitrary, and depends chiefly on the intereſt we take in the phenomenon. It muſt, however, be ſettled with preciſion, ſo that all men in uſing it may mean the ſame thing. It muſt be ſettled, therefore, by the deſcription of that part or circumſtance of the phenomenon which is characteriſtic of the natural power. This deſcription is the *definition* of the meaſure.

Thus Newton aſſumes as his meaſure of the centripetal force, the momentary deviation from uniform rectilineal motion. Others, and ſometimes Newton himſelf, aſſume the momentary change of velocity, which again is meaſured by *twice this deviation.* Theſe meaſures, being thus ſelected, are always proper in a mathematical ſenſe; and if ſtrictly adhered to, can never lead us into any paralogiſm. They may, however, be phyſically wrong: there may not be that indiſſoluble connection between the phenomenon and the ſuppoſed cauſe. But this is no mathematical error, nor does it invalidate any of our mathematical inferences: it only makes them uſeleſs for explaining the phenomenon by the principle which we adopted; but it prepares a modification, of the phenomenon, for ſome more fortunate application of phyſical principles.

All that can be deſired in the definitions or deſcriptions of theſe meaſures is, that they may not deviate from the ordinary uſe of the terms, becauſe this would always create confuſion, and occaſion miſtakes. Dr. Reid has given an example of an impropriety of this kind, which has been the ſubject of much debate among the writers on natural philoſophy. We mean the meaſure of the force inherent in a body in motion. Deſcartes, and all the writers of his time, aſſumed the velocity produced in a body as the meaſure of the force which produces it; and obſerving that a body, in conſequence of its being in motion, produces changes in the ſtate or motion of other bodies, and that theſe changes are in the proportion of the velocity of the changing body, they aſſerted that there is in a moving body a VIS INSITA, an INHERENT FORCE, and that this is proportional to its velocity; ſaying that its force is twice or thrice as great, when it moves twice or thrice as faſt at one time as at another. But Leibnitz obſerved, that a body which moves twice as faſt, riſes four times as high, againſt the uniform action of gravity; that it penetrates four times as deep into a piece of uniform clay; that it bends four times as many ſprings, or a ſpring four times as ſtrong to the ſame degree; and produces a great many effects which are four times greater than thoſe produced by a body which has half the initial velocity. If the velocity be triple, quadruple, &c. the effects are nine times, 16 times, &c. greater; and, in ſhort. are proportional, not to the velocity, but to its ſquare. This obſervation had been made before by Dr. Hooke, who has enumerated a prodigious variety of important caſes in which this proportion of effect is obſerved. Leibnitz, therefore, affirmed that the force inherent in a moving body is proportional to the ſquare of the velocity.

It is evident that a body, moving with the ſame velocity, has the ſame inherent force, whether this be employed to move another body, to bend ſprings, to riſe in oppoſition to gravity, or to penetrate a maſs of ſoft matter. Therefore theſe meaſures, which are ſo widely different, while each is agreeable to a numerous claſs of facts, are not meaſures of this ſomething inherent in the moving body which we call its force, but are the meaſures of its exertions when modified according to the circumſtances of the caſe; or, to ſpeak ſtill more cautiouſly and ſecurely, they are the meaſures of certain claſſes of phenomena conſequent on the action of a moving body. It is in vain, therefore, to attempt to ſupport either of them by a demonſtration. The meaſure itſelf is nothing but a definition. The Carteſian calls that a double force which produces a double velocity in the body on which it acts. The Leibnitzian calls that a quadruple force which makes a quadruple penetration. The reaſonings of both in the demonſtration of a propoſition in dynamics may be the ſame, as alſo the reſult, though expreſſed in different numbers.

But the two meaſures are far from being equally proper: for the Leibnitzian meaſure obliges us to do continual violence to the common uſe of words. When two bodies moving in oppoſite directions meet, ſtrike each other, and ſtop, all men will ſay that their forces are equal, becauſe they have the beſt teſt of equality which we can deviſe. Or when two bodies in motion ſtrike the parts of a machine, ſuch as the oppoſite arms of a lever, and are thus brought completely to reſt, we and all men will pronounce their mutual energies by the intervention of the machine to be equal. Now, in all theſe caſes, it is well known that a perfect equality is found in the products of the quantities of matter and velocity. Thus a ball of two pounds, moving with the velocity of four feet in a ſecond, will ſtop a ball of eight pounds moving with the velocity of one foot per ſecond. But the followers of Leibnitz ſay, that the force of the firſt ball is four times that of the ſecond.

All parties are agreed in calling gravity an uniform or invariable accelerating force; and the definition which they give of ſuch a force is, that it always produces the ſame acceleration, that is, equal accelerations in equal times, and *therefore* produces augmentations of velocity proportionable to the times in which they are produced. The only effect aſcribed to this force, and conſequently the only thing which indicates, characteriſes, and meaſures it, is the augmentation of velocity. What is this velocity, conſidered not merely as a mathematical term, but as a phenomenon, as an event, a production by the operation of a natural cauſe? It cannot be conceived any other way than as a *determination* to move on for ever at a certain rate, if nothing ſhall change it. We cannot conceive this very clearly. We feel ourſelves forced to animate, as it were, the body, and give it not only a will and intention to move in this manner, but a real exertion of ſome faculty in conſequence of this determination of mind. We are conſcious of ſuch a train of operations in ourſelves; and the laſt ſtep of this train is the exertion or energy of ſome natural *faculty*, which we, in the utmoſt propriety of language, call force. By ſuch analogical conception we ſuppoſe a ſomething, an energy inherent in the moving body; and its only office is the production and continuation of this motion, as in our own caſe. Scientific curioſity was among our lateſt wants, and language was formed long before its appearance: as we formed analogical conceptions, we contented ourſelves with the words already familiar to us, and to this ſomething we gave the name FORCE, which expreſſed that energy in ourſelves which bears ſome reſemblance (in office at leaſt) to the determination of a body to move on at a certain rate. This ſort of allegory pervades the whole of our conceptions of natural operations, and we can hardly think or ſpeak of any operation without a language, which ſuppoſes the animation of matter. And, in the preſent caſe, there are ſo many points of reſemblance between the effects of our exertions and the operations of nature, that the language is moſt expreſſive, and has the ſtrongeſt appearance of propriety. By exerting our force, we not only move and keep in motion, but we move other bodies. Juſt ſo a ball not only moves, but puts other bodies in motion, or penetrates them, &c.—This is the origin of that conception which ſo forcibly obtrudes itſelf into our thoughts, that there is inherent in a moving body a force by which it produces changes in other bodies. No ſuch thing appears in the ſame body if it be not in motion. We therefore conclude, that it is the production of the moving force, whatever that has been. If ſo, it muſt be conceived as proportional to its producing cauſe. Now this force, thus produced or exerted in the moving body, is only another way of conceiving that determination which we call velocity, when it is conceived as a natural event. We can form no other notion of it. The *vis inſita*, the determination to move at a certain rate, and the velocity, are one and the ſame thing, conſidered in different relations.

Therefore the *vis inſita corpori moventi*, the determination to move at a certain rate, and the velocity, ſhould have one and the ſame meaſure, or any one of them may be taken for the meaſure of the other. The velocity being an object of perception, is therefore a proper meaſure of the inherent force; and the propriety is more evident by the perfect agreement of this uſe of the words with common language. For we conceive and expreſs the action of gravity as uniform, when we think and ſay that its effects are proportional to the times of its action. Now all agree, that the velocity produced by gravity is proportional to the time of its action. And thus the meaſure of force, in reference to its producing cauſe, perfectly agrees with its meaſure, independent of this conſideration.

But this agreement is totally loſt in the Leibnitzian doctrine; for the body which has fallen four times as far, and has ſuſtained the action of gravity twice as long, is ſaid to have four times the force.

The quaintneſs and continual paradox of expreſſion which this meaſure of inherent force leads us into, would have quickly exploded it, had it not been that its chief abettors were leagued in a keen and acrimonious warfare with the Britiſh mathematicians who ſupported the claim of Sir Iſaac Newton to the invention of fluxions. They rejoiced to find in the elegant writings of Huyghens a phyſical principle of great extent, ſuch as this is, which could be ſet in compariſon with ſome of the wonderful diſcoveries in Newton's Principia. The fact, that in the mutual actions of bodies on each other, the products of the maſſes and the ſquares of the velocities remain always the ſame (which they call the *conſervatio virium vivarum*), is of almoſt univerſal extent; and the knowledge of it enabled them to give ready and elegant ſolutions of the moſt abſtruſe and intricate problem, by which they acquired a great and deſerved celebrity. Dr. Robert Hooke, whoſe obſervation hardly any thing eſcaped, was the firſt (long before Huyghens) who remarked that in all the caſes of the gradual production and extinction of motion, the ſenſible phenomenon is proportional to the ſquare of the produced or extinguiſhed velocity.

John Bernoulli brought all theſe facts together and ſyſtematized them according to the principle advanced by Huyghens in his treatiſe on the centre of oſcillation. He and Daniel Bernoulli gave moſt beautiful ſpecimens of the prodigious uſe of this principle for the ſolution of difficult phyſical problems in their diſſertations on the motion and impulſe of fluids, and on the communication of motion. It was however very early objected to them (we think by Marquis Poleni), that in the colliſion of bodies perfectly hard there was no ſuch *conſervatio virium vivarum*; and that, in this caſe, the forces muſt be acknowledged to be proportional to the velocities. The objections were unanſwerable.—But John Bernoulli evaded their force, by affirming that there were and could be no bodies perfectly hard. This was the origin of another celebrated doctrine, on which Leibnitz greatly plumed himſelf, THE LAW OF CONTINUITY, viz. that nothing is obſerved to change abruptly, or *per ſaltum*. But no one will pretend to ſay that a perfectly hard body is an inconceivable thing; on the contrary, all will allow that ſoftneſs and compreſſibility are adjunct ideas, and not in the leaſt neceſſary to the conception of a particle of matter, nay totally incompatible with our notion of an ultimate atom.

Sir Iſaac Newton never could be provoked to engage in this diſpute: He always conſidered it as a wilful abuſe of words, and unworthy of his attention. He guarded againſt all poſſibility of cavil, by giving the moſt preciſe and perſpicuous definitions of thoſe meaſures of forces, and all other quantities which he had occaſion to conſider, and by carefully adhering to them. And in one propoſition of about 20 lines, viz. the 39th of the 1ſt book of the Principia, he explained every phenomenon adduced in ſupport of the Leibnitzian doctrine, ſhowing them to be immediate conſequences of the action of a force meaſured by the velocity which it produces or extinguiſhes. There it appears that the heights to which bodies will riſe in oppoſition to the uniform action of gravity are as the ſquares of the initial velocities: So are the depths to which they will penetrate uniformly reſiſting matter: So is the number of equal ſprings which they will bend to the ſame degree, &c. &c. &c. We have had frequent occaſion to mention this propoſition as the moſt extenſively uſeful of all Newton's diſcoveries. It is this which gives the immediate application of mechanical principles to the explanation of natural phenomena. It is inceſſantly employed in every problem by the very perſons who hold by the other meaſures of forces, although ſuch conduct is virtually giving up that meaſure. They all adopt, in every inveſtigation, the two theorems $f\dot{t} = \dot{v}$, and $f\dot{s} = v\dot{v}$; both of which ſuppoſe an accelerating force f proportional to the velocity v which it produces by its uniform action during the time t, and the theorem $\int f\dot{s} = v^2$ is the 39th 1. Princip. and is the *conſervatio virium vivarum*.

This famous diſpute (the only one in the circle of mathematical ſcience) has led us ſomewhat aſide. But we have little more to remark with reſpect to meaſurable quantity. We cannot ſay what varieties of quantity are ſuſceptible of ſtrict meaſure, or that it is impoſſible to give accurate meaſures of every thing ſuſceptible of augmentation and diminution. We affirm, however, with confidence, that pain, pleaſure, joy, &c. are not made up of their own parts, which can be contemplated ſeparately; but they may chance to be aſſociated by nature with ſomething that is meaſurable; and we may one day be able to aſſign their degrees with as much preciſion as we now aſcertain the degrees of warmth by the expanſion of the fluid in the thermometer. There is one ſenſe in which they may all be meaſured, viz. numerically, as Newton meaſures denſity, *vis motrix*, &c. We can conceive the pain of each of a dozen men to be the ſame. Then it is evident that the pain of eight of theſe men is to that of the remaining four as two to one: but from ſuch menſuration we do not foreſee any benefit likely to ariſe.

QUANTITY, in grammar, an affection of a ſyllable, whereby its meaſure, or the time wherein it is pronounced, is aſcertained; or that which determines the ſyllable to be long or ſhort. Quantity is alſo the object of proſody, and diſtinguiſhes verſe from proſe; and the economy and arrangement of quantities, that is, the diſtribution of long and ſhort ſyllables, makes what we call the *number*. See POETRY. The quantities are uſed to be diſtinguiſhed, among grammarians, by the characters ⏑, ſhort, as pĕr; and –, long, as rōs. There is alſo a common, variable, or dubious quantity; that is, ſyllables that are one time taken for ſhort ones, and at another time for long ones; as the firſt ſyllable in *Atlas*, *patres*, &c.

QUARANTINE, is a trial which ſhips muſt undergo when ſuſpected of a peſtilential infection. "It may be ordered by the king, with advice of the privy-council, at ſuch times, and under ſuch regulations, as he judges proper. Ships ordered on quarantine muſt repair to the place appointed, and muſt continue there during the time preſcribed) generally ſix weeks); and muſt have no intercourſe with the ſhore, except for neceſſary proviſions, which are conveyed with every poſſible precaution. When the time is expired, and the goods opened and expoſed to the air as directed, if there be no appearance of infection they are admitted to port. Ships infected with the peſtilence muſt proceed to St. Helen's Pool in the Scilly iſlands, and give notice of their ſituation to the cuſtomhouſe officers, and wait till the king's pleaſure be known. Perſons giving falſe information to avoid performing quarantine, or refuſing to go to the place appointed, or eſcaping, alſo officers appointed to ſee quarantine performed, deſerting their office, neglecting their duty, or giving a falſe certificate, ſuffer death as felons. Goods from Turkey, or the Levant, may not be landed without licenſe from the king, or certificate that they have been landed and aired at ſome foreign port. See Plague.

QUARLES (Francis), ſon of James Quarles, clerk to the board of green cloth and purveyor to queen Elizabeth, was born in 1592. He was educated at Cambridge; became a member of Lincoln's inn; and was for ſome time cup-bearer to the Queen of Bohemia, and chronologer to the city of London. It was probably on the ruin of her affairs that he went to Ireland as ſecretary to archbiſhop Uſher; but the troubles in that kingdom forcing him to return, and not finding affairs more at peace in England, ſome diſquiets he met with were thought to have haſtened his death, which happened in 1644. His works both in proſe and verſe are numerous, and were formerly in great eſteem, particularly his Divine Emblems: but the obſolete quaintneſs of his ſtyle has cauſed them to fall into neglect, excepting among particular claſſes of readers. "The memory of Quarles," ſays a late author, "has been branded with more than common abuſe, and he ſeems to have been cenſured merely from the want of being read. If his poetry failed to gain him friends and readers, his piety ſhould at leaſt have ſecured him peace and good-will. He too often, no doubt, miſtook the enthuſiaſm of devotion for the inſpiration of fancy; to mix the waters of Jordan and Helicon in the ſame cup, was reſerved for the hand of Milton; and for him, and him only, to find the bays of Mount Olivet equally verdant with thoſe of Parnaſſus. Yet, as the effuſions of a real poetical mind, however thwarted by untowardneſs of ſubject, will be ſeldom rendered totally abortive, we find in Quarles original imagery, ſtriking ſentiment, fertility of expreſſion, and happy combinations; together with a compreſſion of ſtyle that merits the obſervation of the writers of verſe. Groſs deficiencies of judgment, and the infelicity of his ſubjects, concurred in ruining him. Perhaps no circumſtance whatever can give a more complete idea of Quarles's degradation than a late edition of his Emblems; the following paſſage is extracted from the preface: 'Mr. Francis Quarles, the author of the Emblems that go under his name, was a man of the moſt exemplary piety, and had a deep inſight into the myſteries of our holy religion. But, for all that, the book itſelf is written in ſo old a language, that many parts of it are ſcarce intelligible in the preſent age; many of his phraſes are ſo affected, that no perſon, who has any taſte for reading, can peruſe them with the leaſt degree of pleaſure; many of his expreſſions are harſh, and ſometimes whole lines are included in a parentheſis, by which the mind of the reader is diverted from the principal object. His Latin mottos under each cut can be of no ſervice to an ordinary reader, becauſe he cannot underſtand them. In order, therefore, to accommodate the public with an edition of Quarles's Emblems properly moderniſed, this work was undertaken.' Such an exhibition of Quarles is chaining Columbus to an oar, or making John Duke of Marlborough a train-band corporal." *Headley*.

QUARRIES, a name commonly given to a moſt extraordinary cavern under the city of Paris, the exiſtence of which is known to few even of the inhabitants, and many of thoſe who have heard of it conſider the whole as an idle ſtory. Mr. White, however, who viſited it in 1784, puts the matter beyond a doubt; having, with many others, obtained leave (which was very cautiouſly granted) to inſpect it. The account he gives of it may be ſeen in the ſecond volume of the Mancheſter Tranſactions.

Of its origin Mr. White could not learn any thing ſatisfactory: the only account publiſhed is the following, contained in the *Tableau de Paris, nouvelle edition, tome premier, chapitre 5me, page 12me.*

"For the firſt building of Paris it was neceſſary to get the ſtone in the environs; and the conſumption of it was very conſiderable. As Paris was enlarged, the ſuburbs were inſenſibly built on the ancient quarries, ſo that all you ſee without is eſſentially wanting in the earth for the foundation of the city: hence proceed the frightful cavities which are at this time found under the houſes in ſeveral quarters. They ſtand upon abyſſes. It would not require a very violent ſhock to throw back the ſtones to the place from whence they have been raiſed with ſo much difficulty. Eight men being ſwallowed up in a gulph 150 feet deep, and ſome other leſs known accidents, excited at length the vigilance of the police and the government, and, in fact, the buildings of ſeveral quarters have been privately propped up; and by this means a ſupport given to theſe obſcure ſubterraneous places which they before wanted.

"All the ſuburbs of St. James's, Harp-ſtreet, and even the ſtreet of Tournon, ſtand upon the ancient quarries; and pillars have been erected to ſupport the weight of the houſes. What a ſubject for reflections, in conſidering this great city formed and ſupported by means abſolutely contrary! Theſe towers, theſe ſteeples, the arched roofs of theſe temples, are ſo many ſigns to tell the eye that what we now ſee in the air is wanting under our feet."

QUARRY, a place under ground, out of which are got marble, freeſtone, ſlate, limeſtone, or other matters proper for building. See Strata. Some limeſtone quarries in Fife are highly worthy the attention of the curious, on account of an amazing mixture of marine bodies found in them. One of this kind was opened about the year 1759, at a farm called *Enderteel*, in the neighbourhood of Kirkaldy, belonging to General St. Clair.

The flakes of the ſtone, which are of unequal thickneſs, moſt of them from eight to ten inches, lie horizontally, dipping towards the ſea. Each of theſe flakes, when broken, preſents to our view an amazing collection of petrified ſea bodies, as the bones of fiſhes, ſtalks of ſea-weed, vaſt quantities of ſhells, ſuch as are commonly found on thoſe coaſts, beſides ſeveral others of very uncommon figures. In ſome places the ſhells are ſo numerous, that little elſe is to be ſeen but prodigious cluſters or concretions of them. In the uppermoſt ſtratum the ſhells are ſo entire, that the outer cruſt or plate may be ſcraped off with the finger; and the ſtalks of the ſea-weed have a darkiſh colour, not that gloſſy whiteneſs which they have in the heart of the quarry. The ſmalleſt rays or veins of the ſhells are deeply indented on the ſtone, like the impreſſion of a ſeal upon wax. In ſhort, no ſpot at the bottom of the ocean could exhibit a greater quantity of ſea-bodies than are to be found in this ſolid rock; for we have the ſkeletons of ſeveral fiſhes, the *antennæ* or feelers of lobſters, the roots and ſtalks of ſea-weeds, with the very *capſulæ* which contain the ſeed. The place where all theſe curioſities are found is on an eminence about an Engliſh mile from the ſea; and as the ground is pretty ſteep the whole way, it may be 200 feet higher at leaſt.

There are two or three things to be remarked here. 1. That among all the bodies we have mentioned, there are none but what are ſpecifically heavier than water. This holds ſo conſtantly true, that the ſea-weed, which floats in water when the plant is entire, has been ſtripped of the broad leaves, which make it buoyant, before it has been lodged here. 2. The ſhells have been all empty; for the double ones, as thoſe of the flat kind, are always found ſingle, or with one ſide only. 3. The rock ſeems to have been gradually deſerted by the ſea, and for a long time waſhed with the tides: for the upper ſurface is all eaten, and hollowed in many places like a honey-comb, juſt as we obſerve in flat rocks expoſed every tide to the acceſs and receſs of the waters. See the article Sea.

Quarry, or *Quarrel*, among glaziers, a pane of glaſs cut in a diamond form. Quarries are of two kinds, ſquare and long; each of which are of different ſizes, expreſſed by the number of the pieces that make a foot of glaſs, viz. eighths, tenths, eighteenths, and twentieths: but all the ſizes are cut to the ſame angles, the acute angle in the ſquare quarrels being 77° 19′, and 67° 21′ in the long ones.

Quarry, among hunters, is ſometimes uſed for a part of the entrails of the beaſt taken, given by way of reward to the hounds.

Quarry, in falconry, is the game which the hawk is in purſuit of, or has killed.

QUARTAN, a meaſure containing the fourth part of ſome other meaſure.

Quartan, a ſpecies of intermitting fever. See Medicine.

QUARTATION, is an operation by which the quantity of one thing is made equal to a fourth part of the quantity of another thing. Thus, when gold allayed with ſilver is to be parted, we are obliged to facilitate the action of the aqua-fortis, by reducing the quantity of the former of theſe metals to one fourth part of the whole maſs: which is done by ſufficiently increaſing the quantity of the ſilver, if it be neceſſary. This operation is called *quartation*, and is preparatory to the parting; and even many authors extend this name to the operation of parting. See the article Parting.

QUARTER, the fourth part of any thing, the fractional expreſſion for which is $\frac{1}{4}$.

Quarter, in weights, is generally uſed for the fourth part of a hundred weight avoirdupois, or 28 lb. Uſed as the name of a dry meaſure, *quarter* is the fourth part of a ton in weight, or eight buſhels.

Quarter, a term in the manege. To work from quarter to quarter, is to ride a horſe three times in upon the firſt of the four lines of a ſquare; then changing your hand, to ride him three times upon the ſecond: and ſo to the third and fourth; always changing hands, and obſerving the ſame order.

Quarters, with reſpect to the parts of a horſe, is uſed in various ſenſes: thus, the ſhoulders and fore-legs are called the *fore quarters*, and the hips and hinder-legs the *hind-quarters*. The *quarters* of a horſe's foot are the ſides of the coffin, comprehending between the toe and the heel: the *inner* quarters are thoſe oppoſite to one another, facing from one foot to the other; and theſe are always weaker than the *outſide* quarters, which lie on the external ſides of the coffin. *Falſe quarters*, are a cleft in the horn of a horſe's hoof, extending from the coronet to the ſhoe. A horſe is ſaid to be *quarter-caſt*, when for any diſorder in the coffin we are obliged to cut one of the quarters of the hoof.

Quarter, in aſtronomy, the fourth part of the moon's period: thus, from the new moon to the quadrature is the firſt quarter; from this to full moon, the ſecond quarter, &c.

Quarter, in heraldry, is applied to the parts or members of the firſt diviſion of a coat that is quartered, or divided into four quarters.

Franc-Quarter, in heraldry, is a quarter ſingle or alone; which is to poſſeſs one fourth part of the field. It makes one of the honourable ordinaries of a coat.

Quarter *of a Ship*, that part of a ſhip's ſide which lies towards the ſtern; or which is comprehended between the aftmoſt end of the main chains and the ſides of the ſtern, where it is terminated by the quarter-pieces. Although the lines by which the quarter and bow of a ſhip, with reſpect to her length, are divided, are only imaginary, yet experience appears to have aſcertained their limits: ſo that, if we were to divide the ſhip's ſides into five equal portions, the names of each ſpace would be readily enough expreſſed. Thus, the firſt, from the ſtern, would be the quarter; the ſecond, abaft the midſhips; the third, the midſhips; the fourth, before midſhips; and the fifth, the bow. Whether theſe diviſions, which in reality are ſomewhat arbitrary, are altogether improper, may be readily diſcovered by referring to the mutual ſituation or approach of two adjacent veſſels. The enemy boarded us on the larboard ſide! Whereabouts? Abaft the midſhips, before the midſhips, &c.

Plate 38. fig. 1. repreſents a geometrical elevation of a quarter of a 74 gun ſhip. A the keel, with *a* the falſe keel beneath it. B the ſtern-poſt. DD the quarter-gallery, with its balluſtrades and windows. EE the quarter-pieces, which limit and form the outlines of the ſtern. F the taffarel, or upper pieces of the ſtern. FG the profile of the ſtern, with its galleries. H the gun-ports of the lower-deck; *h* the gun-ports of the upper and quarter-deck. I the after-part of the mizen-channel. K the wing-tranſom. KG the lower counter. LB the ſtation of the deck-tranſom. LQ the after-part of the main-wale. DR the after-part of the channel-wale, parallel to the main-wale. SU the ſheer-rail, parallel to both wales. T *t* the rudder. A *t* F the rake of the ſtern. P *i i* the drift-rails. TU the after-part of the load *water-line*; *k k l* the curve of the ſeveral decks correſponding to thoſe repreſented in the head. See the article Head.

As the marks, by which veſſels of different conſtructions are diſtinguiſhed from each other, are generally more conſpicuous on the ſtern or quarter than any other part, we have repreſented ſome of the quarters, which aſſume the moſt different ſhapes, and form the greateſt contraſt with each other. Fig. 2. ſhows the ſtern and quarter of a Dutch flight. Fig. 3. the ſtern and quarter of a cat. Fig. 4. is the ſtern and quarter of a common galley. Fig. 5. exhibits the quarter of a firſt-rate galley, otherwiſe called a *galleaſſe*. Fig. 6. the quarter of a Dutch dogger, or galliot. Fig. 7. repreſents the ſtern and quarter of a ſloop of war.

The quarters of all other ſhips have a near affinity to thoſe above exhibited. Thus, all ſhips of the line, and Eaſt-India-men, are formed with a quarter little differing from the principal figure in this plate. Xebecs have quarters nearly reſembling thoſe of galleaſſes, only ſomewhat higher. Hagboats and pinks approach the figure of *cats*, the former being a little broader in the ſtern, and the latter a little narrower; and the ſterns and quarters of cats ſeem to be derived from thoſe of fly boats. The ſterns of Dutch doggers and galliots are indeed ſingular, and like thoſe of no other modern veſſel: they have nevertheleſs a great reſemblance to the ſhips of the ancient Grecians, as repreſented in medals and other monuments of antiquity.

On the QUARTER, may be defined an arch of the horizon, contained between the line prolonged from the ſhip's ſtern and any diſtant object, as land, ſhips, &c. Thus, if the ſhip's keel lies on an eaſt and weſt line, the ſtern being weſtward, any diſtant object perceived on the north-weſt or ſouth-weſt is ſaid to be on the larboard or ſtarboard quarter.

QUARTER-*Bill*, a roll, or liſt, containing the different ſtations, to which all the officers and crew of the ſhip are quartered in the time of battle, and the names of all the perſons appointed to thoſe ſtations. See QUARTERS.

QUARTER-*Maſter*, is an officer, generally a lieutenant, whoſe principal buſineſs is to look after the quarters of the ſoldiers, their clothing, bread, ammunition, firing, &c. Every regiment of foot and artillery has a quarter-maſter, and every troop of horſe one, who are only warrant-officers, except in the Blues.

QUARTER-*Maſter-General*, is a conſiderable officer in the army; and ſhould be a man of great judgment and experience, and well-ſkilled in geography. His duty is to mark the marches and encampments of an army: he ſhould know the country perfectly well, with its rivers, plains, marſhes, woods, mountains, defiles, paſſages, &c. even to the ſmalleſt brook. Prior to a march he receives the order and route from the commanding general, and appoints a place for the quarter-maſters of the army to meet him next morning, with whom he marches to the next camp; where being come, and having viewed the ground, he marks out to the regimental quarter-maſters the ground allowed each regiment for their camp: he chooſes the head quarters, and appoints the villages for the generals of the army's quarters: he appoints a proper place for the encampment of the train of artillery: he conducts foraging parties, as likewiſe the troops to cover them againſt aſſaults, and has a ſhare in regulating the winter quarters and cantonments.

QUARTER-*Netting*, a ſort of net-work, extended along the rails on the upper part of a ſhip's quarter. In a ſhip of war theſe are always double, being ſupported by iron cranes, placed at proper diſtances. The interval is ſometimes filled with cork, or old ſails; but chiefly with the hammocks of the ſailors, ſo as to form a parapet to prevent the execution of the enemy's ſmall arms in battle.

QUARTER-*Seſſions*, a general court held quarterly by the juſtices of peace of each county. This court is appointed by ſtat. 2 Hen. V. c. 4. to be in the firſt week after Michaelmas-day; the firſt week after the Epiphany; the firſt week after the cloſe of Eaſter; and in the week after the tranſlation of Saint Thomas a Becket, or the 7th of July. This court is held before two or more juſtices of the peace, one of whom muſt be of the *quorum*. The juriſdiction of this court by 34 Ed. III. c. 1. extends to the trying and determining of all felonies and treſpaſſes whatſoever, though they ſeldom, if ever, try any greater offence than ſmall felonies within the benefit of clergy, their commiſſion providing, that if any caſe of difficulty ariſes, they ſhall not proceed to judgment but in the preſence of one of the juſtices of the courts of king's bench or common pleas, or one of the judges of aſſize. And therefore murderers and other capital felons are uſually remitted for a more ſolemn trial to the aſſizes. They cannot alſo try any new-created offence, without expreſs power given them by the ſtatute which creates it. But there are many offences, and particular matters, which by particular ſtatutes belong properly to this juriſdiction, and ought to be proſecuted in this court; as, the ſmaller miſdemeanors againſt the public or commonwealth, not amounting to felony, and eſpecially offences relating to the game, highways, alehouſes, baſtard children, the ſettlement and proviſion for the poor, vagrants, ſervants wages, apprentices, and popiſh recuſants. Some of theſe are proceeded upon by indictment, and others in a ſummary way by motion and order thereupon; which order may, for the moſt part, unleſs guarded againſt by particular ſtatutes, be removed into the court of king's bench by writ of *certiorari facias*, and be there either quaſhed or confirmed. The records or rolls of the ſeſſions are committed to the cuſtody of a ſpecial officer, denominated the *cuſtos rotulorum*. In moſt corporation towns there are quarter-ſeſſions kept before juſtices of their own, within their reſpective limits, which have exactly the ſame authority as the general quarter-ſeſſions of the county, except in very few inſtances: one of the moſt conſiderable of which is the matter of appeals from orders of removal of the poor, which, though they be from the orders of corporation juſtices, muſt be to the ſeſſions of the county, by 8 and 9 Will. III. c. 30. In both corporations and counties at large, there is ſometimes kept a ſpecial or petty ſeſſion, by a few juſtices, for diſpatching ſmaller buſineſs in the neighbourhood between the times of the general ſeſſions, as for licenſing alehouſes, paſſing the accounts of pariſh-officers, and the like.

QUARTER-*Staff*, a long ſtaff borne by foreſters, park-keepers, &c. as a badge of their office, and occaſionally uſed as a weapon.

QUARTERS, a name given at ſea to the ſeveral ſtations where the officers and crew of a ſhip of war are poſted in action.

The number of men appointed to manage the artillery is always in proportion to the nature of the guns, and the number and condition of the ſhip's crew. They are, in general, as follow, when the ſhip is well manned, ſo as to fight both ſides at once occaſionally:

Pounder.		No. of men.	Pounder.		No. of men.
To a 42	-	15	To a 9	-	6
32	-	13	6	-	5
24	-	11	4	-	4
18	-	9	3	-	3
12	-	7			

This number, to which is often added a boy to bring powder to every gun, may be occaſionally reduced, and the guns nevertheleſs well managed. The number of men appointed to the ſmall arms, on board his Majeſty's ſhips and ſloops of war, by order of the admiralty, are,

Rate of the ſhip.	No. of men to the ſmall arms.
1ſt	150
2d	120
3d of 80 guns	100
— of 70 guns	80
4th of 60 guns	70
4th of 50 guns	60
5th	50
6th	40
Sloops of war	30

The lieutenants are uſually ſtationed to command the different batteries, and direct their efforts againſt the enemy. The maſter ſuperintends the movements of the ſhip, and whatever relates to the ſails. The boatſwain, and a ſufficient number of men, are ſtationed to repair the damaged rigging: and the gunner and carpenter, wherever neceſſary, according to their reſpective offices.

The marines are generally quartered on the poop and fore-caſtle, or gang-way, under the direction of their officers; although, on ſome occaſions, they aſſiſt at the great guns, particularly in diſtant cannonading.

QUARTERS, at a ſiege, the encampment upon one of the moſt principal paſſages round a place beſieged, to prevent relief and convoys.

Head QUARTERS *of an Army*, the place where the commander in chief has his quarters. The quarters of generals of horſe are, if poſſible, in villages behind the right and left wings, and the generals of foot are often in the ſame place: but the commander in chief ſhould be near the centre of the army.

QUARTERS *of Refreſhment*, the place or places where troops that have been much haraſſed are put to recover themſelves during ſome part of the campaign.

Intrenched QUARTERS, a place fortified with a ditch and parapet to ſecure a body of troops.

Winter QUARTERS, ſometimes means the ſpace of time included between leaving the camp and taking the field; but more properly the places where the troops are quartered during the winter. The firſt buſineſs, after the army is in winter-quarters, is to form the chain of troops to cover the quarters well: which is done either behind a river, under cover of a range of ſtrong poſts, or under the protection of fortified towns. Huſſars are very uſeful on this ſervice. It ſhould be obſerved, as an invariable maxim, in winter-quarters, that your regiments be diſpoſed in brigades, to be always under the eye of a general officer; and, if poſſible, let the regiments be ſo diſtributed, as to be each under the command of its own chief.

QUARTERING, in heraldry, is dividing a coat into four or more quarters, or quarterings, by parting, couping, &c. that is, by perpendicular and horizontal lines, &c.

QUARTO-DECIMANS, an ancient ſect in the Chriſtian church, who taught that Eaſter ſhould always be celebrated, according to the cuſtom of the Jews, on the fourteenth day of the moon in the month of March, whenſoever that day fell out. And hence they derived their name *quarto-decimani*, q. d. Fourteenthers: The Aſiatics were mightily attached to this opinion, pretending that it was built on the authority of St. John, who was their apoſtle; and pope Victor could never bring them to obedience in this article, though he was upon the point of excommunicating them: but it is more probable he contented himſelf with menaces. See EASTER.

QUARTZ, a genus of ſiliceous earths very common in Europe. According to Kirwan, the quartz are in general the pureſt of the ſiliceous kind, though moſt of them contain a ſlight mixture of other earths: the moſt obvious diſtinction among them ariſes from their opacity or tranſparency. Cronſtedt gives the following characteriſtics of it: 1. It is generally cracked throughout, even in the rock itſelf, whereby, as well as by its own nature, it breaks into irregular and ſharp fragments. 2. It cannot be eaſily made red hot, without cracking ſtill more. 3. It never decays in the air. 4. Melted with fixed alkali in a due proportion, it gives a more ſolid and fixed glaſs than any of the other ſiliceous ſtones. 5. When there has been no interruption in its natural accretion, it always cryſtallizes into hexagonal priſms pointed at both ends. 6. It is met with in clefts, fiſſures, and ſmall veins in rocks; it ſeldom forms large veins, and ſtill more rarely whole mountains, without a mixture of heterogeneous ſubſtances. It is found,

1. Pure, of ſeveral varieties, as, (1.) Solid, or having no viſible particles, and called *fat quartz*. This is either tranſparent, white, blue, or violet-coloured. The firſt kind is met with in the copper-mines in the northern part of Norway and Siberia, and has no regular form, but is as clear as the fineſt cryſtallized quartz, or rock cryſtal. (2.) *Grained quartz*, of a white or pale green colour, found in various places in Sweden. (3.) The *ſparry quartz* which is the ſcarceſt of the whole, and ought not to be confounded with the white felt-ſpar, becauſe it is of a ſmoother appearance, and breaks into larger and more irregular planes. It is found of a whitiſh yellow, from the gold mines in Hungary; or white, from the iſland of Uto. Brunnich tells us, that the Hungarian gold and ſilver mines near Hodentch, which have veins frequently ſome fathoms wide, afford a kind of lamellated and porous quartz. It is met with of white, yellow, and blue colours, and it is ſometimes finely cryſtallized in pyramidical figures.

2. *Cryſtallized quartz*, or *rock cryſtal*. See CRYSTAL.

3. *Impure quartz*. Of this there are two kinds. (1.) Mixed with iron, in form of a black calx. It is black, gloſſy, and contains a great quantity of iron. It is found in Sweden. (2.) Mixed with copper, and of a red colour, found in the ſame country.

Cronſtedt obſerves, that quartz in general, and eſpecially its cryſtals, are very commonly ſuppoſed, when yet in their ſoft and diſſolved ſtate, to have included within them ſome vegetables, for inſtance graſs and moſs. "This (ſays he) I cannot abſolutely deny; but it deſerves carefully to be examined if that which is ſhown as a graſs be not an aſbeſtos, or a ſtriated cockle; and the moſs only branched varieties filled with earth, which, by their being ramoſe, bear a vegetable appearance. It is very common in agates, and makes them of leſs value than they otherwiſe would be. This is moſt generally the caſe with thoſe ſtones which are ſhown as including vegetables; and for my own part, I have never been ſo fortunate as to meet with any others."

M. Magellan remarks, that quartz is one of the principal kinds of ſtone which contain metals. Some of the Hungarian veins conſiſt entirely of it, and the gold is ſo minutely diſperſed, that it cannot be diſcerned by the beſt microſcopes before it is ſeparated by pounding and waſhing. The width of the veins, ſome of which are half a fathom, and ſome ſtill more, repay the trouble and expenſes, which the ſmall quantity of gold would not otherwiſe counterbalance. Nature has not any where produced mountains of pure quartz; for, though ſome rocks in Sweden are ranked among the quartzes, they are undoubtedly mixed with heterogeneous matters. Near Lauterberg upon the Hartz are veins of this ſtone from one to three fathoms wide, conſiſting of a looſe ſand, in which they find the copper ore in neſts. In the Daniſh iſle of Anhalt we meet with triangular quartz pebbles. There are likewiſe cryſtals of quartz having water encloſed in them; ſome fine pieces of this kind are to be met with in the Imperial cabinet at Vienna, &c.

Rock cryſtals are generally found upon or among quartz, and are to be met with in all parts of the world. The greateſt number are furniſhed to the European countries from Mount Saint Gothard in Switzerland. Here large pieces, weighing from 5 to 800 pounds, were found at Grimſelberg; one of 1200 pounds was found ſome years ago at Fiſbach in the Wallais; and a piece ſix feet long, four broad, and equally thick, was found in the iſland of Madagaſcar, a place where theſe natural productions are of the moſt extraordinary ſize and perfection.

When great quantities of quartz are continually agitated by the ſea or river water, they are ſometimes reduced to ſuch very minute parts as to be eaſily carried away, ſuſpended in the water; and there are ſands of ſo minute a ſize as to meaſure leſs than the two or three hundredth part of an inch. Theſe are called *quick ſands*. Immenſe tracts of land conſiſt only of looſe ſands, particularly along the ſea ſhore in many parts of Europe. Some ſuppoſe that ſea-water has the power of producing this ſand out of its own ſubſtance; and their ſurfaces, in general, are ſo poliſhed, as to ſhow that they could not be reduced in ſize by rubbing againſt each other; but we know not as yet that ſuch a production has ever been demonſtrated. When ſand is about as big as peas, it is called gravel; and when it is free from ſaline and heterogeneous particles, it is employed in making mortar, and for other economical purpoſes. That which is very pure ſerves for making flint-glaſs, with red calces of lead, and the proper alkaline flux; but when mixed with ferruginous black ſand, the glaſs aſſumes a greeniſh black colour. "This (ſays M. Magellan) I have ſeen among the various ſpecimens of glaſs made by Mr. E. Delaval, F. R. S. who produced a very fine tranſparent and colourleſs glaſs out of the ſame ſand with which he had made ſome of that black glaſs, and this only by ſeparating from it all the ferruginous mixture."

QUASHING, in law, the overthrowing and annulling a thing.

QUASI-CONTRACT, in the civil law, an act without the ſtrict form of a contract, but yet having the force thereof. In a contract there muſt be the mutual conſent of both parties, but in a *quaſi-contract* one party may be bound or obligated to the other, without having given his conſent to the act whereby he is obliged. For example: I have done your buſineſs, in your abſence, without your procuration, and it has ſucceeded to your advantage. I have then an action againſt you for the recovery of what I have diſburſed, and you an action againſt me to make me give an account of my adminiſtration, which amounts to a *quaſi-contract*.

QUASI-*Crime*, or *Quaſi-delict*, in the civil law, the action of a perſon who does damage, or evil, involuntarily. The reparation of *quaſi-crimes* conſiſts in making good the damages, with intereſt.

QUASS, a fermented liquor drunk in Ruſſia. Sea PEASANT.

QUASSIA, in botany: A genus of the monogynia order, belonging to the decandria claſs of plants; and in the natural method ranking under the 14th order, *Gruinales*. The calyx is pentaphyllous; there are five petals; the nectarium is pentaphyllous; there are from two to five ſeed-caſes, ſtanding aſunder, and monoſpermous. There are three ſpecies, the *amara*, *ſimaruba*, and *excelſa* or *polygama*.

1. The *quaſſia amara* grows to the height of ſeveral feet, and ſends off many ſtrong branches. The wood is of a white colour and light; the bark is thin and gray: the leaves are placed alternately on the branches, and conſiſt of two pair of oppoſite pinnæ, with an odd one at the end; all the leaflets are of an elliptical ſhape, entire, veined, ſmooth, pointed, ſeſſile, on the upper pagina of a deep green colour, on the under paler: the common footſtalk is articulated, and winged, or edged, on each ſide with a leafy membrane, which gradually expands towards the baſe of the pinnæ: the flowers are all hermaphrodite, of a bright red colour, and terminate the branches in long ſpikes: the bracteæ or floral leaves are lance-ſhaped or linear, coloured, and placed alternately upon the peduncles: the calyx is ſmall, perſiſtent, and five-toothed: the corolla conſiſts of five lance-ſhaped equal petals, at the baſe of which is placed the nectary, or five roundiſh, coloured ſcales: the filaments are ten, ſlender, ſomewhat longer than the corolla, and crowned with ſimple antheræ, placed tranſverſely: the receptacle is fleſhy and orbicular: the germen is ovate, divided into five parts, and ſupports a ſlender ſtyle, longer than the filaments, and terminated by a tapering ſtigma: the capſules are five, two-celled, and contain globular ſeeds. It is a native of South America, particularly of Surinam, and alſo of ſome of the Weſt Indian iſlands. The root, bark and wood of this tree have all places in the materia medica. The wood is moſt generally uſed, and is ſaid to be a tonic, ſtomachic, antiſeptic, and febrifuge.

2. The *quaſſia ſimaruba* is common in all the wood lands in Jamaica. It grows to a great height and conſiderable thickneſs. The trunks of the old trees are black and a little furrowed. Thoſe of the young trees are ſmooth and gray, with here and there a broad yellow ſpot. The inſide bark of the trunk and branches is white, fibrous, and tough. It taſtes ſlightly bitter. On cutting or ſtripping off this bark, no milky juice iſſues, as has been mentioned by various authors. The wood is hard, and uſeful for buildings. It ſplits freely, and makes excellent ſtaves for ſugar hogſheads. It has no ſenſible bitter taſte. The branches are alternate and ſpreading. The leaves are numerous and alternate. On the upper ſide, they are ſmooth, ſhining, and of a deep green colour: on the under ſide they are white. The flowers appear about the beginning of April. They are of a yellow colour, and placed on ſpikes beautifully branched.

The fruit is of that kind called a *drupa*, and is ripe towards the end of May. It is of an oval ſhape, is black, ſmooth, and ſhining. The pulp is fleſhy and ſoft; the taſte a nauſeous ſweet. The nut is flattened, and on one ſide winged. The kernel is ſmall, flat, and taſtes ſweet. The natural number of theſe drupæ is five on each common receptacle; but for the moſt part there are only two or three; the reſt abort by various accidents. The roots are thick, and run at a ſmall depth under the ſurface of the ground to a conſiderable diſtance. The bark is rough, ſcaly, and warted. The inſide when freſh is a full yellow, but when dry paler. It has but little ſmell. The taſte is bitter, but not very diſagreeable. This is the true cortex ſimarubæ of the ſhops. This tree is known in Jamaica by the names of *mountain damſon*, *bitter damſon*, and *ſtave-wood*: The ſhops are ſupplied with this bark from Guiana; but now we may have it from our own iſlands at a moderate expenſe. On examining the fructification, Dr. Wright found this tree to be a ſpecies of quaſſia. Under that name he ſent it to Europe, and Linnæus adopted it into his ſyſtem. There are male flowers on one tree and female flowers on another; and this is invariably the caſe in Jamaica.

Moſt authors who have written on the ſimaruba agree, that in fluxes it reſtores the loſt tone of the inteſtines, allays their ſpaſmodic motions, promotes the ſecretions by urine and perſpiration, removes that lowneſs of ſpirits attending dyſenteries, and diſpoſes the patient to ſleep: the gripes and teneſmus are taken off, and the ſtools changed to their natural colour and conſiſtence. In a moderate doſe it occaſions no diſturbance or uneaſineſs; but in a large doſe it produces ſickneſs at ſtomach and vomiting. Negroes are leſs affected by it than white poeple. Dr. Cullen, however, ſays, "We can perceive nothing in this bark but that of a ſimple bitter; the virtues aſcribed to it in dyſentery have not been confirmed by my experience, or that of the practitioners in this country; and leaving what others are ſaid to have experienced to be further examined and conſidered by practitioners, I can only at preſent ſay, that my account of the effect of bitters will perhaps explain the virtues aſcribed to ſimaruba. In dyſentery I have found an infuſion of chamomile flowers a more uſeful remedy." 3. The *quaſſia excelſa* or *polygama* was named by Sir Joſeph Banks, Dr. Solander, and Dr. Wright, *pricrania amara*, (ſee PRICRANIA *Amara*.) It is ranked, however, by Mr. John Lindſay, in a paper in the third volume of the Edinburgh Tranſactions, under *quaſſia*, who gives the following deſcription of it: "It is very common in the woodlands of Jamaica, is beautiful, tall and ſtately, ſome of them being 100 feet long, and ten feet in circumference eight feet above the ground. The trunk is ſtraight, ſmooth, and tapering, ſending off its branches towards the top. The outſide bark is pretty ſmooth, of a light gray or aſh colour, from various lichens. The bark of the roots is of a yellow caſt, ſomewhat like the cortex ſimaruba. The inner bark is tough, and compoſed of fine flaxy fibres. The wool is of a yellow colour, tough, but not very hard. It takes a good poliſh, and is uſed as flooring. The leaves are ſub-alternate; the ſmall leaves are in pairs, from five to eight, ſtanding oppoſite to each other on ſhort footſtalks, and ending with an odd one. They are of an oblong oval ſhape, and pointed; the ribs reddiſh, and the young leaves are covered with a fine browniſh down: The flowers come out in bunches or cluſters from the lower part of the laſt ſhoot before the leaves, and ſtand on round footſtalks. The flowers are ſmall, of a yellowiſh green colour, with a very ſmall calyx. The male or barren tree has flowers nearly ſimilar to the hermaphrodite, but in it there are only the rudiments of a ſtyle. The fruit is a ſmooth black drupa, round-ſhaped, and of the ſize of a pea. There is but little pulp, and the nut covers a round kernel. Theſe drupæ are generally three, ſometimes two, and often only one, attached ſidewiſe to a roundiſh fleſhy receptacle. It flowers in October and November, and its fruit is ripe in December and January. Except the pulp of the fruit, every other part of this tree has an intenſely bitter taſte. In taſte and virtues it is nearly equal to the quaſſia of Surinam, and I am credibly informed is ſold in London for the quaſſia amara; and it may be ſafely uſed in all caſes where that drug has been thought proper, whether as an antiſeptic, or in caſes of weakneſs in the ſtomach and bowels. It may either be given alone or joined with the Jeſuit's bark. The happieſt effects reſult from the uſe of this medicine in obſtinate remitting fevers from marſh miaſmata, in agues which had reſiſted the uſe of Jeſuit's bark, and in dyſenteries of long ſtanding. It is in daily practice in dropſies from debility, either in ſimple infuſions or tincture by itſelf, or joined with aromatics and chalybeates. Dr. Drummond, an eminent phyſician in Jamaica, preſcribes it with great ſucceſs in the above caſes, as well as in amenorrhœa, chloroſis, dyſpepſia, and in that ſpecies of pica called *dirteating*, ſo fatal to a number of negroes.

The bark of the quaſſia polygama, but eſpecially the wood, is intenſely bitter. They may both be uſed in various forms. In certain caſes of dropſy, aromatics and preparations are joined to it, alſo in amenorrhœa and chloroſis; and in worm fevers, the cabbage bark, or other vegetable anthelmintics.

QUATUORVIR, in antiquity, formerly written IIII. Vir, a Roman magiſtrate, who had three colleagues joined with him in the ſame adminiſtration, and had the care of conducting and ſettling the colonies ſent into the provinces. There where alſo quatuorviri appointed to inſpect and take care of repairs, &c.

QUAVER, in muſic, a meaſure of time equal to half a crotchet, or an eighth part of a ſemibreve.

QUAY. See Key.

QUEBEC, a city of North America, capital of Lower Canada, ſituate at the confluence of the rivers St. Lawrence and St Charles. It is built on a rock, and is divided into the upper and lower town. The houſes in each are of ſtone, and the fortifications ſtrong though not regular. The governor reſides in a citadel, which covers the town, and is both regular and handſome. The river St. Lawrence here narrows all of a ſudden to the breadth of a mile, but from hence to the ſea it is four or five leagues broad, and navigable for large men of war. The harbour is ſafe and commodious, and flanked by two baſtions that are raiſed 25 feet from the ground, which is the height of the tides at the time of the equinox. This city was erected by the French in 1605. The Engliſh reduced it with all Canada, in 16 6 but it was reſtored in 1632. In 1759, it was again taken by the Engliſh; after a battle memorable for the death of general Wolfe in the arms of victory, and confirmed to them by the peace of 1763. It is [illegible] miles by the river, from the Atlantic Ocean, and 590 N.W. of Boſton. W. lon. 69. 48. N. lat. 40. 55.

QUEDA, a kingdom of Aſia, in the peninſula beyond the Ganges, and near the ſtrait of Malacca. The king is tributary to Siam. The principal town is of the ſame name, and ſaid to contain about 8000 inhabitants; and is ſubject to the Dutch. It has a harbour, and is 300 miles north of Malacca. E. lon. 100. 5 N. lat. 7. 5.

QUEDLINBURG, a town of Germany, in the circle of Upper Saxony, and on the confines of the dutchy of Brunſwick. Here is a famous abbey, whoſe abbeſs is a princeſs of the empire, and who ſends deputies to the diets. Her contingent is one horſeman and ten footmen. The inhabitants of the town live by brewing, huſbandry, and feeding of cattle. It is 10 miles ſouth-eaſt of Halberſtadt, and 32 weſt of Bernberg. E. lon. 11. 3[illegible]. N lat. 52. 1.

QUEEN, a woman who holds a crown ſingly. The title of *queen* is alſo given by way of courteſy to her that is married to a king, who is called by way of diſtinction *queen conſort*; the former being termed *queen-regent*. The widow of a king is alſo called *queen*, but with the addition of *dowager*. See Royal-*Family*.

Queen *Charlotte's Sound*, is ſituated at the northern extremity of the ſouthern iſland of New Zealand, near Cook's Strait, lying in 41. 6. of ſouth latitude, and 174. 19. of eaſt longitude. The climate of this ſound is much more mild than at Duſky Bay; and though there is not ſuch plenty of wild fowl and fiſh, the defect is ſufficiently compenſated by abundance of excellent vegetables. The hills about the ſound conſiſt moſtly of an argillaceous ſtone of a greeniſh gray, or bluiſh or yellowiſh brown colour. A green talcous or nephritic (by the jewellers called *jadde*) is likewiſe very common, together with horn ſtone, ſhingle, ſeveral ſorts of flinty ſtones and pebbles, ſome looſe pieces of baſaltes, ſtrata of a compact mica or glimmer, with particles of quartz. Hence, Mr. Forreſter thinks, there is reaſon to believe that this part of New Zealand contains iron-ore, and perhaps ſeveral other metallic ſubſtances. The country is not ſo ſteep as at Duſky Bay, and the hills near the ſea are generally inferior in height, but covered with foreſts equally intricate and impenetrable. Captain Cook ſowed the ſeeds of many vegetables in this place, that have uſeful and nutritive roots. He ſowed alſo corn of ſeveral ſorts, beans, kidney-beans, and peaſe. The dogs here are of the long-haired ſort, with pricked ears, and reſemble the common ſhepherd's cur, but they are very ſtupid animals. They are fed with fiſh, and even dogs fleſh, and perhaps human fleſh, which the natives alſo eat. Captains Cook and Furneaux left on theſe iſlands a boar and two ſows, with a pair of goats, male and female, with ſome geeſe, in order to benefit the natives and future generations of navigators. They left likewiſe among them a number of braſs medals guilt, on one ſide of which was the head of his preſent majeſty, with the inſcription George III. King of Great Britain, France, and Ireland, &c. On the reverſe, a repreſentation of two men of war, with the names Reſolution and Adventure over them; and the exergue, ſailed from England March MDCCLXXII.

Queen-*Gold*, is a royal duty or revenue belonging to every queen of England during her marriage to the king, payable by perſons in this kingdom and Ireland, on divers grants of the king by way of fine or oblation, &c. being one full tenth part above the entire fines, on pardons, contracts, or agreements, which becomes a real debt to the queen, by the name of *aurum reginæ*, upon the party's bare agreement with the king for his fine, and recording the ſame.

Queen's *County*, a diviſion of the province of Leinſter in Ireland; ſo called from the popiſh Queen Mary, in whoſe reign it was firſt made a county by the earl of Suſſex, then lord deputy. It is bounded on the ſouth by Kilkenny and Catherlogh; by King's county on the north and weſt; part of Kildare and Catherlogh on the eaſt; and part of Tipperary on the weſt. Its greateſt length from north to ſouth is 35 miles, and its breadth near as much; but it is unequal both ways. This county was anciently full of bogs and woods, though now pretty well incloſed, cultivated, and inhabited. The baronies contained in it are ſeven; and it ſends eight members to parliament.

Queen-*Bee*. See Bee.

QUEENBOROUGH, a town of the iſle of Sheppey in Kent, which ſends two members to parliament, though conſiſting only of about 100 low brick houſes, and ſcarce 350 inhabitants. The chief employment of the people here is oyſter drudging; oyſters being very plentiful, and of a fine flavour. E. lon. 0. 50. N. lat. 51. 25.

QUEENS-ferry, a town of Scotland, in the ſhire of Lothian, ſeated on the ſouth ſide of the river Forth, 9 miles weſt of Edinburgh.

QUEI-ling-fou, the capital of the province of Quangſi in China, has its name from a flower called *quei*, which grows on a tree reſembling a laurel; it exhales ſo ſweet and agreeable an odour, that the whole country around is perfumed with it. It is ſituated on the banks of a river, which throws itſelf into the Taho; but it flows with ſuch rapidity, and amidſt ſo narrow vallies, that it is neither navigable nor of any utility to commerce. This city is large, and the whole of it is built almoſt after the model of our ancient fortreſſes; but it is much inferior to the greater part of the capitals of the other provinces. A great number of birds are found in the territories belonging to it, the colours of which are ſo bright and variegated, that the artiſts of this country, in order to add to the luſtre of their ſilks, interweave with them ſome of their feathers, which have a ſplendor and beauty that cannot be imitated. Quei ling has under its juriſdiction two cities of the ſecond claſs and ſeven of the third.

Quei, in natural hiſtory, is a name given by the Chineſe to a peculiar earth found in many parts of the eaſt. It is of the nature of an indurated clay, and in ſome degree approaches to the talcs, as our ſteatites and the galactites do. It is very white and abſterſive, uſed by the women of China to take off ſpots from the ſkin, and render it ſoft and ſmooth, as the Italian ladies uſe talc of Venice. They ſometimes uſe the fine powder of this ſtone dry, rubbing it on the hands and face after waſhing; ſometimes they mix it in pomatum.

QUERCI, a late province of France, bounded on the N. by Limoſin, on the E. by Rouergue and Auvergne, on the S. by Languedoc, and on the W. by Perigord. It was divided into the Upper and Lower, and is fertile in corn, wine, and fruits. It now forms the department of Lot.

QUERCUS, the oak-tree: A genus of the polyandria order, belonging to the monœcia claſs of plants; and in the natural method ranking under the 50th order, *Amentaceæ*. The calyx is nearly quinquefid; there is no corolla; the ſtamina are from five to ten in number. The female calyx is monophyllous, very entire, and ſcabrous. There is no corolla; the ſtyles are from two to five; and there is an ovate ſeed. See oak.

The ſpecies are, 1. The *robur*, or common Engliſh oak; grows from about 60 or 70 to 100 feet high, with a prodigious large trunk, and monſtrous ſpreading head; oblong leaves, broadeſt towards the top, the edges acutely ſinuated, having the angles obtuſe. There is a variety having the leaves finely ſtriped with white. This ſpecies grows in great abundance all over England, in woods, foreſts, and hedge-rows; is naturally of an amazing large growth; there being accounts of ſome above 100 feet ſtature, with wonderful large trunks and ſpreading heads; and is ſuppoſed to continue its growth many centuries. 2. The *prinus*, or cheſnut-leaved American oak, grows 50 or 60 feet high; having large oblong-oval ſmooth leaves pointed both ways, the edges ſinuated-ſerrated, with the ſinuſes uniformly round. 3. The *phellos*, or willow-leaved American oak, grows 40 or 50 feet high, having long narrow ſmooth entire leaves, like thoſe of the willow. There is a variety called the *dwarf willow-leaved oak*. 4. The *alba*, or white Virginian oak, grows 30 or 40 feet high, having a whitiſh bark, with long obliquely-pinnatifid light-green leaves, the ſinuſes and angles obtuſe. 5. The *nigra*, or black Virginian oak, grows 30 or 40 feet high, having a dark-coloured bark, large wedge-ſhaped ſlightly-trilobated leaves. 6. The *rubra*, or red Virginian oak, grows about 60 feet high, having a dark-grayiſh bark, long obtuſely-ſinuated leaves, with the ſinuſes terminated by briſtly points, and have ſometimes red ſpotted veins, but generally dyeing in autumn to a reddiſh colour, remaining on the trees late in the ſeaſon. 7. The *eſculus* of Pliny, or cut-leaved Italian oak, grows about 30 feet high, having a purpliſh bark, oblong deeply-ſinuated ſmooth leaves, and long ſlender cloſe-fitting acorns in very large cups. 8. *Ægilops*, or large prickly-cupped Spaniſh oak, grows 70 or 80 feet high or more, with a very large trunk, and widely-ſpreading head, having a whitiſh bark, large oblong-oval deeply-ſerrated ſmooth leaves, the ſerratures bowed backward, and large acorns placed in ſingularly large prickly cups. This is a noble ſpecies, almoſt equal in growth to our common Engliſh oak. 9. *Cerris*, or ſmaller prickly-cupped Spaniſh oak, grows 30 or 40 feet high, and has oblong lyre-ſhaped pinnatifid tranſverſely-jagged leaves, downy underneath, and ſmall acorns placed in prickly cups. 10. The *ilex*, or common evergreen oak, grows 40 or 50 feet high, having a ſmooth bark, oval and oblong undivided ſerrated petiolated leaves, downy and whitiſh underneath. The varieties are, broad-leaved, narrow-leaved, and ſometimes both ſorts and other different ſhaped leaves on the ſame tree, alſo ſometimes with ſawed and prickly leaves. 11. The *gramuntia*, or Montpelier holly leaved evergreen oak, grows 40 or 50 feet high; and has oblong-oval, cloſe fitting ſinuated ſpinous leaves, downy underneath, bearing a reſemblance to the leaves of holly. 12 The *ſuber*, or cork tree, grows 30 or 40 feet high, having a thick, rough, fungous, cleft bark, and oblong-oval undivided ſerrated leaves, downy underneath. This ſpecies furniſhes that uſeful material cork; it being the bark of the tree, which becoming of a thick fungous nature, under which, at the ſame time, is formed a new bark, and the old being detached for uſe, the tree ſtill lives, and the ſucceeding young bark becomes alſo of the ſame thick ſpongy nature in ſix or ſeven years, fit for barking, having likewiſe another freſh bark forming under it, becoming cork like the others in the like period of time; and in this manner theſe trees wonderfully furniſh the cork for our uſe, and of which is made the corks for bottles, bungs for barrels, and numerous other uſeful articles. The tree grows in great plenty in Spain and Portugal, and from theſe countries we receive the cork. The Spaniards burn it, to make that kind of light black we call Spaniſh black, uſed by painters. Cups made of cork are ſaid to be good for hectical perſons to drink out of. The Egyptians made coffins of cork; which being lined with a reſinous compoſition, preſerved dead bodies uncorrupted. The Spaniards line ſtone walls with it, which not only renders them very warm, but corrects the moiſture of the air. 13. The *coccifera*, ſcarlet, or kermes oak, grows but 14 or 15 feet high, branching all the way, and of buſhy growth; with large oval, undivided, indented, ſpinous leaves; and producing ſmall glandular excreſcences, called *kermes* or *ſcarlet grain*, uſed by the dyers. The ſmall ſcarlet glands found in this tree are the effect of certain inſects depoſiting their eggs betwixt the bark of the branches and leaves, cauſing an extravaſation of the ſap, and forming the excreſcence or ſubſtance in queſtion, which being dried is the kermes or ſcarlet paſtel. 14 The *Molucca*, Moluccan oak, commonly called *American live oak*, grows about 40 feet high, having oval, ſpear-ſhaped, ſmooth, entire leaves, and ſmall oblong eatable acorns.

All the above produce flowers annually in the ſpring, about April or May, of a yellowiſh colour, but make no ornamental appearance, and are males and females ſeparated in the ſame tree; the males being in looſe amentums, and the females ſitting cloſe to the buds in thick leathery hemiſpherical calyxes, ſucceeded by the fruit or acorns, which are oval nuts fixed by their baſe into rough permanent cups, and moſtly ſit quite cloſe, and ſome on ſhort footſtalks, ripening in autumn; which in the common Engliſh oak is in great abundance, and often in tolerable plenty on ſome of the other ſorts: thoſe of all the kinds ſerve for propagating their reſpective ſpecies; they are alſo excellent food for ſwine and deer, the common oak in particular.

Oak-trees, of all the above ſorts, may be employed in gardening to diverſify large ornamental plantations in out-grounds, and in forming clumps in ſpacious lawns, parks, and other extenſive opens; the evergreen kinds in particular have great merit for all ornamental purpoſes in gardens. But all the larger growing kinds, both deciduous and evergreens, demand eſteem principally as firſt-rate foreſt-trees for their timber. The Engliſh oak, however, claims precedence as a timber-tree, for its prodigious height and bulk, and ſuperior worth of its wood. Every poſſeſſor of conſiderable eſtates ought therefore to be particularly aſſiduous in raiſing woods of them, which is effected by ſowing the acorns either in a nurſery and the plants tranſplanted where they are to remain, or ſowed at once in the places where they are always to ſtand. All the ſorts will proſper in any middling ſoil and open ſituation, though in a loamy ſoil they are generally more proſperous: however, there are but few ſoils in which oaks will not grow; they will even thrive tolerably in gravelly, ſandy, and clayey land, as may be obſerved in many parts of this country of the common oak.

The oak is of the utmoſt importance to Britain, and its cultivation deſerves the utmoſt attention. Much, therefore, to the honour of the members of the *London Society for encouraging Arts, Manufactures, and Commerce*, they have excited particular attention to it; and many excellent obſervations, drawn from practice, will be found in their Tranſactions.

The propagation of the ſtriped-leaved varieties of the common oak, and any particular variety of the other ſpecies, muſt be effected by grafting, as they will not continue the ſame from ſeed; the grafting may be performed upon any kind of oakling-ſtocks raiſed from the acorns, and train them for ſtandards like the others.

The oak is remarkable for its ſlowneſs of growth, bulk, and longevity. It has been remarked that the trunk has attained to the ſize only of 14 inches in diameter, and of ſome to 20, in the ſpace of fourſcore years. As to bulk, we have an account of an oak belonging to Lord Powis, growing in Broomfield wood, near Ludlow in Shropſhire, in the year 1764, the trunk of which meaſured 68 feet in girth, 23 in length, and which, reckoning 90 feet for the larger branches, contained in the whole 1455 feet of timber, round meaſure, or 29 loads and five feet, at 50 feet to a load.

The Greendale oak, &c. we have already mentioned (ſee OAK), In the opinion of many, the Cowthorp oak near Wetherby in Yorkſhire is the father of the foreſt. Dr. Hunter, in his edition of Evelyn, has given an engraving of it. Within three feet of the ſurface he ſays it meaſures 16 yards, and cloſe to the ground 26. In 1776, though in a ruinous condition, it was 85 feet high, and its principal limb extended 16 yards from the bole. The foliage was very thin. If this meaſurement were taken as the dimenſion of the *real ſtem*, the ſize of this tree would be enormous; but, like moſt very large trees, its ſtem is ſhort, ſpreading wide at the baſe, the roots riſing above the ground like buttreſſes to the trunk, which is ſimilar not to a cylinder but to the fruſtum of a cone. Mr. Marſham ſays, "I found it in 1 68, at four feet, 40 feet 6 inches; at five feet, 36 feet 6 inches; and at ſix feet, 32 feet 1 inch." In the principal dimenſions then, *the ſize of the ſtem*, it is exceeded by the Bentley oak; of which the ſame writer gives the following account. "In 1759 the oak in Holt-Foreſt, near Bentley, was at 7 feet, 34 feet. There is a large excreſcence at 5 and 6 feet that would render the meaſure unfair. In 1778 this tree was increaſed half an inch in 19 years. It does not appear to be hollow, but by the trifling increaſe I conclude it not ſound." Theſe dimenſions, however, are exceeded by thoſe of the Boddington oak. It grows in a piece of rich graſs land, called the *Old Orchard Ground*, belonging to Boddington Manor-Farm, lying near the turnpike-road between Cheltenham and Tewkſbury, in the vale of Glouceſter. The ſtem is remarkably collected at the root, the ſides of its trunk being much more upright than thoſe of large trees in general; and yet its circumference at the ground is about 20 paces: meaſuring with a two foot rule, it is more than 18 yards. At three feet high it is 42 feet, and where ſmalleſt, *i. e.* from five to ſix feet high, it is 36 feet. At ſix feet it ſwells out larger, and forms an enormous head, which has been furniſhed with huge, and probably extenſive, arms. But time and the fury of the wind have robbed it of much of its grandeur; and the greateſt extent of arm in 1783 was eight yards from the ſtem.

In the Gentleman's Magazine for May 1794 we have an account of an oak tree growing in Penſhurſt park in Kent, together with an engraving. It is called the *Bear* or *Bare oak*, from being ſuppoſed to reſemble that which Camden thought gave name to the county of Berkſhire. The tradition at Penſhurſt is, that it is the very tree planted on the day that the celebrated Sir Philip Sydney was born. "Some late writers (ſays Mr. Rawlet) have queſtioned this, and think that to have been a different tree, which was cut down ſome years ago, and was indeed much larger than this. I remember being once in the hollow of the preſent oak with the late Sir John Cullum; and his opinion then was, that its antiquity was greater than the period aſſigned. But, I aſſure you, the tradition of this place is conſtant for this tree; and, in confirmation of it, an old lady, 94 years of age, now living, has told me that all the tenants uſed to furniſh themſelves with boughs from this tree, to ſtick in their hats, whenever they went to meet the earls of Leiceſter, as was always the cuſtom to do at the end of the park when they came to reſide at their ſeat here. This fine old oak ſtands upon a plain about 500 yards from their venerable manſion, near a large piece of water called *Lancup-well*. Ben Jonſon and Waller have particularly noticed it; and, from the diſtinguiſhed owners of this place, it may be truly ſaid to ſtand on claſſic ground. Within the hollow of it there is a ſeat, and it is capable of containing five or ſix perſons with eaſe. The bark round the entrance was ſo much grown up, that it has lately been cut away to facilitate the acceſs. The dimenſions of the tree are theſe.

	Feet.	inches.
Girth cloſe to the ground - - -	35	6
Ditto one foot from ditto - -	27	6
Ditto five feet from ditto - -	24	0
Height taken by ſhadow - -	73	0
Girth of loweſt, but not largeſt, limb	6	9

With reſpect to longevity, Linnæus gives account of an oak 260 years old: but we have had traditions of ſome in England (how far to be depended upon we know not) that have attained to more than double that age. Mr. Marſham, in a letter to Thomas Beevor, Eſq. Bath Papers, Vol. I. p. 79, makes ſome very ingenious calculations on the age of trees, and concludes from the increaſe of the Bentley oak, &c. that the Fortworth cheſnut is 1100 years old.

Beſides the grand purpoſes to which the timber is applied in navigation and architecture, and the bark in tanning of leather, there are other uſes of leſs conſequence, to which the different parts of this tree have been referred. The Highlanders uſe the bark to dye their yarn of a brown colour, or, mixed with copperas, of a black colour. They call the oak *the king of all the trees in the foreſt*; and the herdſman would think himſelf and his flock unfortunate if he had not a ſtaff of it. The acorns are a good food to fatten ſwine and turkeys; and after the ſevere winter of the year 1709, the poor people in France were miſerably conſtrained to eat them themſelves. There are, however, acorns produced from another ſpecies of oak, which are eaten to this day in Spain and Greece, with as much pleaſure as cheſnuts, without the dreadful compulſion of hunger.

Quercus *Marina*, the *Sea oak*, in botany, the name of one of the broad-leaved dichotomous ſea-fucuſes. It is not agreed, among the late botaniſts, what was the ſea oak of Theophraſtus; and the moſt ancient botaniſts, Cluſius and Cæſalpinus, ſuppoſe it to have been a ſpecies of the ſhrubby coralline; but that ſeems by no means to have been the caſe, ſince Theophraſtus ſays his ſea oak had a long, thick, and fleſhy leaf; whence we may much more naturally conclude it to have been of the fucus claſs.

QUERIA, in botany: A genus of the trigynia order, belonging to the triandria claſs of plants; and in the natural method ranking under the 22d order, *Caryophyllei*. The calyx is pentaphyllous; there is no corolla; the capſule is unilocular, and trivalved, with one ſeed. There are two ſpecies, *viz*, *hiſpanica* and *canadenſis*.

QUESNE (Abraham du), marquis of Queſne, admiral of the naval forces of France, and one of the greateſt men of the laſt age, was born in Normandy in 1610. He contributed to the defeating of the naval power of Spain before Gattari; was dangerouſly wounded before Barcelona in 1642, and on other occaſions: he went into the ſervice of the Swedes, and became vice-admiral; gave the Danes an entire defeat, killed their admiral, and took his ſhip. He was recalled into France in 1647, and commanded the ſquadron ſent to Naples. The ſea-affairs of France being much fallen, he fitted out divers ſhips for the relief of the royal army that blocked up Bourdeaux; which was the principal cauſe of the ſurrender of the town. He was very fortunate in the laſt wars of Sicily, where he beat the Dutch thrice, and De Ruyter was killed. He alſo obliged the Algerines to ſue for peace from France in a very humble manner. In ſhort, Aſia, Africa, and Europe, felt the effects of his valour. He was a Proteſtant; yet the king beſtowed on him the land of Bouchet, and to immortalize his memory gave it the name of that great man. He died in 1688.

QUESTION, in logic, a propoſition ſtated by way of interrogation.

Question, or *Torture*. See Rack.

QUESTOR, or Quæstor, in Roman antiquity, an officer who had the management of the public treaſure. The queſtorſhip was the firſt office any perſon could bear in the commonwealth, and gave a right to ſit in the ſenate. At firſt there were only two; but afterwards two others were created, to take care of the payment of the armies abroad, of ſelling the plunder, booty, &c. for which puropoſe they generally accompanied the conſuls in their expeditions; on which account they were called *peregrini*, as the firſt and principal two were called *urbani*. The number of queſtors was afterwards greatly increaſed. They had the keeping of the decrees of the ſenate: and hence came the two officers of *queſtor principis*, or *auguſti*, ſometimes called *candidatus principis*, whoſe office reſembled in moſt reſpects that of our ſecretaries of ſtate; and the *queſtor palatii*, anſwering in a great meaſure to our lord-chancellor.

QUEUE, in heraldry, ſignifies the tail of a beaſt: thus, if a lion be borne with a forked tail, he is blazoned double queued.

QUEVEDO de Villegas (Francisco), a celebrated Spaniſh poet, born at Madrid in 1570. He was deſcended from a noble family, and was made a knight of St. James; but was thrown into priſon by order of Count Olivarez, whoſe adminiſtration he ſatirized in his verſes, and was not ſet at liberty till after that miniſter's diſgrace. Quevedo wrote ſome heroic, lyric, and facetious poems. He alſo compoſed ſeveral treatiſes on religious ſubjects, and has tranſlated ſome authors into Spaniſh. He died in 1645. The moſt known of his works are, 1. The Spaniſh Parnaſſus. 2. The adventurer Buſcon. 3. Viſions of Hell Reformed, &c. Quevedo was one of the greateſt ſcholars and moſt eminent poets of his time. His youth was ſpent in the ſervice of his country in Italy, where he diſtinguiſhed himſelf with the utmoſt ſagacity and prudence. His moral diſcourſes prove his ſound doctrine and religious ſentiments, while his literary pieces diſplay his infinite judgment and refined taſte. His great knowledge of Hebrew is apparent from the report of the hiſtorian Mariana to the king, requeſting that Quevedo might reviſe the new edition of the Bible of Arias Montanus. His tranſlations of Epictetus and Phocylides, with his imitations of Anacreon, and other Greek authors, ſhow how well he was verſed in that language: that he was a Latin ſcholar, his conſtant correſpondence, from the age of twenty, with Lipſius, Chifflet, and Scioppius, will ſufficiently illuſtrate. As a poet, he excelled both in the ſerious and burleſque ſtyle, and was ſingularly happy in that particular turn we have ſince admired in Butler and Swift. His library, which conſiſted of about five thouſand volumes, was reduced at his death to about two thouſand, and is preſerved in the convent of St. Martin at Madrid.

QUICK, or Quickset *Hedge*, among gardeners, denote all live hedges, of whatever ſort of plants they are compoſed, to diſtinguiſh them from dead hedges; but in a more ſtrict ſenſe of the word, it is reſtrained to thoſe planted with the hawthorn, under which name thoſe young plants or ſets are ſold by the nurſery-gardeners who raiſe them for ſale. See the article Hedges.

QUICKLIME, a general name for all calcareous ſubſtances when deprived of their fixed air; ſuch as chalk, limeſtone, oyſter-ſhells, &c. calcined. See Chemistry. Quicklime has the following properties.

1. It is entirely ſoluble in water, with which it unites ſo rapidly as to occaſion conſiderable heat. When expoſed to air, it imbibes moiſture from thence. When united with as much water as is ſufficient to make it a fluid paſte, it is called *ſlaked lime*. Water ſaturated with quicklime is called *lime-water*. According to Brandt lime water contains about one part of quicklime to 700 or 800 parts of water. Slaked lime, or lime water, being expoſed to the atmoſphere, attract from thence particles of fixable air which float in it, by which means the quicklime is rendered mild, inſoluble in water. and therefore appears on the ſurface of the lime-water, or of the ſlaked lime where this combination happens, in the ſtate of mild or combined calcareous earth, convertible by a ſecond calcination into quicklime, and is called *cream of lime*.

If the earth diſſolved in lime water be, precipitated from thence by any ſubſtance containing fixable air as by mild alkalis or magneſia, it will unite with this air, become mild, and reſume its former weight and properties which it poſſeſſed before calcination. But if it be precipitated from the water by means of ſome ſubſtance which does not contain fixable air, but which is more ſtrongly diſpoſed than the earth to unite with the water, for inſtance, ſpirit of wine, the earth thus precipitated will be in the ſtate of quicklime, that is, cauſtic, and ſoluble in water.

2. Quicklime unites with acids without efferveſcence, which is nothing elſe than an extrication of the fixable air, of which quicklime has been already deprived. It nevertheleſs ſaturates as much acid as it would have done if it had not been calcined.

3. Quicklime is more powerfully diſpoſed to unite with fixable air than fixed or volatile alkalis, or magneſia. Hence, when treated with theſe ſubſtances, it takes from them their fixable air, and is itſelf rendered mild, and reſtored to its original weight and properties. Thus two drams of chalk, having been by

calcination reduced to one dram and eight grains of quicklime, were thrown into a filtrated ſolution of an ounce of mild fixed alkali in two ounces of water, and digeſted during ſome time; by which the calcareous earth became mild, and weighed one dram and 58 gr. By means of magneſia, the calcareous earth may be precipitated from lime-water; and this earth is found to be mild, and to have deprived the magneſia of its fixable air. By depriving alkalis of their fixable air, quicklime renders them more cauſtic and ſolvent, for the ſame reaſon that itſelf is by this privation of air rendered more cauſtic and powerfully ſolvent. This increaſe of cauſticity and diſſolving power is conſiſtent with a general rule, namely, that the more ſimple or leſs compounded any body is, that is, the leſs its general tendency to union is ſatisfied, the more diſpoſed it is to unite with or diſſolve other ſubſtances.

4. Quicklime has a diſpoſition to unite with ſulphur, with which it forms a hepar of ſulphur, ſimilar to that made by ſulphur united with an alkali, and, like this, ſoluble in water. It is alſo diſpoſed to unite with oils and with animal and vegetable matters, with reſpect to which it diſcovers a cauſtic and corroſive property.

5. Quicklime mixed with ſand forms a maſs which hardens, and is uſed as a cement or mortar.

All theſe properties of quicklime have been the objects of conſideration to the chemiſts and philoſophers; who have, as uſual, been divided in their opinions on the ſubject. The evident reſemblance of the action of quicklime to fire, has given occaſion for one party to derive all the active properties of this ſubſtance from fire; while, on the other hand, its want of heat, and incapacity of ſetting bodies on fire, unleſs by an acceſſion of water, were objections altogether inſurmountable. On the other hand, thoſe who denied the materiality of fire, and affirmed that it conſiſts only in a motion mechanically produced among the particles of bodies, were altogether at a loſs to ſhow a reaſon why this motion, or any thing reſembling it, ſhould continue perhaps for months after the exciting cauſe is taken away. To remove this difficulty, ſome have had recourſe to the action of a latent acid communicated to the quicklime by the fire; and which one chemiſt (Mr. Meyer) has diſtinguiſhed by the name of *acidum pingue*. But on this hypotheſis it may be remarked in the firſt place, that the action of acids is as difficult to be explained as that of fire; and, in the ſecond place, that as all ſubſtances, by calcination into quicklime, loſe conſiderably of their weight, it ſeems very improbable that they ſhould acquire an acid or any other ſubſtance which could increaſe their weight. Beſides, from the experiments of Dr. Black, it appears that the diminution of weight in calcareous ſubſtances is owing to their parting with a quantity of fixed air, the weight of which is much more conſiderable than that of any moiſture or fatty matter they contain. The loſs of this fixed air is now alſo univerſally allowed to be the reaſon of the cauſticity of the quicklime, as its ſuperior attraction for fixed air is looked upon to be the reaſon why it renders fixed and volatile alkalis cauſtic like itſelf. The only queſtion therefore can be, By what means are the calcareous earths deprived of their fixed air? To this queſtion the anſwer is evident, namely, that the action of the fire expels the fixed air; and if this is the caſe, it is evident, that to this action of fire, continued, the cauſtic properties of the lime are owing.

We come now to the diſcuſſion of the queſtion, Whether quicklime is to be conſidered as a pure earth, or a combination of it with ſomething elſe?—Moſt of the chemiſts, ſince the diſcovery of fixed air, have been inclined to think that quicklime is a pure earth uncombined with any thing elſe, and that it approaches more nearly to the ſtate of elementary earth than any other. But this opinion ſeems not to have a ſolid foundation; for there are other earths, ſuch as the baſis of alum, which, as far as they can be examined by us, are equally pure with quicklime, and yet diſcover not the ſmalleſt cauſticity, even after the moſt violent calcination. Beſides, from the property which quicklime has of depriving alkaline ſalts of their fixed air, we may learn, that there exiſts in it, when kept by itſelf, a certain principle which prevents it from abſorbing again the fixed air, with which it was once ſo cloſely united, except in certain circumſtances. It is well known, that fixed alkalis, as well as thoſe which are volatile, will abſorb fixed air from the common atmoſphere; and hence, though they are prepared in the moſt cauſtic ſtate, they will in a very ſhort time become mild by an expoſure to the atmoſphere; nay, it requires no ſmall degree of care to prevent the atmoſphere from having as much acceſs to them as is neceſſary to change them from a cauſtic to a mild ſtate. Now, as theſe ſubſtances thus attract the fixed air from the atmoſphere, it thence appears that the atmoſphere parts very readily with the fixed air which it contains. The quicklime, however, though it has a greater attraction for fixed air than the alkalis, yet does not become near ſo ſoon mild from expoſure to the air as the alkalis which have leſs attraction than itſelf. Hence the neceſſary inference muſt be, that quicklime, after being once calcined, inſtead of attracting, repels fixed air, unleſs it is placed in certain circumſtances, wherein the repelling power is deſtroyed, and the attractive power again manifeſts itſelf. Now it is manifeſt, that the power which originally repelled the fixed air was the action of fire; and conſequently, while the quicklime refuſes to attract fixed air, we muſt conclude that it is the ſame action which prevents the union. Quicklime therefore is not a pure earth, but a combination of a pure earth with fire; juſt as chalk, or limeſtone uncalcined, is not a pure earth, but a combination of a pure earth with fixed air. In all chemical trials, then, where quicklime is uſed, the double elective attraction will manifeſt itſelf as much as in a combination of different ſalts, metals, and acids. Thus, when water is poured on quicklime, the attraction between that element and earth is ſtronger than the attraction between earth and fire. The conſequence is, that the water expels the fire, juſt as vitriolic acid poured upon ſea-ſalt expels the marine acid. The fire, then, having nothing with which it can form a chemical combination, becomes ſenſible to the touch, firſt making the lime very hot, and then gradually diſſipating in the atmoſphere. However, as the water combines with the earth but in very ſmall quantity, it can only expel the fire from that quantity with which it does combine; and conſequently the lime ſtill retains its cauſtic quality, though in a degree ſomewhat milder than what it was originally. We muſt alſo conſider, that water itſelf has a conſiderable attraction for fire as well as for earth; and the conſequence of this muſt be, that part of the lime will be diſſolved in the water, if more of that element is added than what the earth can abſorb without loſing the form of a dry powder. Hence the origin of lime-water, which is only a ſmall quantity of lime in its cauſtic ſtate diſſolved a large quantity of water. This diſſolution is owing to the double attraction of fire to earth and water; for, as long as the water can admit the calcined earth to that intimate union with itſelf which is called a *chemical combination*, the earth muſt ſtill retain all the cauſticity which the fire gives it, and diſſolve in the water. When the earth is in too large quantity to be thus combined with the water, the latter is only abſorbed into the pores of the earth, where by its bulk it ſplits the ſtone or calcined matter all to pieces, and reduces it to an impalpable powder, expelling a proportionable quantity of fire from thoſe pores which it now occupies. The water, however, is capable of radically diſſolving but a very ſmall portion of calcined earth: and therefore the ſame quantity of quicklime will ſerve for preparing lime-water a great number of times over; but at laſt a large quantity is left, which ſeems to be quite inert, and has loſt the properties of quicklime. Thoſe who have tried the experiment of lixiviating lime with freſh quantities of water till it ceaſes to be ſoluble, have fixed the proportion of ſoluble matter in the lime at about one-third of the whole; but from Dr. Black's experiments it appears that quicklime may all be diſſolved in water at once, provided the water is in ſufficient quantity. Its inactivity, therefore, after repeated affuſions of water, muſt be owing to ſome change produced by the water; but whether this is owing to an abſorption of all the fire it contained by the great quantity of water, or to a ſupply of fixed air given by the water, has not yet been determined by any experiment.

If, inſtead of pouring cold water upon quicklime, we pour that which is already heated, the abſorption is much leſs complete; becauſe the water, having already a ſuperfluous quantity of heat, is reſiſted by that which is contained in the quicklime in a latent ſtate; and hence it is a general obſervation, that hot water is leſs proper for ſlaking lime than cold. But if we pour any acid upon quicklime which contains a great quantity of fire in a latent ſtate, and has likewiſe a violent attraction for the earth, a much greater degree of heat is produced than with ſimple water. With the vitriolic acid, indeed, this is not ſo well perceived, if the common calcareous earths are made uſe of; becauſe their inſolubility in this acid diminiſhes its effect: but if, inſtead of theſe earths, we take magneſia newly calcined, the heat is ſo great, that the aqueous vapour, not having time to evaporate ſlowly, is driven off with a conſiderable exploſion. If the common calcareous earths, well calcined, are diſſolved in the nitrous acid, a moſt violent degree of heat is produced; more indeed than in any other caſe where a liquid is concerned: for the nitrous acid itſelf contains a great deal of latent heat; the quicklime does the ſame; and by the intimate union of the earth with the acid, all this latent heat, at leaſt a great part of it, both in the quicklime and ſpirit of nitre, is diſplaced, and attacks the aqueous fluid, as being neareſt to it; from whence it is diſſipated in the air, or abſorbed by the neighbouring ſubſtances. The ſame thing happens, only in a leſs degree, when the marine acid is employed.

When quicklime is mixed with a ſolution of mild alkali, a double decompoſition, and two new compoſitions, take place. The quicklime may be conſidered as a combination of earth and fire, while the alkali in the preſent caſe acts as a combination of ſalt and air. Theſe two ſubſtances, therefore, are no ſooner put into ſuch circumſtances as enable them to act on each other, than the quicklime attracts the air from the alkali, and gives its own fire in exchange, which the alkali takes up, and thus is rendered cauſtic, while the quicklime becomes mild. Nevertheleſs, though the alkali here ſeems to have the greater attraction for fire, and the quicklime for air; yet it appears that the alkali is by no means capable of keeping the fire which it has imbibed for any length of time: for, no ſooner is it expoſed to the action of the air, than it parts with the fire which it had imbibed, regains its air, and becomes mild. This, however, in all probability is owing to its extreme ſolubility in water while in a cauſtic ſtate; for quicklime itſelf, when diſſolved in water, very eaſily regains its fixed air, nay, even more than it contains in a natural ſtate. See the article SALT.

On the whole, then, the properties of quicklime may be explained in a very eaſy manner on Dr. Black's principle of latent heat. That heat conſiſts in a latent ſtate in quicklime, as well as in vapour, we have inconteſtable proofs; becauſe, in all caſes where quicklime changes its nature and becomes more mild, a degree of heat is produced, and which is always proportionable to the change made on the quicklime. In the making of quicklime, therefore, the air is expelled, and a proportional quantity of fire enters; in diſſolving it in an acid, ſlaking, &c. an acid, air, or water, expels part of the heat, which then becomes ſenſible. By long expoſure to the air, the heat gradually evaporates; the fixed air reſumes its place; and the quicklime, being thus increaſed in bulk, embraces thoſe bodies very cloſely which lie neareſt to it; inſomuch that, when mixed with ſand and ſtones, it will harden with them almoſt into the ſolidity of a rock (ſee CEMENT and MORTAR). When mixed with animal or vegetable ſubſtances, it deſtroys or decompounds them, both by the action of its internal heat, and by its attraction for a certain acid contained in the animal ſubſtances, and an oily matter in the vegetables; and hence its property of burning cloth, though its attraction for the oily matter juſt mentioned makes it an excellent whitener when properly applied. See BLEACHING.

QUICKSILVER, or MERCURY, one of the perfect metals, and ſo fuſible that it cannot be reduced to a ſolid ſtate but by the moſt intenſe degree of cold, ſcarcely, if at all, under 40° below 0 of Fahrenheit's thermometer. See CONGELATION. For the method of extracting quickſilver from its ore, &c. ſee METALLURGY. For the various preparations, &c. from it, ſee CHEMISTRY and PHARMACY. And for its uſe in medicine, ſee MEDICINE, and MERCURY.

1. It is found *Native*, as in the mines of India, Friuli, Lower Auſtria, Deux Ponts, &c. flowing through beds of ſtone, and collecting in the clefts or cavities of rocks. In theſe mines, however, Mr. Kirwan is of opinion that it is mixed with ſome other metal, as the globules into which it is divided are not perfectly ſpherical. In Sweden and Germany it has been found united to ſilver in form of a hard and ſomewhat brittle amalgam. It has alſo been obſerved viſibly diffuſed through maſſes of clay or ſtone, of a white, red, or blue colour, and very heavy in Spain and Idria; and in Sicily in beds of chalk.

Mines of quickſilver, however, are very rare, inſomuch that, according to the calculations of Hoffman, there is 50 times more gold got every year out of the mines than mercury and its ores. But Dr. Lewis in his notes upon Neumann ſays, that Cramer ſuſpects that Hoffman only meant five times inſtead of 50: but neither the Latin nor the Engliſh edition of this author expreſſes any ſuch thought; on the contrary, he adopts the ſame opinion; and only adds, that mercury is much more frequently met with than is commonly believed; but being ſo volatile in the fire, it often flies off in the roaſting of ores, and eſcapes the attention of metallurgiſts.

According to Neumann, the mines of Idria have produced at the rate of 231,778 pounds weight of mercury *per annum*; but thoſe of Almaden in Spain produce much more. The chemiſts of Dijon inform us, that their annual produce is five or ſix thouſand quintals, or between five and ſix hundred thouſand pounds weight. In the year 1717 there were upwards of 2,500,000 pounds of quickſilver ſent from them to Mexico, for the amalgamation of the gold and ſilver ores of that country.

At Guancavelica in Peru, the annual produce of the mines, according to Bomare, amounts to one million of pounds, which are carried over land to Lima, thence to Arica, and laſtly to Potoſi, for the ſame purpoſe.

Beſides theſe mines there are others in Braſil near Villa Rica, where ſuch a quantity of cinnabar and native running mercury are found near the ſurface of the earth, that the black ſlaves often collect it in good quantities, and ſell it for a trifling price to the apothecaries; but none of theſe mines have ever been worked or taken notice of by the owners. Gold naturally amalgamated with mercury is likewiſe met with in the neighbourhood of that place; and it is ſaid that almoſt all the gold mines of that country are worked out by ſimply waſhing them out with running water, after reducing into powder the hard ores, which are ſometimes imbedded in quartzoſe and rocky matrices.

In the duchy of DeuxPonts, and in the Lower Auſtria, the quickſilver flows from a ſchiſtoſe or ſtony matrix, and is probably, ſays Mr. Kirwan, mixed with ſome other metal, as its globules are not perfectly ſpherical. The mines of Friuli are all in ſimilar beds or ſtrata. The metal is likewiſe found viſibly diffuſed through maſſes of clay or very heavy ſtone, of a white, red, or blue colour; of which laſt kind are the mines of Spain, ſome of Idria, and of Sicily. Maſcagni found fluid quickſilver, as well as native cinnabar and mineral ethiops, near the lake of Pravale in the duchy of Sienna; but the quantity was ſo ſmall as not to be worth the expenſe of working. On the other hand, the following mines afford profits to the owners after clearing all expenſes, viz. thoſe at Kremnitz in Hungary; at Horowitz in Bohemia; Zorge in Saxony; Wolfſteim, Stahlberg, and Moeſchfeld in the Palatinate. Mercury is alſo brought from Japan in the Eaſt Indies; but the greateſt part of what is ſold in Europe as Japan cinnabar is ſaid to be manufactured in Holland.

Lemery, Pomet, and others, lay down ſome external marks by which we may diſtinguiſh thoſe places where there are mines of quickſilver, viz. thick vapours like clouds ariſing in the months of April and May; the plants being much larger and greener than in other places: the trees ſeldom bearing flowers or fruit, and putting forth their leaves more ſlowly than in other places; but, according to Neumann, theſe marks are far from being certain. They are not met with in all places where there is quickſilver, and are obſerved in places where there is none. Abundance of theſe cloudy exhalations are met with in the Hartz foreſt in Germany, though no mercury has ever been found there; to which we may add, that though vaſt quantities of mercurial ores are found at Almaden in Spain, none of the above-mentioned indications are there to be met with.

Native mercury was formerly ſought from the mines of Idria with great avidity by the alchemiſts for the purpoſe of making gold; and others have ſhown as ridiculous an attachment to the Hungarian cinnabar, ſuppoſing it to be impregnated with gold; nay, we are informed by Neumann, that not only the cinnabar, antimony, and copper of Hungary, but even the vine-trees of that country, were thought to be impregnated with the precious metal. Not many years ago a French chemiſt advertiſed that he had obtained a conſiderable quantity of gold from the aſhes of vine-twigs and ſtems, as well as of the garden ſoil where they grew; but the falſehood of theſe aſſertions was demonſtrated by the count de Lauragais to the ſatisfaction of the Royal Academy of Sciences.

The reduction of mercury into a ſolid ſtate, ſo that it might be employed like ſilver, was another favourite alchemical purſuit. But all proceſſes and operations of this kind, ſays Neumann, if they have mercury in them, are no other than hard amalgams. When melted lead or tin are juſt becoming conſiſtent after fuſion, if a ſtick be thruſt into the metal, and the hole filled with quickſilver, as ſoon as the whole is cold, the mercury is found ſolid. Macquer informs us, that mercury becomes equally ſolid by being expoſed to the fumes of lead. Maurice Hoffman, as quoted by Neumann, even gives a proceſs for reducing mercury, thus coagulated, to a ſtate of malleability, viz. by repeatedly melting and quenching it in linſeed oil. Thus, he tells us, we obtain a metal which can be formed into rings and other utenſils. But here the mercury is entirely diſſipated by the repeated fuſions, and nothing but the original lead is left. Wallerius, after mentioning ſtrong ſoap leys, or cauſtic lixivium, and ſome other liquors proper for fixing quickſilver, tells us, that by means of a certain gradatory water, the compoſition of which he learned from Creuling *de Aureo Vellere*, he could make a coagulum of mercury whenever he pleaſed, of ſuch conſiſtency that great part of it would reſiſt cupellation; but what this gradatory water was, he has not thought proper to lay before the public.

2. *Native precipitate per ſe*, in which the metal is mineralized by aerial acid. This was lately found in Idria, in hard compact maſſes of a browniſh red colour and granular texture, mixed with ſome globules of native mercury. A hundred parts of it afford 91 of running mercury.

Various litttle globules of mercury were contained in this ore, which are rendered very viſible by being heated, but are ſoon reabſorbed by cooling. On expoſing it to the fire in an iron ſpoon, the red colour ſoon became more vivid, but turned yellowiſh on cooling. Diſtilled in a pneumonic apparatus, a quantity of dephlogiſticated air was produced, though leſs by one fourth than what ſhould have been produced by an equal quantity of cinnabar. On diſtilling an ounce of this ore in a glaſs retort, a little yellow powder was left, which weighed a fourth part of a grain, and ſtained the bottom of the retort in a manner ſimilar to what is done by the calx of ſilver to white glaſs in ſimilar circumſtances. On cupelling this powder with 144 grains of lead wrapped up in paper, the increaſed weight of the lead over that of the teſt of compariſon ſhowed that the calx was reduced into its metallic ſtate of ſilver, and mixed with that of lead.

3. *Mineraliſed by the vitriolic and marine acids.* This kind of ore was firſt diſcovered in the year 1776, at Obermoſchal in the duchy of Deux Ponts. It has a ſpar-like appearance, and is either bright and white, or yellow or black, and mixed with cinnabar in a ſtony matrix. The native marine ſalt of mercury is in the ſtate of corroſive ſublimate.

4. *Native cinnabar*, in which the metal is mineraliſed by ſulphur. This is of different ſhades, from a yellowiſh to a deep red; and is found either pure in hard friable maſſes, either ſhapeleſs or cryſtallized in cubes, and ſometimes tranſparent, or intermixed with clay or ſtone, or interſperſed through the ores of other metals, particularly thoſe of ſilver, copper, or martial pyrites. Its texture is either radiated, ſtriated, ſcaly, or granular A hundred parts of cinnabar contain about 80 of mercury and 20 of ſulphur; but artificial cinnabar contains a little more ſulphur, and hence its colour is darker. Its ſpecific gravity is about 7.000; it ſublimes in cloſe veſſels, and is decompoſed and volatilized in open ones. It is found in the duchy of Deux Ponts, in the Palatinate, in Hungary, Friuli, and Almaden, in Spain, and in South America, eſpecially at Guancavelica in Peru. It is ſometimes compact, and ſometimes found in tranſparent, ruby-coloured cryſtals, and often in a kind of ſcales or flattened laminæ. It is called native vermilion, and cinnabar in flowers, when it is in the form of a very bright red powder. It is alſo found in different earths, in ſelenite mixed with iron, with pyrites, and with ſulphur. Mr. Fourcroy enumerates the following varieties: 1. Tranſparent cinnabar, red and cryſtallized in very ſhort triangular priſms, terminated by triangular pyramids. 2. Tranſparent red cinnabar, in octohedral cryſtals, conſiſting of two triangular pyramids united at their baſes and truncated. 3. Solid compact cinnabar, of a brown or bright red; it is ſometimes foliated. 4. Red cinnabar diſtributed in ſtriæ, on a ſtony matrix, or on ſolid cinnabar. It is ſometimes compoſed of needles like cobalt. 5. Cinnabar in flowers, or native vermilion. It is of a bright red colour, and ſatin appearance, adhering to different matrices, in form of a very fine powder. It is ſometimes cryſtallized in very ſmall needles, and then greatly reſembles the foregoing.

The finer-coloured ores of mercury are never worked for extracting the metal, but uſed entirely as pigments; but they have been very injudiciouſly preferred for medicinal uſes to the more pure factitious cinnabars; for we ſeldom meet with any native cinnabar that has not ſome earthy or ſtony matter intermixed with it, nor with two pieces that perfectly agree. There are three varieties principally diſtinguiſhed in the ſhops; viz. 1. Cinnabar in maſſes weighing from one to ſix ounces or more. 2. In grains, prepared by breaking the worſe coloured maſſes, and picking out the beſt coloured bits. 3. Waſhed cinnabar, prepared by waſhing over the lighter impurities that are to be found in it. No native cinnabar ſhould ever be employed in medicine without being previouſly purified by ſublimation. Neumann informs us that he never met with any native cinnabar which did not leave a gray aſh or ſand, amounting, among different parcels, from one ninth to one fifth of the mineral employed. The reſiduum had no gold in it, though the colour of its ſolution and precipitate gave ſome expectation of it at firſt ſight.

Neumann remarks, that though vitriolic acid forms with mercury a lively yellow concrete, viz. turbith mineral, and with the inflammable principle a yellow ſulphur; and though ſulphur itſelf forms with mercury a beautiful red cinnabar; yet the ſame vitriolic acid deſtroys the red colour entirely, rendering it as white as milk. This change is not immediately produced on common cinnabar by the vitriolic acid; but, on being digeſted over a ſtrong ſand heat in a glaſs cup, it ſoon becomes as white as cream; and the vitriolic acid takes the form of a ſtrong ſulphureous and volatile vapour, very ſuffocating and corroſive; emitting very piercing fumes for ſome time, which turned the paper that covered it black, and deſtroyed its texture.

5. *Black ore of mercury*, in which the metal is mineralized by ſulphur and copper. This is of a blackiſh gray colour, a glaſſy texture, brittle, heavy, and decrepitating ſtrongly when heated. It is found at Muſchel Lanſberg. An ore of this kind is alſo found in the duchy of Deux Ponts. In the ſulphur of Idria a black cinnabar is likewiſe ſaid to be found, which retains its colour in ſublimation: but this is not yet ſufficiently confirmed, though it is too bold an aſſertion of Dr. J. R. Forſter that no ſuch cinnabar has ever been found. He adds, that a certain learned man thought he had diſcovered ſome near the copper ores at Lauterberg; but that it proved to be a red copper calx, which is ſtill to be met with in that place.

6. *Pyritous mercurial ore* was brought from Dauphiny by Mr. Montigny in 1768. It is gray, whitiſh, and friable. A hundred parts yielded one of mercury, one half of ſilver, the remainder being iron, cobalt, ſulphur, and arſenic.

7. An ore of mercury, in which the metal is *mineralized with iron by ſulphur*, is mentioned by ſir Torbern Bergman in his *Sciagraphia*, ſect. 177. He ſays that it is doubtful whether this does not belong to the ſpecies of cinnabar, as the iron is perhaps only mechanically diffuſed thereon. Mr. Mongez informs us, that there are but few inſtances of cinnabar in which iron is not found in its calcined form, though, in the act of the ore being reduced, it paſſes to its metallic ſtate, and becomes capable of being acted upon by the loadſtone.

Another pyritous ore of cinnabar was found at Menidot, near St. Lo in Lower Normandy. It conſiſted of differently ſized grains of a red brown colour: they had a vitriolic taſte and ſulphureous ſmell. Pyritous ores of this kind are likewiſe found at Almaden in Spain, and at Stahlberg in the Palatinate. The cinnabaric pyrites of this laſt place are of a dodecahedral form.

8. Mr. Gellert informs us, that an ore of quickſilver is met with in Idria, where the mercury lies in an earth or ſtone, as if it were in a dead form; and has the appearance of a red-brown iron-ſtone, but much heavier. It contains from three quarters to ſeven-eighths of the pureſt mercury, leaving after diſtillation a very black ſtrong earth, giving alſo ſome marks of cinnabar. For, as we do not know the ultimate diviſibility of mercury, we cannot juſtly determine the point of its fluidity, although its globules may be no more diſcernible.

The *liver-ore*, which is moſt common in Idria, and has its name from its colour, reſembles an indurated iron clay; but its weight diſcovers it to have metallic contents. A hundred weight of it ſometimes yields 80 pounds of quickſilver.

The *brand-erz*, or burning ore of the Germans, likewiſe belongs to this ſpecies. It may be lighted at a candle, and yields from 9 to 50 pounds of metal in the 100.

9. Dr. Gmelin informs us, that cinnabar mixed with arſenic or realgar is ſaid to be found in Japan; and that at Morsfield the cinnabar and white calx of arſenic preſent themſelves in the ſame rock.

10. Beſides the ores already mentioned, we ſometimes meet with quickſilver *natively amalgamated* with gold, ſilver, and other metals. This is taken notice of by Bergman; and from the authorities of Monet and Prof. Gmelin, Mr. Kirwan informs us, that in Sweden and Germany this metal has been found united to ſilver in a hard and brittle amalgam. M. de l'Iſle had a ſpecimen of this ore from Germany; which, as M. Mongez informs us, is imbedded in a quartzoſe maſs, and mixed with cinnabar. A ſpecimen brought from the mine called *Carolina*, in a cryſtalline form, was depoſited in the royal cabinet at the king's garden at Paris. M. de l'Iſle likewiſe informs us, that a ſpecimen of native gold was brought from Hungary, which, according to Cronſtedt, was probably an amalgam of mercury and gold. It is compoſed of quadrangular priſms, of a grayiſh yellow colour, and brittle texture. Neumann likewiſe obſerves, that ſometimes a mineral containing gold or ſilver is met with among mercurial ores, though very rarely.

Theſe natural amalgams account for the great ſpecific gravity of ſome kinds of quickſilver. This may proceed from a natural mixture of gold, though, according to Boerhaave, it may alſo ariſe from its being rediſtilled a great number of times. By a ſimilar mode of reaſoning we may conclude, that the ſmalleſt ſpecific gravities of quickſilver proceed from its amalgamation with ſilver, lead, and other metals or ſemimetals, which in ſpite of repeated diſtillations may ſtill preſerve their union with it; for Dr. Boerhaave informs us that he could not, by any number of diſtillations, free mercury perfectly either from tin or lead.

M. Magellan, in his Notes on Cronſtedt's Mineralogy, ſays, "That mercury is many times found amalgamated with lead, is eaſily evinced by the proceſs of M. Groſſe mentioned by Macquer in his Elements of Chemiſtry, where the method of extracting mercury from ſome ſolutions of lead is deſcribed; but the ſame Macquer, in his Chemical Dictionary, poſitively affirms, that, though Becher and Kunckel have both given other proceſſes for extracting mercury from lead, and though the method pointed out by M. Groſſe is eaſier than the others, nevertheleſs it does not ſucceed if the lead be quite pure without any amalgamation with mercury. And Boerhaave has expreſsly made the ſame aſſertion, complaining of thoſe authors who affirm the contrary." Dr. Black, however, ſeems to be of a different opinion; and, in his public courſe of lectures, teaches that, "by ſome proceſſes of the more difficult kind, mercury may be extracted from lead;" though he cautions us, at the ſame time, not to infer from this, or any other chemical proceſs, the poſſibility of the tranſmutation of metals.

Mercury is not in any way altered by the action of light. Its dilatation by heat is extremely regular, as has lately been ſhown, in a very great variety of experiments, by Dr. Adair

Crawford; for which reaſon it is uſed as the meaſure of heat, and thermometers are uſually filled with this metal. When oppoſed to the heat of about 600° of Fahrenheit, it boils and is diſperſed in an inviſible fume; which, however, has been obſerved to have the elaſticity of the ſteam of water, and to burſt an iron box in which it was attempted to confine it. If it be made to boil in a cloſe veſſel fitted with a proper apparatus, it will all come over in its proper form, and leave any fixed matter it might contain in the retort. This affords an eaſy method of purifying it from the baſe metals with which it is frequently adulterated; though even in this way it is neceſſary to raiſe the fire cautiouſly, or a part of the fixed metal will be carried up along with the mercury. And even with all the care that can be taken, it has been found impoſſible, as has been already ſaid, to free it perfectly from a mixture of the baſe metals by any number of diſtillations.

By a very great number of diſtillations, however, it was ſaid that ſome change might be made upon this metal; and that it became not only purer, but ſpecifically *heavier*, by ſuch an operation. Boerhaavé, after making it undergo this operation 511 times, found ſome difference; but three years after, in a Memoir inſerted in the Philoſophical Tranſactions for 1736, he acknowledged, that, on repeating the operation 877 times, its ſpecific gravity, as ſhown by Dr. Graveſande's nice hydroſtatic balance, appeared to be no more than 13.500 to diſtilled water.

" Boerhaave died (ſays Mr. Magellan in his notes on Cronſtedt's Mineralogy) two years after, on the 23d of September 1738, and left his papers to his two nephews, Herman, who died the 7th of October 1753, and Kaw, who died five years after. On their deaths the manuſcripts fell into the hands of Charles Frederick Kruſe phyſician to the Emperor of Ruſſia. This gentleman publiſhed a ſhort extract from Boerhaave's Diary in the ninth volume of the *Novi Commentarii* of the Imperial Academy of Peterſburg, of which the following are the reſults.

" The ſpecific gravity of the pureſt gold to that of diſtilled water is - - - -	19,024
That of mercury diſtilled once in a retort -	13,570
Diſtilled 1009 times - - -	13,590
Once from its amalgam with gold - -	13,550
750 times from the ſame amalgam -	13,520
877 times from the ſame - - -	13,500
Once from its amalgam with ſilver -	13,550
217 times from the ſame amalgam - -	13,500

" It is evident, therefore, by theſe facts, that mercury does not acquire any additional increaſe to its ſpecific gravity by the mere repetition of ſimple diſtillations, nor by its amalgamations with gold or ſilver, provided it be afterwards properly ſeparated by fire."

It is certain, however, that there are very conſiderable differences in the ſpecific gravity of different ſpecimens of quickſilver; and authors have by no means agreed in fixing the ſtandard.—Bergman ſtates it at 14.110; and Muſchenbroek aſſerts that ſuch was the ſpecific gravity of Boerhaave's quickſilver that had been diſtilled 511 times: but ſome modern authors, among whom is M. Fourcroy, ſtate the ſpecific gravity of this metal at no more than 13.000. Modern experiments, however, ſhow that it is generally about 13.500 or 13.600. " This (ſays Mr. Magellan) I am informed was the mean ſpecific gravity found by the late lord Cavendiſh, after the repeated and nice trials he made upon 20 different ſpecimens of quickſilver, on which he employed all his induſtry and attention to determine this point.

" The hydroſtatical experiments I lately undertook of this kind upon ten different ſpecimens of mercury, two of which were revived from natural and artificial cinnabar by the operator of Mr. Kirwan, confirmed me in the ſame opinion.

" The temperature of the atmoſphere was nearly the mean, viz. at the 50th degree of Fahrenheit's thermometer; and the ſcales employed were ſo nice, that they turned with the hundredth part of a grain when loaded with four pounds weight. —The method made uſe of to aſcertain theſe ſpecific gravities is the eaſieſt of all. A phial of white glaſs with a ground ſtopple was counter-balanced with lead or other matter in a nice pair of ſcales. The ſubſtance to be tried was introduced into the phial and weighed together, and the weight we ſuppoſe $= a$. The remaining ſpace of the phial being then filled with diſtilled water, we ſuppoſe the weight now to be $= b$. Laſtly, the phial was filled with diſtilled water, and the weight ſuppoſed $= c$. It is evident, that $b - a = d$, the quantity of water in the ſecond operation; $c - d = e$, the water whoſe bulk is equal to that of the ſubſtance; and that $\frac{a}{e}$ is the ſpecific gravity ſought for.—Particular care was taken that no bubble of air remained in the inſide. For this purpoſe a very ſmall groove was made with a file on the inſide of the glaſs ſtopper; and this was introduced ſidewiſe without admitting any air, leaving the ſuperfluous water to ruſh out.

" The greateſt ſpecific gravity of any of thoſe ſpecimens was 13.620, and the leaſt 13.450. The heavieſt was neither of the two that had been diſtilled from cinnabar, but a common quickſilver bought at Apothecaries Hall, London; and the lighteſt was taken from a barometer of the beſt and deareſt kind made by one of the moſt reputed inſtrument-makers in England.

" The moſt obvious cauſe of this difference of ſpecific gravity in quickſilver ſeems to be its mixture or amalgamation with other metals. Certainly, when united to gold, its gravity muſt of courſe be ſpecifically augmented: on the contrary, it muſt be leſſened when united with any other metal, platina only excepted; and the ſame muſt be the caſe whether water or any other moiſture is mixed with it; for in ſuch a caſe the metal will be found heavier after evaporation. A ſimple boiling of the quickſilver over the fire in an open veſſel will completely free it from this mixture; and no careful maker of experiments ſhould neglect the preparation before he undertakes to employ mercury in any proceſs, or for any purpoſe of the philoſophic kind. The boiling muſt be continued for 20 or 30 minutes in order to expel the whole moiſture.

Another cauſe by which the ſpecific gravity of quickſilver becomes ſubject to alteration is the difference of temperature of the atmoſphere at the time of making the experiment. Nor is it quickſilver alone, but every other ſubſtance whoſe ſpecific gravity is affected by this cauſe in a greater or leſſer degree; inſomuch that Mr. Magellan does not heſitate to pronounce the labours of all thoſe who have undertaken to compoſe tables of ſpecific gravities, without regard to this circumſtance, to be, if not entirely uſeleſs, at leaſt incapable of affording proper ſatisfaction in the nice inquiries that depend on this knowledge.

In Eiſenchmid's table of ſpecific gravities it is aſſerted, that a cubic inch of mercury in ſummer weighs ſeven ounces, one gros, 66 grains; but in winter it weighs 20 grains more: the whole weight then being ſeven ounces, two gros, 14 grains (allowing 72 grains to the gros). This, however, leaves the matter almoſt in as great uncertainty as before; the ſummer and winter temperature being widely different in different places, and very often even in the ſame place. Unleſs therefore the temperature of the air is attended to at every experiment in taking the ſpecific gravity of any ſubſtance whatever, there can be no certainty of the reſult.

Quickſilver always feels cold when touched in the common temperature of the atmoſphere. Our ſenſations, according to Fourcroy, deceive us in this caſe, for a thermometer dipped in quickſilver always ſhows the common temperature. "The great continuity of contact between the live ſkin and numerous metallic particles in an equal ſpace, and which are proportional to its great ſpecific gravity, neceſſarily produces a ſtronger ſenſation of its own temperature, this being always much leſs than that of a living body; and the multiplicity of theſe points of contact being all at once applied to this organ of ſenſation, muſt be more powerfully felt than whenever we touch any other matter that is lighter in itſelf, or of a leſs denſity."

Notwithſtanding this apparent coldneſs, however, quickſilver, when expoſed to the ſame degree of heat, and in the ſame circumſtances with various other ſubſtances, ſoon becomes hotter to the touch than any of them. The fundamental principle of this (ſays Mr. Magellan) conſiſts in the ſmall quantity of ſpecific fire, or the leſs capacity which mercury is endowed with of receiving heat. This is ſuch, that, compared with the capacity of water for the ſame purpoſe, it is in the ratio of 0.033 to 1.000, as appears by the table of the quantities of ſpecific fire contained in various bodies.—This table, publiſhed in Magellan's Eſſay on Elementary Fire, was grounded upon various important experiments and obſervations made by Mr. Kirwan, in conſequence of the new Theory of Fire diſcovered by Dr. Crawford. Hence it follows, that if equal quantities of heat be communicated to equal quantities of water and mercury, the latter will have a temperature 30 times greater than that of the water; that is to ſay, in the inverſe ratio of their reſpective capacities, or as 1 to 30 (= 0.033 : 1.000), in the ſame manner as it muſt happen, when equal meaſures of corn or of any fluid are thrown into veſſels whoſe bottoms are as 30 to 1; for then their heights muſt neceſſarily be in their inverſe ratio, viz. of 1 to to 30, &c. See CHEMISTRY.

Quickſilver does not appear to diſſolve in water; but Fourcroy remarks, that phyſicians are in the practice of ſuſpending a bag full of it in vermifuge ptiſans during their ebullition, and that experience has evinced the good effects of it. Lemery aſſerts, that in this proceſs there is no loſs of weight; but this is denied by others. Fourcroy aſſerts, that this metal, rubbed between the fingers, emits a perceptible odour, though Magellan ſays he tried the experiment many times without ſucceſs.

Fourcroy likewiſe aſſerts, that mercury when pure emits a phoſphoric light by agitation, particularly in hot ſeaſons. This phenomenon has certainly been obſerved in the mercury of the barometer; but its appearance on other occaſions reſts entirely on the authority of Mr. Fourcroy. Even in the barometer it does not take place unleſs the Torricellian vacuum be not perfectly made in the ſpace at the top of the tube. Phials of glaſs nearly exhauſted of air, and containing ſome quickſilver hermetically ſealed up, will, on being ſhaken, produce as much light in the dark as is ſufficient to ſhow the hour on the dial-plate of a watch. But if a perfect vacuum be produced by nicely boiling the quickſilver within the glaſs, no appearance of this kind is to be perceived. The phenomenon is certainly of the electrical kind; and its not appearing in the perfect vacuum is owing to the difficulty there is in ſetting in motion any large quantity of electric matter by itſelf, which indeed can ſcarce be done without producing very violent effects.

Mercury unites with all the metals and ſemimetals, excepting iron and regulus of antimony. Theſe compounds are called *amalgams*; and Mr. Machy has obſerved that in forming them a certain degree of cold is produced. He made the experiment by covering the ball of a thermometer with tin-foil, and then dipping it into quickſilver; upon which that in the thermometer fell ſome degrees: which agrees perfectly well with the doctrine of latent heat firſt diſcovered by Dr. Black, as it ſhows that in this, as well as other caſes, where a body paſſes from a ſolid into a fluid ſtate, a degree of cold is produced.—The following obſervations on the amalgams of mercury with different metals are extracted from the Memoirs of the Academicians of Dijon.

1. The amalgam of gold and mercury cryſtallizes into quadrangular pyramids. Six ounces of mercury are retained by one of gold in this cryſtallization; but that with ſilver retains a third part more of quickſilver.

2. The amalgam with ſilver is likewiſe ſuſceptible of cryſtallization, and aſſumes the form of a tree; every ounce of ſilver retaining eight of mercury. This amalgam by means of the nitrous acid, well freed from the vitriolic by ſolution of ſilver in the ſame, forms that curious kind of vegetation, called *Arbor Dianæ*, or *Arbor Philoſophorum*.—The following is recommended by Mr. Magellan as the ſhorteſt proceſs:

"Diſſolve 228 grains of ſilver, and half as much quickſilver, in pure nitrous acid. Add to the ſolution when made, five ounces (of 576 grains each) of diſtilled water. Put this ſolution into a ſpherical veſſel of white glaſs, at the bottom of which muſt already be put 432 grains of an amalgam of ſilver of the conſiſtence of butter: let the veſſel be kept in a quiet place, free from any ſhaking or external agitation; and at the end of ſome few hours, the figure of a buſh or tree of ſilver will be formed within the water of the glaſs veſſel. The metals contained in the ſolution and in the amalgam attract each other, and a number of ſmall tetrahedral cryſtals are formed, which lay hold at one another's end, and form the appearance of a vegetation.

3. Copper is amalgamated with mercury with great difficulty, and only by mixing blue vitriol with mercury and water in an iron retort over the fire. The acid then attacks the veſſel, and the copper is precipitated in a metallic ſtate, which by ſtirring it with a hot iron ſpatula, unites to the mercury, but does not cryſtallize.

4. Two ounces of melted lead poured on a pound of mercury produce a half fluid amalgam, which being decanted gives ſome cryſtals like thoſe of ſilver. One ounce of theſe cryſtals retains an ounce and a half of mercury.

5. The amalgam of tin cryſtallizes into thin ſhining lamellæ, with polygonous cavities between one another. Two ounces of tin retain ſix of mercury in this cryſtallization.

6. Mercury amalgamates with biſmuth by means of heat, and produces cryſtals of an octohedral form, and lamellated triangles and hexagons. They are black on the upper ſurface, and ſhining underneath. In this cryſtallization the biſmuth retains double its weight of mercury.

7. *Zinc*, in fuſion, poured upon mercury, produces a crackling noiſe reſembling that produced by a hot body thrown into boiling water. It cryſtallizes very well into lamellated hexagonal figures, leaving cavities among themſelves. One ounce of zinc retains two and a half of mercury in this cryſtallization.

8. *Quickſilver* does not amalgamate with arſenic, except by heat, and then only in very ſmall quantity.

This metal anſwers very important purpoſes both in medicine and the arts. Though it has no perceptible taſte, it produces very remarkable effects on the ſtomach and inteſtines of animals, as well as on the ſurface of the ſkin. Inſects and worms are extremely ſenſible of this effect, and the metal, almoſt in any ſtate, is exceedingly pernicious to them. Phyſicians, therefore, employ it as a vermifuge (ſee MEDICINE), and it is likewiſe one of the moſt powerful remedies in the materia medica for many obſtinate diſorders beſides thoſe of the venereal kind, in which its efficacy under the form of *hydrargyrus muriatus* or corroſive ſublimate has long been celebrated.

But whatever uſes this ſalt may be put to when taken in ſmall quantities, it is certainly not leſs violent than arſenic itſelf, if taken in a large doſe; and the danger is the greater, on account of the difficult ſolution of the ſalt, which requires for this purpoſe 19 times its weight of water. The late Dr. Houlſton however diſcovered, that a ſolution of alkaline ſalts proves a very effectual antidote, and will inſtantly relieve the ſymptoms; but, on account of the inſolubility of the poiſonous ſalt, the diſorders occaſioned by it ſoon return, and require a repetition of the ſame remedy. In caſes where alkaline ſalts are not immediately at hand ſoap diſſolved in water will anſwer the ſame purpoſe; or if this alſo ſhould not be inſtantly procureable, chalk, lime, ſpirit of hartſhorn, or magneſia might be uſed with good effect.

Quickſilver is employed in Chili and Peru to extract gold and ſilver, when native, from the earthy matters with which they are mixed. The principle on which this method is founded is the ſtrong mutual attraction betwixt mercury and the precious metals. By reaſon of this the ſmalleſt particles either of gold or ſilver form an amalgam with the mercury, part of which is ſtrained off, and the remainder either ſeparated by diſtillation in iron retorts, or by a kind of diſtillation *per deſcenſum*; putting it in a kind of metallic ſieve over a veſſel of water, to receive the mercury, which is driven down by a fire lighted in a veſſel above the amalgam.

The amalgam with gold ſerves alſo to gild copper or ſilver, ſo that they appear as if made of ſolid gold.—For this purpoſe the pieces are to be well cleaned, and then dipped in a weak aquafortis; then in a nitrous ſolution of quickſilver, which covers them with a kind of ſilvering. After this the amalgam of gold is very equally ſpread over them; which being done, the piece is expoſed to a heat ſufficient to volatilize the quickſilver, and the gold is then left ſtrongly adhering to the metal. The only uſe to which the amalgam of mercury with lead has hitherto been applied, is the luting glaſs veſſels in which ſpecimens of natural hiſtory are to be preſerved in ſpirit of wine. For this it is more proper than any other ſubſtance, having an excellent effect in preventing evaporation. The amalgam of tin is commonly employed in making looking-glaſſes or mirrors. The thin ſheet of tin is laid down on a large flat table of ſtone; a proper quantity of mercury, in which ſome tin has already been diſſolved to prevent it from deſtroying the tin ſheet, is rubbed over with a bunch of cloth like a flat bung, and the glaſs carefully ſlided upon it from one end to the other, in ſuch a manner that the dirty cruſt of the quickſilver is driven off before its edge; and the glaſs is then loaded with weights all over: by inclining gradually the ſtone table, the ſuperfluous mercury is diſcharged; and in a few hours both cohere together. This amalgam is uſed for exciting the electricity of glaſs globes in the common electrical machines, but is ſaid to be inferior in ſtrength to that made with zinc.

Quickſilver heated by itſelf with acceſs of air, is by degrees converted into a red powder, improperly called *Mercurius precipitatus per ſe*. It conſiſts of the calx of the metal united with the baſis of dephlogiſticated or pure air, which may be expelled from it again by a ſtrong heat; and this was the firſt method by which Dr. Prieſtley obtained this kind of air.

Mercury is not altered by the contact of air: It is only obſerved, that it becomes tarniſhed by the particles of duſt which the air depoſits; and from that circumſtance mercury has been called the loadſtone of duſt.—Though all bodies have this property, it ſeems more remarkable in mercury than any other, on account of its great ſplendour; but it is not in the leaſt changed by this circumſtance, nothing more being neceſſary to reſtore it to its original brilliancy than filtration through a piece of ſhamoy leather.

The volatility of mercury prevents it from uniting with earths in the way of fuſion: though M. Fourcroy is of opinion that its red calx, or precipitate *per ſe*, might perhaps fix in glaſſes, and colour them, as is obſerved in the calx of arſenic.

QUICK-MATCH, among artillery men, a kind of combuſtible preparation formed of three cotton ſtrands drawn into length, and dipped in a boiling compoſition of white-wine vinegar, ſaltpetre, and mealed powder. After this immerſion it is taken out hot, and laid in a trough where ſome mealed powder, moiſtened with ſpirits of wine, is thoroughly incorporated into the twiſts of the cotton, by rolling it about therein. Thus prepared, they are taken out ſeparately, and drawn through mealed powder; then hung upon a line and dried, by which they are fit for immediate ſervice.

QUID PRO QUO, in law, *q. d.* "what for what," denotes the giving one thing of value for another; or the mutual conſideration and performance of both parties to a contract.

Quid *pro quo*, or Qui *pro quo*, is alſo uſed in phyſic to expreſs a miſtake in the phyſician's bill, where *quid* is wrote for *quo*, i. e. one thing for another; or of the apothecary in reading *quid* for *quo*, and giving the patient the wrong medicine. Hence the term is in the general extended to all blunders or miſtakes committed in medicine, either in the preſcription, the preparation, or application of remedies.

QUIDDITY, QUIDDITAS, a barbarous term uſed in the ſchools for *eſſence*. The name is derived hence, that it is by the eſſence of a thing that it is *tale quid*, ſuch a *quid*, or thing, and not another. Hence what is eſſential to a thing is ſaid to be *quiddative*.

QUIETISTS, a religious ſect, famous towards the cloſe of the laſt century. They were ſo called from a kind of abſolute reſt and inaction, which they ſuppoſed the ſoul to be in when arrived at that ſtate of perfection which they called the *unitive life*; in which ſtate they imagined the ſoul wholly employed in contemplating its God, to whoſe influence it was entirely ſubmiſſive; ſo that he could turn and drive it where and how he would. In this ſtate, the ſoul no longer needs prayers, hymns, &c. being laid, as it were, in the boſom and between the arms of its God, in whom it is in a manner ſwallowed up.

Molinos, a Spaniſh prieſt, is the reputed author of Quietiſm; though the Illuminati of Spain had certainly taught ſomething like it before. The ſentiments of Molinos were contained in a book which he publiſhed at Rome in the year 1681, under the title of the *Spiritual Guide*; for which he was caſt into priſon in 1685, and where he publicly renounced the errors of which he was accuſed. This ſolemn recantation, however, was followed by a ſentence of perpetual impriſonment, and he died in priſon in the year 1696. Molinos had numerous diſciples in Italy, Spain, France, and the Netherlands. One of the principal patrons and propagators of Quietiſm in France was Marie-Bouvieres de la Mothe Guyon, a woman of faſhion, remarkable for goodneſs of heart and regularity of manners; but of an unſettled temper, and ſubject to be drawn away by the ſeduction of a warm and unbridled fancy. She derived all ideas of religion from the feelings of her own heart, and deſcribed its nature to others as ſhe felt it herſelf. Accordingly, her religious ſentiments made a great noiſe in the year 1687; and they were declared unſound, after accurate inveſtigation, by ſeveral men of eminent piety and learning, and profeſſedly confuted, in the year 1697, by the celebrated Boſſuet. Hence aroſe a controverſy of greater moment between the prelate laſt mentioned and Fenelon archbiſhop of Cambray, who ſeemed diſpoſed to favour the ſyſtem of Guyon, and who in 1697 publiſhed a book containing ſeveral of her tenets. Fenelon's book, by means of Boſſuet, was condemned in the year 1699, by Innocent XII. and the ſentence of condemnation was read by Fenelon himſelf at Cambray, who exhorted the people to reſpect and obey the papal decree. Notwithſtanding this ſeeming acquieſcence, the archbiſhop perſiſted to the end of his days in the ſentiments, which in obedience to the order of the pope, he retracted and condemned in a public manner.

A ſect ſimilar to this had appeared at Mount Athos in Theſſaly, near the end of the 14th century, called *Heſychaſts*, meaning the ſame with Quietiſts. They were a branch of the myſtics, or thoſe more perfect monks, who, by long and intenſe contemplation, endeavoured to arrive at a tranquillity of mind free from every degree of tumult and perturbation. In conformity to an ancient opinion of their principal doctors (who thought there was a celeſtial light concealed in the deepeſt retirements of the mind), they uſed to ſit every day during a certain ſpace of time in a ſolitary corner, with their eyes eagerly and immoveably fixed upon the middle regions of the belly or navel; and boaſted, that while they remained in this poſture, they found, in effect, a divine light beaming forth from their ſoul, which diffuſed through their hearts inexpreſſible ſenſations of pleaſure and delight. To ſuch as inquired what kind of light this was, they replied, by way of illuſtration, that it was the glory of God, the ſame celeſtial radiance that ſurrounded Chriſt during his transfiguration on the Mount. Barlaam, a monk of Calabria, from whom the Barlaamites derived their denomination, ſtyled the monks who adhered to this inſtitution *Maſſalians* and *Euchites*; and he gave them alſo the new name of *Umbilicani*. Gregory Palamas, archbiſhop of Theſſalonica, defended their cauſe againſt Barlaam, who was condemned in a council held at Conſtantinople in the year 1341.—See *Fenelon's Max. des Saints*.

The Mahometans ſeem to be no ſtrangers to quietiſm. They expound a paſſage in the 17th chapter of the Koran, viz. "O thou ſoul which art at reſt, return unto thy Lord, &c." of a ſoul which, having, by purſuing the concatenation of natural cauſes, raiſed itſelf to the knowledge of that being which produced them, and exiſts of neceſſity, reſts fully contented, and acquieſces in the knowledge, &c. of him, and in the contemplation of his perfection.

QUILLET (Claude), an eminent Latin poet of the 17th century, was born at Chinon, in Touraine, and practiſed phyſic there with reputation: but having declared againſt the pretended poſſeſſion of the nuns of Loudun, in a manuſcript treatiſe, the original of which was depoſited in the library of the Sorbonne, he was obliged to retire into Italy, where he became ſecretary to the marſhal d'Eſtrees, the French ambaſſador at Rome. In 655 Quillet having publiſhed in Holland a Latin poem, entitled *Callipædia*, under the name of *Galvidius Lætus*, he there inſerted ſome verſes againſt the cardinal Mazarine and his family; but that cardinal making him ſome gentle reproaches, he retrenched what related to the cardinal in another edition, and dedicated it to him, Mazarine having, before it was printed, given him an abbey. He died in 1661, aged 59, after having given Menage all his writings, and 500 crowns to pay the expenſe of printing them; but the abbé took the money and papers, and publiſhed none of them. His *Callipædia*, or the art of getting beautiful children has been tranſlated into Engliſh verſe.

QUILLS, the large feathers taken out of the end of the wing of gooſe, crow, &c. They are denominated from the order in which they are fixed in the wing; the ſecond and third quills being the beſt for writing, as they have the largeſt and roundeſt barrels. Crow-quills are chiefly uſed for drawing. In order to harden a quill that is ſoft, thruſt the barrel into hot aſhes, ſtirring it till it is ſoft, and then taking it out, preſs it almoſt flat upon your knee with the back of a penknife, and afterwards reduce it to a roundneſs with your fingers. If you have a number to harden, ſet water and alum over the fire, and while it is boiling put in a handful of quills, the barrels only, for a minute, and then lay them by.

QUIN (James), a celebrated performer on the Engliſh ſtage, was born at London in 16 3. He was intended for the bar; but preferring Shakeſpeare to the ſtatutes at large, he, on the death of his father, when it was neceſſary for him to do ſomething for himſelf, appeared on the ſtage at Drury-lane. In 1720, he firſt diſplayed his comic powers in the character of Falſtaff, and ſoon after appeared to as great advantage in Sir John Brute; but it was upon Booth's quitting the ſtage that Quin appeared to full advantage, in the part of Cato. He continued a favourite performer until the year 1748, when, on ſome diſguſt between him and Mr. Rich the manager, he retired to Bath, and only came up annually to act for the benefit of his friend Ryan; until the loſs of two front teeth ſpoiled his utterance for the ſtage. While Mr. Quin continued upon the ſtage, he conſtantly kept company with the greateſt geniuſes of the age. He was well known to Pope and Swift; and the earl of Cheſterfield frequently invited him to his table: but there was none for whom he entertained a higher eſteem than for the ingenious Mr. Thomſon, to whom he made himſelf known by an act of generoſity that does the greateſt honour to his character; and for an account of which ſee our life of Thomson. Mr. Quin's judgment in the Engliſh language recommended him to his royal highneſs Frederick prince of Wales, who appointed him to inſtruct his children in ſpeaking and reading with a graceful propriety; and Quin being informed of the elegant manner in which his preſent majeſty delivered his firſt gracious ſpeech from the throne, he cried out in a kind of ecſtaſy, "Ay—I taught the boy to ſpeak!" Nor did his majeſty forget his old tutor; for, ſoon after his acceſſion to the throne, he gave orders, without any application being made to him, that a genteel penſion ſhould be paid to Mr. Quin during his life. Mr. Quin, indeed, was not in abſolute need of this royal benefaction; for as he was never married, and had none but diſtant relations, he ſunk 2000l. which was half his fortune, in an annuity, for which he obtained 200l. a-year; and with about 2000l. more in the funds, lived in a decent manner during the latter part of his life at Bath, from whence he carried on a regular correſpondence with Mr. Garrick, and generally paid a viſit to his friends in the metropolis once a year, when he conſtantly paſſed a week or two at Mr. Garrick's villa at Hampton. He died of a fever in 1766.

QUINARIUS, was a ſmall Roman coin equal to half the denarius, and conſequently worth about three pence three farthings of our money. See Money. It was called *quinarius*, becauſe it contained the value of five aſſes, in the ſame manner as the denarius was named from its containing ten.

QUINAUT (Philip), a celebrated French poet, born of a good family at Paris in 1635. He cultivated poetry from his infancy, and 16 dramatic pieces of his were acted between the year 1653 and 1666. In the mean time, Quinaut was not ſo much devoted to poetry but that he applied himſelf to the ſtudy of the law; and made his fortune by marrying the widow of a rich merchant to whom he had been uſeful in his profeſſion. Quinaut afterwards turned his attention to the compoſing of operas, which were ſet to muſic by the famous Lully; and Lully was charmed with a poet whoſe verſes were not too nervous to yield to the capricious airs of muſic. He died in 1688, after having enjoyed a handſome penſion from Louis XIV. for many years: and we are told he was extremely penitent in his laſt illneſs for all thoſe of his compoſitions which tended to inſpire love and pleaſure.

QUINCE, in botany. See Cydonia.

QUINCUNX, in Roman antiquity, denotes any thing that conſiſts of five-twelfths of another; but particularly of the *as*.

Quincunx *Order*, in gardening, is a plantation of trees, diſpoſed originally in a ſquare conſiſting of five trees, one at each corner, and a fifth in the middle; which diſpoſition repeated again and again, forms a regular grove, wood, or wilderneſs.

QUINDECAGON, in geometry, a plain figure with 15 ſides and 15 angles.

QUINDECEMVIRI, in Roman antiquity, a college of 15 magiſtrates, whoſe buſineſs it was to preſide over the ſacrifices. They were alſo the interpreters of the Sybil's books; which, however they never conſulted but by an expreſs order of the ſenate.

QUINQUAGENARIUS, in Roman antiquity, an officer who had the command of 50 men.

QUINQUAGESIMA sunday, Shrove Sunday, ſo called as being about the 50th day before Eaſter.

QUINQUATRIA, or Quinquatrus, was a feſtival kept at Rome in honour of Minerva, which began on the 18th of March, or as others will have it on the 19th, and laſted five days. On the firſt day they offered ſacrifices and oblations without the effuſion of blood; the ſecond, third, and fourth, were ſpent in ſhows of gladiators; and on the fifth day they went in proceſſion through the city. Scholars had a vacation during the ſolemnity, and preſented their maſters at this time with a gift or fee called *Minerval.* Boys and girls uſed now to pray to the goddeſs Minerva for wiſdom and learning, of which ſhe had the patronage. Plays were acted, and diſputations held, at this feaſt, on ſubjects of polite literature. The quinquatria were ſo called becauſe they laſted five days. There ſeems to be a ſtrong reſemblance betwixt this feſtival and the panathenæa of the Greeks.

QUINQUENNALIS, in Roman antiquity, a magiſtrate in the colonies and municipal cities of that empire, who had much the ſame office as the ædile at Rome.

QUINQUEREMIS, in the naval architecture of the ancients, a name given to a galley which had five rows of oars. They divided their veſſels in general into *monocrota* and *polycrota.* See Polycrota. The former had only one tire of rowers: the latter had ſeveral tires of them, from two or three up to 20, 30, or even 40; for ſuch a veſſel we have an account of in the time of Philopater, which required no leſs than 4000 men to row it.

Meibom has taken off from the imaginary improbability of there ever having been ſuch a veſſel, by reducing the enormous height ſuppoſed neceſſary for ſuch a number of rows of oars and men to work them, by finding a better way of placing the men than others had thought of. The quinqueremes of the ancients had 420 men in each; 300 of which were rowers, and the reſt ſoldiers. The Roman fleet at Meſſina conſiſted of 330 of theſe ſhips; and the Carthaginian, at Lilybœum of 350 of the ſame ſize. Each veſſel was 150 feet long. Thus 130,000 men were contained in the one, and 150,000 in the other, with the apparatus and proviſions neceſſary for ſuch expeditions as they were intended for. This gives ſo grand an idea of the ancient naval armaments, that ſome have queſtioned the truth of the hiſtory: but we find it related by Polybius, a hiſtorian too authentic to be queſtioned, and who expreſſes his wonder at it while he relates it.

QUINQUEVIRI, in Roman antiquity, an order of five prieſts, peculiarly appointed for the ſacrifices to the dead, or celebrating the rites of Erebus.

QUINQUINA. See Cinchona.

QUINSEY, or Quinzy. See Medicine.

QUINTEN, a town of France, in the department of the north coaſt and late province of Bretagne, with a caſtle. It is ſeated in a valley, near the river Goy, and a large foreſt of the ſame name, eight miles SSW. of St. Brieux, and 200 W. of Paris. W. long. 2. 40. N. lat. 48. 26.

QUINTESSENCE, in chemiſtry, a preparation conſiſting of the eſſential oil of ſome vegetable ſubſtance, mixed and incorporated with ſpirit of wine.

Quintessence, in alchemy, is a myſterious term ſignifying the fifth or laſt and higheſt eſſence of power in a natural body.

QUINTILE, in aſtronomy, an aſpect of the planets when they are 72 degrees diſtant from one another, or a fifth part of the zodiac.

QUINTILIANUS (Marcus Fabius), a celebrated Latin orator, and the moſt judicious critic of his time, was a native of Calagurris, or Calahorra, in Spain; and was the diſciple of Domitius Afer, who died in the year 59. He taught rhetoric at Rome for 20 years with great applauſe: and not only laid down rules for ſpeaking, but exhibited his eloquence at the bar. Some authors imagine, but with little foundation, that he arrived to the conſulſhip; but it is more certain that he was preceptor to the grandſons of the emperor Domitian's ſiſter. There is ſtill extant his excellent work, intitled, *Inſtitutiones Oratoriæ,* which is a treatiſe of rhetoric in 12 books; where precepts, judgment, and taſte, are juſtly admired. Theſe inſtitutions were found entire by Poggius, in an old tower of the abbey of St. Gal, and not in a grocer's ſhop in Germany as ſome authors have imagined. There is alſo attributed to Quintilian a dialogue *De cauſis corruptæ eloquentiæ*; but it is more commonly aſcribed to Tacitus. The beſt editions of Quintilian's works are thoſe of Mr. Obreight, publiſhed at Straſburg in 2 vols. 4to, in 1698, and of M. Capperonier, in folio. There is an Engliſh tranſlation by Mr. Guthrie.

Quintilian had a ſon of the ſame name, on whom he beſtows great praiſes. This ſon ought not to be confounded with Quintilian the father, or rather the grandfather, of him who is the ſubject of this article, and who wrote 145 declamations. Ugolin of Parma publiſhed the firſt 136 in the 15th century; the nine others were publiſhed in 1563 by Peter Ayrault, and afterwards by Peter Pithou in 1580. There have alſo been 19 other declamations printed under the name of Quintilian the Orator; but, in the opinion of Voſſius, they were written neither by that orator nor his grandfather.

QUINTILIANS, a ſect of ancient heretics, thus called from their propheteſs Quintilia. In this ſect the women were admitted to perform the ſacerdotal and epiſcopal functions. They attributed extraordinary gifts to Eve for having firſt eaten of the tree of knowledge; told great things of Mary the ſiſter of Moſes, as having been a propheteſs, &c. They added, that Philip the deacon had four daughters, who were all propheteſſes, and were of their ſect. In theſe aſſemblies it was uſual to ſee the virgins entering in white robes, perſonating propheteſſes.

QUINTIN Matsys, alſo called the *Farrier of Antwerp,* famous for being transformed, by the force of love, from a blackſmith to a painter. He had followed the trade of a blackſmith and farrier near twenty years; when falling in love with a painter's daughter who was very handſome, and diſliked nothing but his trade, he quitted it, and betook himſelf to painting, in which he made a very uncommon progreſs. He was a diligent and careful imitator of ordinary life, and ſucceeded better in repreſenting the defects than the beauties of nature. Some hiſtorical performances of this maſter deſerve commendation, particularly a Deſcent from the Croſs, in the Cathedral at Antwerp: but his beſt known picture is that of the two Miſers in the gallery at Windſor. He died in 1529.

QUINTINIE (John de la), a celebrated French gardener, born at Poictiers in 1626. He was brought up to the law; and acquitted himſelf ſo well at the bar as to acquire the eſteem of the chief magiſtrate. M. Tamboneau, preſident of the chamber of accounts, engaged him to undertake the preceptorſhip of his only ſon, which Quintinie executed entirely to his ſatisfaction;

applying his leiſure hours to the ſtudy of writers on agriculture, ancient and modern, to which he had a ſtrong inclination. He gained new lights by attending his pupil to Italy; for all the gardens about Rome being open to him, he failed not to add practice to his theory. On his return to Paris, M. Tamboneau gave up the management of his garden entirely to him; and Quintinie applied ſo cloſely to it, that he became famous all over France. Louis XIV. erected a new office purpoſely for him, that of director of the royal fruit and kitchen-gardens; and theſe gardens, while he lived, were the admiration of the curious. He lived to a good old age, though we learn not the time of his death; his Directions for the Management of Fruit and Kitchen Gardens are eſteemed all over Europe.

QUINTUS Calaber, a Greek poet, who wrote a large Supplement to Homer's Iliad, in 14 books, in which a relation is given of the Trojan war from the death of Hector to the deſtruction of Troy. It is conjectured, from his ſtyle and manner, that he lived in the fifth century. Nothing can be collected either concerning his perſon or country. His poem was firſt made known by Cardinal Beſſarion, who diſcovered it in St. Nicolas's church, near Otranto in Calabria; from whence the author was named *Quintus Calaber*. It was firſt publiſhed at Venice by Aldus, but it is not ſaid in what year.

QUINTUS Curtius. See Curtius.

QUINZY, Quinsey, or *Angina*. See Medicine.

QUIRE of Paper, the quantity of 24 or 25 ſheets.

QUIRINALIA, in antiquity, a feaſt celebrated among the Romans in honour of Romulus

QUIRITES, in Roman antiquity. In conſequence of the agreement entered into by Romulus and Tatius king of the Sabines, Rome was to retain its name, taken from Romulus; and the people were to be called *Quirites*, from Cures, the principal town of the Sabines, a name uſed in all public addreſſes to the Roman people.—Dion. Hal. ſays, that each particular citizen was to be called *Romanus*, and the collective body of them *Quirites*; yet it appears by this ancient form of words uſed at funerals, *Ollus Quiris letho datus eſt*, that each private citizen was alſo called *Quiris*. The origin of the word *Quirites*, which was at firſt peculiar to the Sabines, and became in Romulus's time the general name of the inhabitants of Rome, has been much ſought for; and the moſt probable account antiquity gives us of it is this: The word *Quiris*, according to Plutarch and ſome others, ſignified, in the Sabine language, both "a dart," and "a warlike deity armed with a dart." It is uncertain whether the god gave name to the dart, or the dart to the god. But be that as it will, this *Quiris*, or *Quirinus*, was either Mars or ſome other god of war; and the worſhip of *Quiris* continued in Rome all Romulus's reign: but after his death he was honoured with the name *Quirinus*, and took the place of the god *Quiris*.

QUIRK, in a general ſenſe, denotes a ſubtilty or artful diſtinction.

Quirk, in building, a piece of ground taken out of any regular ground-plot, or floor: thus, if the ground-plot were oblong or ſquare, a piece taken out of a corner to make a court or yard, &c. is called a *quirk*.

QUISQUALIS, in botany: A genus of the monogynia order, belonging to the decandria claſs of plants; and in the natural method ranking under the 31ſt order, *Veprecculæ*. The calyx is quinquefid and filiform; the petals five; the fruit is a quinqueangular plum. There is only one ſpecies, viz. Indica.

QUITO, a city of Peru, in an audience of the ſame name, and a biſhop's ſee. It is ſeated in a pleaſant valley, between high mountains, and on much higher ground than the reſt of Peru that is habitable, being 300 yards above the level of the ſea. Here are ſeveral religious communities, and two colleges, which are a ſort of univerſity. It is 820 miles north of Lima. W. lon. 77. 50 S. lat. 0. 13.

QUITTER-bone, in farriery. See Farriery.

QUIT-rent (*quietus redditus*, i. e. "quiet rent,") is a certain ſmall rent payable by the tenants of manors, in token of ſubjection, and by which the tenant goes quiet and free. In ancient records it is called *white rent*, becauſe paid in ſilver money, to diſtinguiſh it from rent-corn, &c.

QUOIN, or Coin, on board a ſhip, a wedge faſtened on the deck, cloſe to the breach of the carriage of a gun, to keep it firm up to the ſhip's ſide. Cantic quoins are ſhort three-legged quoins put between caſks to keep them ſteady.

Quoins, in architecture, denote the corners of brick or ſtone walls. The word is particularly uſed for the ſtones in the corners of brick buildings. When theſe ſtand out beyond the brick-work, their edges being chamfred off, they are called *ruſtic quoins*.

QUOTIDIAN, any thing which happens every day. Hence, when the paroxyſms of an ague recur every day, it is called a *quotidian ague*. See Medicine.

QUOAD hoc, is a term uſed in the pleadings and arguments of lawyers; being as much as to ſay, As to this thing the law is ſo and ſo.

QUORUM, a word frequently mentioned in our ſtatutes, and in commiſſions both of juſtices of the peace and others. It is thus called from the words of the commiſſion, *quorum* A. B. *unum eſſe volumus*. For an example, where a commiſſion is directed to ſeven perſons, or to any three of them, whereof A. B. and C. D. are to be two; in this caſe, they are ſaid to be of the quorum, becauſe the reſt cannot proceed without them: ſo a juſtice of the peace and quorum is one without whom the reſt of the juſtices in ſome caſes cannot proceed.

QUOTIENT, in arithmetic, the number reſulting from the diviſion of a greater number by a ſmaller; and which ſhows how often the ſmaller is contained in the greater, or how often the diviſor is contained in the dividend. The word is formed from the Latin *quoties*; *q. d.* How often is ſuch a number contained in ſuch another? In diviſion, as the diviſor is to the dividend, ſo is unity to the quotient.—Thus the quotient of 12 divided by 3 is 4; which is thus diſpoſed, 3) 12 (4 quotient. See Arithmetic.

R.

R, or *r*, a liquid conſonant, being the 17th letter of our alphabet. Its ſound is formed by a guttural extruſion of the breath vibrated through the mouth, with a ſort of quivering motion of the tongue drawn from the teeth, and canulated with the tip a little elevated towards the palate. In Greek words it is frequently aſpirated with an *h* after it, as in *rhapſody*, *rhetoric*, &c. otherwiſe it is always followed by a vowel at the beginning of words and ſyllables.

In the notes of the ancients, R. or RO. ſignifies *Roma*; R. C. *Romana civitas*; R. G. C. *rei gerendæ cauſa*; R. F. E. D. *recte factum et dictum*; R. G. F. *regis filius*; R. P. *res publica*, or *Romani principes*; and R. R. R. F. F. F. *res Romana ruet ferro, fame, flamma*.

Uſed as a numeral, R anciently ſtood for 80: and with a daſh over it, thus $\overline{R}$, for 80,000; but the Greek *r*, ʽρ with a ſmall mark over it, ſignified 100; with the ſame mark under it, it denoted 1000 × 100; thus ρ͵ ſignified 100,000. In the Hebrew numeration ר denoted 200: and with two horizontal points over it 1000 × 200; thus ר̈ = 200,000.

In the preſcriptions of phyſicians, R or ℞ ſtands for *recipe*, *i. e.* "take."

RAAB, a town of Lower Hungary, capital of Javerin, with a caſtle and a biſhop's ſee. It is a ſtrong frontier bulwark againſt the Turks, and has two bridges, one over a double ditch, and another that leads towards Alba Regalis. The ſurrounding country is plain, and there is nothing that ſeems to command it but a ſmall hill at ſome diſtance, which is undermined and may be blown up. It was taken by Amurath III. with the loſs of 20,000 men; but was ſurpriſed ſoon after by Count Palfi, who killed all the Turks that were found therein. It is ſeated at the confluence of the rivers Rab and Rabnitz, not far from the Danube, 3 miles weſt of Gran, and 55 ſouth-eaſt of Vienna. E. lon. 17. 25. N. lat. 47. 48.

RABAC, a ſmall port on the Arabian coaſt of the Red Sea, in N. lat. 22° 35′ 40″ by Mr. Bruce's account. The entry to the harbour is from the E. N. E. and is about a quarter of a mile broad. The port extends about two miles in length to the eaſtward. The mountains are about three leagues to the north, and the town about four miles north by eaſt from the entrance to the harbour. The water is good, and all ſhips may be ſupplied here from the wells which are in the neighbourhood of the town. The country is bare and uncultivated; but from the appearance of it, and the freſhneſs of the water, Mr. Bruce ſuppoſes that it ſometimes rains among the mountains here, which is the more probable as it is conſiderably within the tropic.

RABAT, a large and handſome ſea-port town of Africa, in the kingdom of Fez and province of Tremeſen. It has fine moſques and handſome palaces, and is ſeated at the mouth of the river Burrigrig, almoſt in the mid-way between Fez and Tangier. W. lon. 5. 28. N. lat. 34. 40. Rabat, together with Sallee, which is oppoſite to it was formerly famous for fitting out piratical veſſels; but the late emperor Sidi Mahomet ſubdued them both, and annexed them to the empire: ſince which time the harbour of Rabit has been ſo filled with the ſand waſhed in by the ſea as to render it unfit to carry on ſuch piracies in future.

The town of Rabat, whoſe walls incloſe a large ſpace of ground, is defended on the ſea ſide by three forts tolerably well finiſhed, which were erected ſome little time ago by an Engliſh renegado, and furniſhed with guns from Gibraltar. The houſes in general are good, and many of the inhabitants are wealthy. The Jews, who are very numerous in this place, are generally in better circumſtances than thoſe of Larache or Tangier, and their women are extremely beautiful.

The caſtle, which is very extenſive, contains a ſtrong building, formerly uſed by the late emperor as his principal treaſury, and a noble terrace, which commands an extenſive proſpect of the town of Sallee, the ocean, and all the neighbouring country. There are alſo the ruins of another caſtle, which is ſaid to have been built by Jacob Almonzor, one of their former emperors, and of which at preſent very little remains but its walls, containing within them ſome very ſtrong magazines for powder and naval ſtores. On the outſide of theſe walls is a very high and ſquare tower, handſomely built of cut ſtone, and called the tower of *Haſſen*. From the workmanſhip of this tower, contraſted with the other buildings, a very accurate idea may be formed how greatly the Moors have degenerated from their former ſplendour and taſte for architecture.

RABBETTING, in carpentry, the planning or cutting of channels or grooves in boards, &c. In *ſhip carpentry*, it ſignifies the letting in of the planks of the ſhip into the keel; which, in the rake and run of a ſhip, is hollowed away, that the planks may join the cloſer.

RABBI, or Rabbins, a title which the Phariſees and doctors of the law among the Jews aſſumed, and literally ſignifies *maſters* or *excellents*. There were ſeveral gradations before they arrived at the dignity of a rabbin; which was not conferred till they had acquired the profoundeſt knowledge of the law and the traditions. It does not, however, appear that there was any fixed age or previous examination neceſſary; but when a man had diſtinguiſhed himſelf by his ſkill in the written and oral law, and paſſed through the ſubordinate degrees, he was ſaluted a rabbin by the public voice. Among the modern Jews, for near 700 years paſt, the learned men retain no other title than that of *rabbi*, or *rabbins*; they have great reſpect paid them, have the firſt places or ſeats in their ſynagogues, determine all matters of controverſy, and frequently pronounce upon civil affairs; they have even power to excommunicate the diſobedient.

RABBINISTS, among the modern Jews, an appellation given to the doctrine of the rabbins concerning traditions, in oppoſition to the Caraites; who reject all traditions. See Caraite.

RABELAIS (Francis), a French writer famous for his facetiouſneſs, was born at Chinon in Touraine about the year 1483. He was firſt a Franciſcan friar; but quitting his religious habit ſtudied phyſic at Montpelier, where he took his doctor's degree. It is ſaid, that the chancellor du Pratt having aboliſhed the privileges of the faculty of phyſic at Montpelier by a decree of the parliament, Rabelais had the addreſs to make him revoke what he had done; and that thoſe who were made doctors of that univerſity wore Rabelais's robe, which is there held in great veneration. Some time after he came to Rome in quality of phyſician in ordinary to cardinal John du Bellay archbiſhop of Paris. Rabelais is ſaid to have uſed the freedom to jeer Pope Paul III. to his face. He had quitted his religious connections for the ſake of leading a life more agreeable to his taſte; but renewed them on a ſecond journey to Rome, when he obtained, in 1536, a brief to qualify him for holding eccleſiaſtical benefices; and, by the intereſt of his friend cardinal John du Bellay, he was received as a ſecular canon in the abbey of St. Maur near Paris. His profound knowledge in phyſic rendered him doubly uſeful; he being as ready, and at leaſt as well qualified, to preſcribe for the body as for the ſoul: but as he was a man of wit and humour, many ridiculous things are laid to his charge, of which he was quite innocent. He publiſhed ſeveral things; but his chief performance is a ſtrange incoherent romance, called the *Hiſtory of Gargantua and Pantagruel*, being a ſatire upon prieſts, popes, fools, and knaves of all kinds. This work contains a wild, irregular profuſion of wit, learning, obſcenity, low conceits, and arrant nonſenſe; hence the ſhrewdneſs of his ſatire, in ſome places where he is to be underſtood, gains him credit for thoſe where no meaning is diſcoverable. Some alluſions may undoubtedly have been ſo temporary and local as to be now quite loſt: but it is too much to conclude thus in favour of every unintelligible rhapſody; for we are not without Engliſh writers of great talents, whoſe ſportive geniuſes have betrayed them into puerilities, no leſs incoherent at the times of writing than thoſe of Rabelais appear above two centuries after. He died about 1553.

RABBIT, in zoology. See Lepus. The buck rabbits, like our boar cats, will kill the young ones if they can get at them; and the does in the warrens prevent this, by covering their ſtocks, or neſts, with gravel or earth, which they cloſe ſo artificially up with the hinder part of their bodies, that it is hard to find them out. They never ſuckle their young ones at any other time than early in the morning and late at night; and always, for eight or ten days, cloſe up the hole at the mouth of the neſt, in this careful manner when they go out, After this they begin to leave a ſmall opening, which they increaſe by degrees; till at length, when they are about three weeks old, the mouth of the hole is left wholly open that they may go out; for they are at that time grown big enough to take care of themſelves, and to feed on graſs.

People who keep rabbits tame for profit, breed them in hutches; but theſe muſt be kept very neat and clean, elſe they will be always ſubject to diſeaſes. Care muſt be taken alſo to keep the bucks and does apart till the latter have juſt kindled; then they are to be turned to the bucks again, and to remain with them till they ſhun and run from them.

The general direction for the chooſing of tame rabbits is, to pick the largeſt and faireſt; but the breeder ſhould remember that the ſkins of the ſilvered-haired ones ſell better than any other. The food of the tame rabbits may be colewort and cabbage leaves, carrots, parſnips, apple-rinds, green corn, and vetches, in the time of the year; alſo vine-leaves, graſs, fruits, oats, and oatmeal, milk-thiſtles, ſow-thiſtles, and the like; but with theſe moiſt foods they muſt always have a proportionable quantity of the dry foods, as hay, bread, oats, bran, and the like, otherwiſe they will grow pot-bellied, and die. Bran and grains mixed together have been alſo found to be very good food. In winter they will eat hay, oats, and chaff, and theſe may be given them three times a-day; but when they eat green things, it muſt be obſerved that they are not to drink at all, for it would throw them into a dropſy. At all other times a very little drink ſerves their turn, but that muſt always be freſh. When any green herbs or graſs are cut for their food, care muſt be taken that there be no hemlock among it; for though they will eat this greedily among other things when offered to them, yet it is ſudden poiſon to them.

Rabbits are ſubject to two principal infirmities. Firſt, the rot, which is cauſed by giving them too large a quantity of greens, or from giving them freſh gathered with the dew or rain hanging in drops upon them. It is over-moiſture that always cauſes this diſeaſe. The greens therefore are always to be given dry; and a ſufficient quantity of hay, or other dry food, intermixed with them, to take up the abundant moiſture of their juices. On this account the very beſt food that can be given them, is the ſhorteſt and ſweeteſt hay that can be got, of which one load will ſerve 200 couples a year; and out of this ſtock of 200, 200 may be eat in the family, 200 ſold to the markets, and a ſufficient number kept in caſe of accidents.

The other general diſeaſe of theſe creatures is a ſort of madneſs: this may be known by their wallowing and tumbling about with their heels upwards, and hopping in an odd manner into their boxes. This diſtemper is ſuppoſed to be owing to the rankneſs of their feeding; and the general cure is the keeping them low, and giving them the prickly herb called *tare-thiſtle* to eat.

The general computation of males and females is, that one buck-rabbit will ſerve for nine does: ſome allow ten to one buck; but thoſe who go beyond this always ſuffer for it in their breed.

The wild rabbits are either to be taken by ſmall cur dogs, or by ſpaniels bred up to the ſport; and the places of hunting thoſe who ſtraggle from their burrows, is under cloſe hedges or buſhes, or among corn-fields and freſh paſtures. The owners uſe to courſe them with ſmall greyhounds; and though they are ſeldom killed this way, yet they are driven back to their burrows, and are prevented from being a prey to others. The common method is by nets called *purſe nets*, and ferrets. The ferret is ſent into the hole to fetch them out; and the purſe net being ſpread over the hole, takes them as they come out. The ferrets mouths muſt be muffled, and then the rabbit gets no harm. For the more certain taking of them, it may not be improper to pitch up a hay-net or two, at a ſmall diſtance from the burrows that are intended to be hunted: thus very few of the number that are attempted will eſcape.

Some who have not ferrets ſmoke the rabbits out of their holes with burning brimſtone and orpiment. This certainly brings them out into the nets: but then it is a very troubleſome and offenſive method; and is very detrimental to the place, as no rabbit will for a long time afterwards come near the burrows which have been fumed with thoſe ſtinking ingredients.

The teſticle of a rabbit is a very good object for examining the ſtructure of this part of generation in animals.

RABIRIUS (C.) a Roman knight, who lent an immenſe ſum of money to Ptolemy Auletes king of Egypt. The monarch afterwards not only refuſed to repay him, but even confined him, and endangered his life. Rabirius eſcaped from Egypt with difficulty; but at his return to Rome he was accuſed by the ſenate of having lent money to an African prince for unlawful purpoſes. He was ably defended by Cicero, and acquitted with difficulty. There was a Latin poet of the ſame name in the age of Auguſtus. He wrote a poem on the victory which the emperor had gained over Antony at Actium. Seneca has compared him to Virgil for elegance and majeſty; but Quintilian is not ſo favourable to his poetry. And there was an architect in the reign of Domitian, called *Rabirius*. He built a celebrated palace for the emperor, of which the ruins are ſtill ſeen at Rome.

RACCOON. See URSUS.

RACE, in general, ſignifies running with others in order to obtain a prize, either on foot, or by riding on horſeback, in chariots, &c. The race was one of the exerciſes among the ancient Grecian games, which was performed in a courſe containing 125 paces; and thoſe who contended in theſe foot-races were frequently clothed in armour. Chariot and horſe races alſo made a part of theſe ancient games.

Races were known in England in very early times. Fitz-Stephen, who wrote in the days of Henry II. mentions the great delight that the citizens of London took in the diverſion. But by his words, it appears not to have been deſigned for the purpoſes of gaming, but merely to have ſprung from a generous emulation of ſhowing a ſuperior ſkill in horſemanſhip. Races appear to have been in vogue in the reign of queen Elizabeth, and to have been carried to ſuch exceſs as to injure the fortunes of the nobility. The famous George earl of Cumberland is recorded to have waſted more of his eſtate than any of his anceſtors; and chiefly by his extreme love to horſe-races, tiltings, and other expenſive diverſions. It is probable that the parſimonious queen did not approve of it; for races are not among the diverſions exhibited at Kennelworth by her favourite Leiceſter. In the following reign, were places allotted for the ſport: Croydon in the ſouth, and Garterly in Yorkſhire, were celebrated courſes. Camden alſo ſays, that in 1607 there were races near York, and the prize was a little golden bell. See RACING.

RACE, in genealogy, a lineage or extraction continued from father to ſon. See DESCENT.

RACINE (JOHN), of the French academy, treaſurer of France in the generality of Moulins, and ſecretary to his majeſty, was born at Ferre-Milon in 1639. He had a fine genius for the *Belles Lettres*, and became one of the firſt poets of the age. He produced his *Thebaide* when but very young; and afterwards other pieces, which met with great ſucceſs, though they appeared when Corneille was in his higheſt reputation. In his career, however, he did not fail to meet with all that oppoſition which envy and cabal are ever ready to ſet up againſt a ſuperior genius. It was particularly owing to a chagrin from this circumſtance that he took a reſolution to quit the theatre for ever; although his genius was ſtill in full vigour, being not more than 38 years of age. But he had alſo imbibed in his infancy a deep ſenſe of religion; and this, though it had been ſmothered for a while by his connection with the theatre, and particularly with the famous actreſs Champmelle, whom he greatly loved, and by whom he had a ſon, now at length broke out, and bore down all before it. In the firſt place, he reſolved not only to write no more plays, but to do a rigorous penance for thoſe he had written; and he actually formed a deſign of becoming a Carthuſian friar. His religious director, however, a good deal wiſer than he, adviſed him to think more moderately, and to take meaſures more ſuitable to his character. He put him upon marrying, and ſettling in the world: with which propoſal this humble and tractable penitent complied; and immediately took to wife the daughter of a treaſurer of France for Amiens, by whom he had ſeven children.

He had been admitted a member of the French academy in 1673, in the room of La Mothe le Vayer deceaſed; but ſpoiled the ſpeech he had made upon that occaſion by pronouncing it with too much timidity. In 1677 he was nominated with Boileau, with whom he was ever in ſtrict friendſhip, to write the hiſtory of Louis XIV.: and the public expected great things from two writers of their diſtinction, but were diſappointed. Boileau and Racine, after having for ſome time laboured at this work, perceived that it was entirely oppoſite to their genius.

He ſpent the latter years of his life in compoſing a hiſtory of the houſe of Port-Royal, the place of his education; which, however, though finely drawn up, as many have aſſerted, has not been publiſhed. Too great ſenſibility, ſay his friends, but more properly an impotence of ſpirit, ſhortened the days of this poet. Though he had converſed much with the court, he had not learned the wiſdom, which is uſually learned there, of diſguiſing his real ſentiments. Having drawn up a well-reaſoned and well-written memorial upon the miſeries of the people, and the means of relieving them, he one day lent it to Madame de Maintenon to read; when the king coming in, and demanding what and whoſe it was, commended the zeal of Racine, but diſapproved of his meddling with things that did not concern him: and ſaid with an angry tone, "Becauſe he knows how to make good verſes, does he think he knows every thing? And would he be a miniſter of ſtate, becauſe he is a great poet?" Theſe words hurt Racine greatly: he conceived dreadful ideas of the king's diſpleaſure; and his chagrin and fears brought on a fever, of which he died the 22d of April 1699.

The king, who was ſenſible of his great merit, and always loved him, ſent often to him in his illneſs; and finding after his death that he had more glory than riches, ſettled a handſome penſion upon his family.—There is nothing in the French language written with more wit and elegance than his pieces in proſe. Beſides his plays, ſeveral of his letters have been publiſhed; he alſo wrote ſpiritual ſongs, epigrams, &c. Racine's works were printed at Amſterdam in 1722, in 2 vols. 12mo, and the next year a pompous edition was printed in 2 vols. quarto.

RACING, the riding heats for a plate, or other premium. See Plate. The amuſement of horſe-racing, which is now ſo common, was not unknown among the great nations of antiquity, nor wholly unpractiſed by our anceſtors in Britain, as we have already mentioned in the article Race. In 1599, private matches between gentlemen, who were their own jockeys and riders, were very common; and, in the reign of James I. public races were eſtabliſhed at various places, when the diſcipline, and mode of preparing the horſes for running, &c. were much the ſame as they are now. The moſt celebrated races of that time were called bell-courſes, the prize of the conqueror being a bell: hence, perhaps, the phraſe of *bearing the bell*, when applied to excellence, is derived. In the latter end of Charles I.'s reign, races were performed in Hyde-Park. Newmarket was alſo a place for the ſame purpoſe, though it was firſt uſed for hunting. Racing was revived ſoon after the Reſtoration, and much encouraged by Charles II. who appointed races for his own amuſement at Datchet Mead, when he reſided at Windſor. Newmarket, however, now became the principal place. The king attended in perſon, eſtabliſhed a houſe for his own accommodation, and kept and entered horſes in his own name. Inſtead of bells, he gave a ſilver bowl or cup value 100 guineas; on which prize the exploits and pedigree of the ſucceſsful horſe were generally engraved. Inſtead of the cup or bowl, the royal gift is now a hundred guineas. William III. not only added to the plates, but even founded an academy for riding; and queen Anne continued the bounty of her anceſtors, adding ſeveral plates herſelf. George I. towards the end of his reign, diſcontinued the plates, and gave in their room a hundred guineas. An act was paſſed in the 13th year of the reign of George II. for ſuppreſſing races by ponies and other ſmall and weak horſes, &c. by which all matches for any prize under the value of 50l. are prohibited, under a penalty of 200l. to be paid by the owner of each horſe running; and 100l. by ſuch as advertiſe the plate; and by which each horſe entered to run, if five years old, is obliged to carry ten ſtone; if ſix, eleven; and if ſeven, twelve. It is alſo ordained, that no perſon ſhall run any horſe at a courſe, unleſs it be his own, nor enter more than one horſe for the ſame plate, upon pain of forfeiting the horſes; and alſo every horſe-race muſt be begun and ended in the ſame day. Horſes may run for the value of 50l. with any weight, and at any place. 13 Geo. II. cap. 19. 18 Geo. II. cap. 34. Pennant's Britiſh Zoology, vol. i. p. 6, &c. Berenger's Hiſtory and Art of Horſemanſhip, vol. i. p. 185, &c. At Newmarket there are two courſes, the long and the round: the firſt is exactly four miles and about 380 yards, *i. e.* 7420 yards. The ſecond is 6640 yards. Childers, the ſwifteſt horſe ever known, has run the firſt courſe in ſeven minutes and a half, and the ſecond in ſix minutes forty ſeconds; which is at the rate of more than forty-nine feet in a ſecond. But all other horſes take up at leaſt ſeven minutes and fifty ſeconds in completing the firſt and longeſt courſe, and ſeven minutes only in the ſhorteſt, which is at the rate of more than forty ſeven feet in a ſecond. And it is commonly ſuppoſed that theſe courſers cover, at every bound, a ſpace of ground in length about twenty-four Engliſh feet. Race-horſes have been for ſome time an object of taxation.

RACHITIS, the Rickets. See Medicine.

RACK (Edmund), a perſon well known in the literary world by his attachment to, and promotion of, agricultural knowledge: he was a native of Norfolk, a Quaker. His education was common, and he was apprenticed originally to a ſhopkeeper: his ſociety was ſelect in his ſituation, and, by improving himſelf in learning, his converſation was enjoyed by a reſpectable acquaintance. He wrote many eſſays, poems, and letters, and ſome few controverſial tracts. At length he ſettled, about his 40th year, at Bath in 1775, and was ſoon introduced to the moſt eminent literati of that place, among whom Dr. Wilſon and Mrs. Macaulay highly eſteemed him for his integrity and abilities. In 1777 he publiſhed *Mentor's Letters*, a moral work, which has run through many editions. But this year he gained great celebrity by his plan of an agricultural ſociety, which was ſoon adopted by four counties. He ſtill further advanced his fame by his papers in the Farmer's Magazine, and his communications in the Bath Society's papers; a work remarkable for its ingenuity and ſpirit. His laſt engagement was in the Hiſtory of Somerſetſhire, where the topographical parochial ſurveys were his. This work, in 3 vols. 4to, was publiſhed in 1791, by his colleague the Reverend Mr. Collinſon.—Mr. Rack died of an aſthma in February 1787, aged 52.

RACK, an engine of torture, furniſhed with pulleys, cords, &c. for extorting confeſſion from criminals.—The trial by rack is utterly unknown to the law of England; though once, when the dukes of Exeter and Suffolk, and other miniſters of Henry VI. had laid a deſign to introduce the civil law into this kingdom as the rule of government; for a beginning thereof they erected a rack for torture, which was called in deriſion the duke of Exeter's daughter, and ſtill remains in the Tower of London, where it was occaſionally uſed as an engine of ſtate, not of law, more than once in the reign of queen Elizabeth. But when, upon the aſſaſſination of Villiers duke of Buckingham, by Felton, it was propoſed in the privy council to put the aſſaſſin to the rack, in order to diſcover his accomplices; the judges, being conſulted, declared unanimouſly, to their own honour and the honour of the Engliſh law, that no ſuch proceeding was allowable by the laws of England. It ſeems aſtoniſhing that this uſage of adminiſtering the torture ſhould be ſaid to ariſe from a tenderneſs to the lives of men; and yet this is the reaſon given for its introduction in the civil law, and its ſubſequent adoption by the French and other foreign nations, viz. becauſe the laws cannot endure that any man ſhould die upon the evidence of a falſe, or even a ſingle witneſs, and therefore contrived this method that innocence ſhould manifeſt itſelf by a ſtout denial, or guilt by a plain confeſſion: thus rating a man's virtue by the hardineſs of his conſtitution, and his guilt by the ſenſibility of his nerves. The marquis Beccaria, in an exquiſite piece of raillery, has propoſed this problem, with a gravity and preciſion that are truly mathematical: "The force of the muſcles and the ſenſibility of the nerves of an innocent perſon being given; it is required to find the degree of pain neceſſary to make him confeſs himſelf guilty of a given crime." See ACT *of Faith*, INQUISITION, and TORTURE.

RACK, a ſpirituous liquor made by the Tartars of Tonguſa. This kind of rack is made of mare's milk, which is left to be ſour, and afterwards diſtilled twice or thrice between two earthen pots cloſely ſtopped; whence the liquor runs through a ſmall wooden pipe. This liquor is more intoxicating than brandy diſtilled from wine.

RACK, or *Arack*. See ARACK.

To RACK *Wines, &c.* To draw them off from their lees, after having ſtood long enough to ebb and ſettle. Hence rack-vintage is frequently uſed for the ſecond voyage our wine-merchants uſed to make into France for racked wines.

RACKOON, in zoology, a ſpecies of URSUS.

RACONI, a populous town of Italy, in Piedmont, ſeated in a pleaſant plain, on the road from Savillan to Turin, on the rivers Grana and Macra. It belongs to the prince of Carignan, who has a handſome caſtle here. It is ſix miles from Savillan, and ſix from Carignan. E. lon. 7. 46. N. lat. 44. 39.

RADCLIFFE (DR. JOHN), an Engliſh phyſician of great eminence in his time, born at Wakefield in Yorkſhire in 1650. He was educated at Oxford, and enrolled himſelf upon the phyſical line; but it was remarkable that he recommended himſelf more by his ready wit and vivacity, than by any extraordinary acquiſitions in learning. He began to practiſe at Oxford in 1675; but never paid any regard to eſtabliſhed rules, which he cenſured whenever he thought fit, with great freedom and acrimony; and as this drew all the old practitioners upon him, he lived in a continual ſtate of hoſtility with them. Nevertheleſs, his reputation increaſed with his experience; ſo that, before he had been two years in buſineſs, his practice was very extenſive among perſons of high rank. In 1684 he removed to London, and ſettled in Bow-ſtreet Covent Garden, where in leſs than a year he got into prime buſineſs.—In 1687 the princeſs Anne of Denmark made him her phyſician: yet when her huſband and ſhe joined the prince of Orange, Radcliffe, either not chooſing to declare himſelf, or unwilling to favour the meaſures then in agitation, excuſed himſelf from attending them, on the plea of the multitude of his patients. Nevertheleſs, he was often ſent for to king William and other great perſonages, though he did not incline to be a courtier. He incurred ſome cenſure for his treatment of queen Mary, who died of the ſmall-pox; and ſoon after loſt his place about the princeſs Anne, by his attachment to his bottle. He alſo totally loſt the favour of king William by his uncourtly freedom; for, in 1699, when the king ſhowed him his ſwollen ancles, while the reſt of his body was emaciated, and aſked him what he thought of them? "Why truly I would not have your majeſty's two legs for your three kingdoms," replied Radcliffe. He continued increaſing in buſineſs and inſolence as long as he lived, continually at war with his brethren the phyſicians; who conſidered him in no other light than that of an active ingenious empiric, whom conſtant practice had at length brought to ſome degree of ſkill in his profeſſion. He died in 1714; and, if he never attempted to write any thing himſelf, has perpetuated his memory by founding a fine library at Oxford, to preſerve the writings of other men.

RADIALIS, the name of two muſcles in the arm. See ANATOMY, *Table of the Muſcles*.

RADIANT, in optics, is any point of a viſible object from whence rays proceed.

RADIATED FLOWERS, in botany, are ſuch as have ſeveral ſemifloſcules ſet round a diſk, in form of a radiant ſtar; thoſe which have no ſuch rays are called *diſcous flowers*.

RADIATION, the act of a body emitting or diffuſing rays of light all round as from a centre.

RADICAL, in general, ſomething that ſerves as a baſis or foundation. Hence phyſicians talk much of a radical moiſture. In grammar, we give the appellation *radical* to primitives, in contradiſtinction to compounds and derivatives. Algebraiſts alſo ſpeak of the radical ſign of quantities, which is the character expreſſing their roots.

RADICLE, that part of the ſeeds of all plants which upon vegetating becomes their root, and is diſcoverable by the microſcope. See PLANT.

RADISH, in botany. See RAPHANUS.

RADIUS, in geometry, the ſemidiameter of a circle, or a right line drawn from the centre to the circumference. In trigonometry, the radius is termed the whole ſine, or ſine of 90°. See SINE.

RADIUS, in anatomy, the exterior bone of the arm, deſcending along with the ulna from the elbow to the wriſt.

RADIX. See ROOT.

RADNOR, the county-town of Radnorſhire, in South Wales. It is a poor little place, diſtant from London about 150 miles. It is ſituated near the ſpring-head of the river Somergil, in a fruitful valley at the bottom of a hill, where there are ſheep grazing in abundance. It is a very ancient borough-town, whoſe juriſdiction extends near 12 miles round about: the government of it is veſted in a bailiff and 25 burgeſſes. Though it is the county-town, the aſſizes are held at Preſteign: it has one privilege, however, that is very extraordinary, beſides that of ſending one member to parliament; and that is, it keeps a court of pleas for all actions, without being limited to any particular ſum. It was formerly fenced with a wall and a ſtrong caſtle; but both were in a great meaſure demoliſhed by Owen Glendower, when he aſſumed the title of Prince of Wales, upon the depoſition of king Richard II. W. lon. 2. 45. N. lat. 52. 10.

RADNORSHIRE, a county of South Wales, is bounded on the north by Montgomeryſhire; on the eaſt by Shropſhire and Herefordſhire; on the ſouth and ſouth-weſt by Brecknockſhire; and on the weſt by Cardiganſhire; extending 30 miles in length and 25 in breadth. This county is divided into ſix hundreds, in which are contained three market-towns, 52 pariſhes, about 3160 houſes, and 18,960 inhabitants. It is ſeated in the dioceſe of Hereford, and ſends two members to parliament, one for the county and one for the town of Radnor. The air of this county is in winter cold and piercing. The ſoil in general is but indifferent; yet ſome places produce corn, particularly the eaſtern and ſouthern parts; but in the northern and weſtern, which are mountainous, the land is chiefly ſtocked with horned cattle, ſheep, and goats.

RAFT, a ſort of float, formed by an aſſemblage of various planks or pieces of timber faſtened together ſide by ſide, ſo as to be conveyed more commodiouſly to any ſhort diſtance in a harbour or road than if they were ſeparate. The timber and plank with which merchant-ſhips are laden, in the different parts of the Baltic Sea, are attached together in this manner, in order to float them off to the ſhipping.

RAFTERS, in building, are pieces of timber which, ſtanding by pairs on the reaſon or railing piece, meet in an angle at the top, and form the roof of a building. See ARCHITECTURE.

ROWLEY RAGG, a genus of ſtones, belonging to the ſiliceous claſs. It is of a duſky or dark gray colour, with many ſmall ſhining cryſtals, having a granular texture, and acquiring an ochry cruſt by expoſure to the air. The ſpecific gravity is 2748. It becomes magnetic by being heated in an open fire. In a ſtrong fire it melts without addition, but with more difficulty than baſaltes. It was analyſed by Dr. Withering, who found that 100 parts of it contain 47.5 of ſiliceous earth, 32.5 of argil, and 20 of iron.

RAGMAN'S ROLL, Rectius Ragimund's roll, ſo called from one Ragimund a legate in Scotland, who calling before him all the beneficed clergymen in that kingdom, cauſed them on oath to give in *the true value* of their benefices; according to which they were afterwards taxed by the court of Rome; and this roll, among other records, being taken from the Scots by Edward I. was re-delivered to them in the beginning of the reign of Edward III.

RAGOUT, or RAGOO, a ſauce, or ſeaſoning, intended to rouſe the appetite when loſt or languiſhing. This term is alſo uſed for any high-ſeaſoned diſh prepared of fleſh, fiſh, greens, or the like; by ſtewing them with bacon, ſalt, pepper, cloves, and the like ingredients. We have ragouts of celery, of endive, aſparagus, cock's combs, giblets, craw-fiſh, &c. The ancients had a ragout called *garum*, made of the putrefied guts of a certain fiſh kept till it diſſolved into a mere ſanies, which was thought ſuch a dainty, that, according to Pliny, its price equalled that of the richeſt perfumes.

RAGSTONE, a genus of ſtones belonging to the claſs of ſiliceous earths. It is of a gray colour; the texture obſcurely laminar, or rather fibrous; but the laminæ or fibres conſiſt of a congeries of grains of a quartzy appearance, coarſe and rough. The ſpecific gravity is 2729; it effervesces with acids, and ſtrikes fire with ſteel. Mr. Kirwan found it to contain a portion of mild calcareous earth, and a ſmall proportion of iron. It is uſed as a whetſtone for coarſe cutting tools. It is found about Newcaſtle, and many other parts of England, where there are large rocks of it in the hills.

RAGULED, or RAGGED, in heraldry, jagged or knotted. This term is applied to a croſs formed of the trunks of two trees without their branches, of which they ſhow only the ſtumps. *Raguled* differs from *indented*, in that the latter is regular, the former not.

RAGUSA, an ancient town of Sicily, in the Val-di-Noto, near the river Maulo, 12 miles north of Modica. E. lon. 14. 59. N. lat. 37. 0.

RAGUSA, a city of Dalmatia, and capital of Raguſen. It is about two miles in circumference, is pretty well built, and ſtrong by ſituation, having an inacceſſible mountain on the land-ſide, and on the ſide of the ſea a ſtrong fort. It has an archbiſhop's ſee and a republic, and has a doge like that of Venice, but he continues a month only in his office. It carries on a conſiderable trade with the Turks, and is 60 miles north-weſt of Scutari, and 110 north of Brindiſi. E. lon. 18. 10. N. lat. 42. 50.

RAGUSEN, a territory of Europe in Dalmatia, lying along the coaſt of the gulph of Venice, about 55 miles in length, and 20 in breadth. It is a republic under the protection of the Turks and Venetians. Raguſa is the capital town.

RAJA, the title of the Indian black princes, the remains of thoſe who ruled there before the Moguls. Some of the rajas are ſaid to preſerve their independency, eſpecially in the mountainous parts; but moſt of them pay an annual tribute to the Mogul. The Indians call them *rai*; the Perſians, *raian*, in the plural; and our travellers *rajas*, or *ragias*.

RAJA, the *Ray-Fiſh*, in ichthyology; a genus belonging to the order of chondropterygia. There are five ſpiracula below towards the peak; the body compreſſed; and the mouth is ſituated under the head. The moſt remarkable ſpecies are,

1. The *batis*, or ſkate: this ſpecies is the thinneſt in proportion to its bulk of any of the genus, and alſo the largeſt, ſome weighing near 200 pounds. The noſe, though not long, is ſharp-pointed; above the eyes is a ſet of ſhort ſpines: the upper part is of a pale brown, ſometimes ſtreaked with black: the lower part is white, marked with great numbers of minute black ſpots. The jaws are covered with ſmall granulated but ſharp-pointed teeth. The tail is of a moderate length: near the end are two fins: along the top of it is one row of ſpines, and on the edges are irregularly diſperſed a few others; which makes us imagine with Mr. Ray, that in this reſpect theſe fiſh vary, ſome having one, others more orders of ſpines on the tail. It is remarked, that in the males of this ſpecies the fins are full of ſpines. Skates generate in March and April; at which time they ſwim near the ſurface of the water, ſeveral of the males purſuing one female. They adhere ſo faſt together in coition, that the fiſhermen frequently draw up both together, though only one has taken the bait. The females begin to caſt their *purſes*, as the fiſhermen call them (the bags in which the young are included) in May, and continue doing it till September. In October they are exceedingly poor and thin: but in November they begin to improve, and grow gradually better till May, when they are in the higheſt perfection. The males go ſooner out of ſeaſon than the females.

2. The *oxyrinchus*, or ſharp-noſed ray, in length near ſeven feet, and breadth five feet two inches; when juſt brought on ſhore, it makes a remarkable ſnorting noiſe. The noſe is very long, narrow, and ſharp-pointed, not unlike the end of a ſpontoon. The body is ſmooth, and very thin in proportion to the ſize; the upper part aſh-coloured, ſpotted with numerous white ſpots, and a few black ones. The tail is thick; towards the end are two ſmall fins; on each ſide is a row of ſmall ſpines, with another row in the middle, which runs ſome way up the back. The lower part of the fiſh is quite white. The mouth is very large, and furniſhed with numbers of ſmall ſharp teeth bending inwards. This fiſh has been ſuppoſed to be the *bos* of the ancients; which was certainly ſome enormous ſpecies of ray, though we cannot pretend to determine the particular kind. Oppian ſtyles it, *the modeſt among fiſhes*: he adds an account of its fondneſs of human fleſh, and the method it takes of deſtroying men, by over-laying and keeping them down by

its vaſt weight till they are drowned. Phile (*De propriet. anim.* p. 85.) gives much the ſame relation. We are inclined to give them credit, ſince a modern writer, of undoubted authority, gives the very ſame account of a fiſh found in the South Seas, the terror of thoſe employed in the pearl-fiſhery. It is a ſpecies of ray, called there *manta*, or the *quilt*, from its ſurrounding and wrapping up the unhappy divers till they are ſuffocated; therefore the negroes never go down without a ſharp knife to defend themſelves againſt the aſſaults of this terrible enemy.

3. The *aſpera*, or rough ray, is found in Loch-Broom in Scotland. The length from the noſe to the tip of the tail is two feet nine The tail is almoſt of the ſame length with the body. The noſe is very ſhort. Before each eye is a large hooked ſpine; and behind each another, beſet with leſſer. The upper part of the body is of a cinereous brown mixed with white, and ſpotted with black, and entirely covered with ſmall ſpines. On the tail are three rows of great ſpines: all the reſt of the tail is irregularly beſet with leſſer. The fins and under ſide of the body are equally rough with the upper. The teeth are flat and rhomboidal.

4. The *fullonica*, or fuller, derives its Latin name from the inſtrument fullers make uſe of in ſmoothing cloth, the back being rough and ſpiney. The noſe is ſhort and ſharp. At the corner of each eye are a few ſpines. The membrane of nictitation is fringed. Teeth ſmall and ſharp. On the upper part of the pectoral fins are three rows of ſpines pointing towards the back, crooked like thoſe on a fuller's inſtrument. On the tail are three rows of ſtrong ſpines: the middle row reaches up part of the back. The tail is ſlender, and rather longer than the body. The colour of the upper part of the body is cinereous, marked uſually with numerous black ſpots: the lower part is white. This, as well as moſt other ſpecies of rays, vary a little in colour, according to age. This grows to a ſize equal to the ſkate. It is common at Scarborough, where it is called the *white hans*, or *gullet*.

5. The *ſhagreen ray* increaſes to the ſize of the ſkate; is fond of launces or ſand-eels, which it takes generally as a bait. The form is narrower than that of the common kinds; the noſe long and very ſharp; pupil of the eye ſapphirine; on the noſe are two ſhort rows of ſpines; on the corner of the eyes another of a ſemicircular form; on the tail are two rows, continued a little up the back, ſmall, ſlender, and very ſharp: along the ſides of the tail is a row of minute ſpines, intermixed with innumerable little ſpiculæ. The upper part of the body is of a cinereous brown, covered cloſely with ſhagreen-like tubercles, reſembling the ſkin of the dog-fiſh: the under ſide of the body is white; from the noſe to the beginning of the pectoral fins is a tuberculated ſpace. The teeth ſlender, and ſharp as needles.

6. The *torpedo*, cramp-fiſh, or electric ray, is frequently taken in Torbay: has been once caught off Pembroke, and ſometimes near Waterford in Ireland. It is generally taken, like other flat fiſh, with the trawl; but there is an inſtance of its taking the bait. It commonly lies in water of about 40 fathoms depth; and in company with the congenerous rays. The torpedo brings forth its young at the autumnal equinox, as affirmed by Ariſtotle. A gentleman of La Rochelle, on diſſecting certain females of this ſpecies, the 10th of September, found in the matrices ſeveral of the fœtuses quite formed, and nine eggs in no ſtate of forwardneſs: ſuperfœtation ſeems therefore to be a property of this fiſh. The food of the torpedo is fiſh; a ſurmullet and a plaiſe have been found in the ſtomach of two of them. The ſurmullet is a fiſh of that ſwiftneſs, that it was impoſſible for the torpedo to take it by purſuit. It is probable, therefore, that by their electric ſtroke they ſtupefy their prey; yet the crab and ſea leech will venture to annoy them. They will live 24 hours out of the ſea; and but very little longer if placed in freſh water. They inhabit ſandy places; and will bury themſelves ſuperficially in it, by flinging the ſand over, by a quick flapping of all the extremities. It is in this ſituation that the torpedo gives his moſt forcible ſhock, which throws down the aſtoniſhed paſſenger who inadvertently treads upon him. In our ſeas it grows to a great ſize, and above 80 pounds weight. The tail is thick and round; the caudal fin broad and abrupt. The head and body, which are indiſtinct, are nearly round; attenuating to extreme thinneſs on the edges; below the body, the ventral fins form on each ſide a quarter of a circle. The two dorſal fins are placed on a trunk of the tail. The eyes are ſmall, placed near each other: behind each is a round ſpiracle, with ſix ſmall cutaneous rays on their inner circumference. Mouth ſmall; teeth minute, ſpicular. Five openings to the gills, as in others of this genus. The ſkin every where ſmooth; cinereous brown above, white beneath.

7. The *clavata*, or thornback, is eaſily diſtinguiſhed from the others by the rows of ſtrong ſharp ſpines diſpoſed along the back and tail. In a large one ſeen by Mr. Pennant, were three rows on the back, and five on the tail, all inclining towards its end. On the noſe, and on the inner ſide of the forehead, near the eyes, were a few ſpines, and others were ſcattered without any order on the upper part of the pectoral fins. The mouth was ſmall, and filled with granulated teeth: the upper part of the body was of a pale aſh colour, marked with ſhort ſtreaks of black, and the ſkin rough with ſmall tubercles like ſhagreen. The belly white, croſſed with a ſtrong ſemilunar cartilage beneath the ſkin: in general, the lower part was ſmooth, having only a few ſpines on each ſide. The young fiſh have very few ſpines on them; and their backs are often ſpotted with white, and each ſpot is encircled with black. This ſpecies frequent our ſandy ſhores; are very voracious, and feed on all ſorts of flat fiſh; are particularly fond of herrings and ſand eels; and ſometimes eat cruſtaceous animals, ſuch as crabs. Theſe ſometimes weigh 14 or 15 pounds, but with us ſeldom exceed that weight. They begin to generate in June, and bring forth their young in July and Auguſt, which (as well as thoſe of the ſkate) before they are old enough to breed, are called *maids*. The thornback begins to be in ſeaſon in November, and continues ſo later than the ſkate, but the young of both are good at all times of the year.

8. The *paſtinaca*, or ſting ray, does not grow to the bulk of the others: The body is quite ſmooth, of ſhape almoſt round, and is of a much greater thickneſs and more elevated form in the middle than any other rays, but grows thin towards the edges. The noſe is very ſharp-pointed, but ſhort; the mouth is ſmall, and filled with granulated teeth. The irides are of a gold colour: behind each eye the orifice is very large. The tail is very thick at the beginning: the ſpine is placed about a third the length of the former from the body; is about five inches long, flat on the top and bottom, very hard, ſharp-pointed, and the two ſides thin, and cloſely and ſharply bearded the whole way. The tail extends four inches beyond the end of the ſpine, and grows very ſlender at the extremity. Theſe fiſh are obſerved to ſhed their ſpine, and renew them annually; ſometimes the new ſpine appears before the old one drops off; and the Corniſh call this ſpecies *cardinal triloſt*, or *three-tailed*, when ſo circumſtanced. The colour of the upper part of the body is a dirty yellow, the middle part of an obſcure blue: the lower ſide white, the tail and ſpine duſky. The weapon with which nature has armed this fiſh, hath ſupplied the ancients with many tremendous fables relating to it. Pliny, Ælian, and Oppian, have given it a venom that affects even the inanimate creation: trees that are ſtruck by it inſtantly loſe their verdure and periſh, and rocks themſelves are incapable of reſiſting the potent poiſon. The enchantreſs Circe armed her ſon

with a ſpear headed with the ſpine of the trygon, as the moſt irreſiſtible weapon ſhe could furniſh him with; and with which he afterwards committed parricide unintentionally on his father Ulyſſes. That ſpears and darts might in very early times have been headed with this bone inſtead of iron we have no kind of doubt; that of another ſpecies of this fiſh being ſtill uſed to point the arrows of ſome of the South American Indians, and being, from its hardneſs, ſharpneſs, and beards, a moſt dreadful weapon. But in reſpect to its venomous qualities, there is not the leaſt credit to be given to the opinion, though it was believed (as far as it affected the animal world) by Rondeletius, Aldrovand, and others, and even to this day by the fiſhermen in ſeveral parts of the kingdom. It is in fact the weapon of offence belonging to the fiſh, capable of giving a very bad wound, and which is attended with dangerous ſymptoms when it falls on a tendinous part or on a perſon in a bad habit of body. As to any fiſh having a ſpine charged with actual poiſon, it ſeems very dubious, though the report is ſanctified by the name of Linnæus. He inſtances the *paſtinaca*, the *torpedo*, and the *tetrodon lineatus*. The firſt is incapable of conveying a greater injury than what reſults from the mere wound; the ſecond, from its electric effluvia; and the third, by imparting a pungent pain like the ſting of nettles, occaſioned by the minute ſpines on its abdomen.

RAIANIA, in botany: A genus of the hexandria order, belonging to the diœcia claſs of plants; and in the natural method ranking under the 11th order, *Samentaceæ*. The male calyx is ſexpartite; there is no corolla. The female calyx as in the male, without any corolla; there are three ſtyles; the fruit is roundiſh with an oblique wing, inferior. There are three ſpecies, the haſtata. cordata, and quinquefolia.

RAIETEA, one of the South Sea iſlands, named alſo Ulietea.

RAIL, in ornithology. See Rallus.

RAILLERY, according to Dr. Johnſon, means ſlight ſatire, or ſatirical merriment; and a beautiful writer of the laſt century compares it to a light which dazzles, and which does not burn. It is ſometimes innocent and pleaſant, and it ſhould always be ſo, but it is moſt frequently offenſive. Raillery is of various kinds; there is a ſerious, ſevere, and good-humoured raillery; and there is a kind which perplexes, a kind which offends, and a kind which pleaſes. To rally well, it is abſolutely neceſſary that kindneſs run through all you ſay; and you muſt ever preſerve the character of a friend to ſupport your pretenſions to be free with a man. Alluſions to paſt follies, hints to revive what a man has a mind to forget for ever, ſhould never be introduced as the ſubjects of raillery. This is not to thruſt with the ſkill of fencers, but to cut with the barbarity of butchers. But it is below the character of men of humanity and good-breeding to be capable of mirth, while there is any in the company in pain and diſorder.

RAIN, the deſcent of water from the atmoſphere in the form of drops of a conſiderable ſize. By this circumſtance it is diſtinguiſhed from dew and fog: in the former of which the drops are ſo ſmall that they are quite inviſible; and in the latter, though their ſize is larger, they ſeem to have very little more ſpecific gravity than the atmoſphere itſelf, and may therefore be reckoned hollow ſpherules rather than drops.

It is univerſally agreed, that rain is produced by the water previouſly abſorbed by the heat of the ſun, or otherwiſe, from the terraqueous globe, into the atmoſphere; but very great difficulties occur when we begin to explain why the water, once ſo cloſely united with the atmoſphere, begins to ſeparate from it. We cannot aſcribe this ſeparation to cold, ſince rain often takes place in very warm weather; and though we ſhould ſuppoſe the condenſation owing to the ſuperior cold of the higher regions, yet there is a remarkable fact which will not allow us to have recourſe to this ſuppoſition. It is certain that the drops of rain increaſe in ſize conſiderably as they deſcend. On the top of a hill, for inſtance, they will be ſmall and inconſiderable, forming only a drizzling ſhower; but at the bottom of the ſame hill the drops will be exceſſively large, deſcending in an impetuous rain; which ſhows that the atmoſphere is diſpoſed to condenſe the vapours, and actually does ſo, as well where it is warm as where it is cold.

For ſome time the ſuppoſitions concerning the cauſe of rain were exceedingly inſufficient and unſatisfactory. It was imagined, that when various congeries of clouds were driven together by the agitation of the winds, they mixed, and run into one body, by which means they were condenſed into water. The coldneſs of the upper parts of the air alſo was thought to be a great means of collecting and condenſing the clouds into water; which being heavier than the air, muſt neceſſarily fall down through it in the form of rain. The reaſon why it falls in drops, and not in large quantities, was ſaid to be the reſiſtance of the air; whereby being broken. and divided into ſmaller and ſmaller parts, it at laſt arrives to us in ſmall drops. But this hypotheſis is entirely contrary to almoſt all the phenomena: for the weather, when coldeſt, that is, in the time of ſevere froſt, is generally the moſt ſerene; the moſt violent rains alſo happen where there is little or no cold to condenſe the clouds; and the drops of rain, inſtead of being divided into ſmaller and ſmaller ones as they approach the earth, are plainly increaſed in ſize as they deſcend.

Dr. Derham accounted for the precipitation of the drops of rain from the veſiculæ being full of air, and meeting with an air colder than they contained, the air they contained was of conſequence contracted into a ſmaller ſpace; and conſequently the watery ſhell rendered thicker, and thus ſpecifically heavier than the common atmoſphere. But it has been ſhown that the veſiculæ, if ſuch they are, of vapour, are not filled with air, but with fire, or heat; and conſequently, till they part with this latent heat, the vapour cannot be condenſed. Now, cold is not always ſufficient to effect this, ſince in the moſt ſevere froſts the air is very often ſerene, and parts with little or none of its vapour for a very conſiderable time. Neither can we admit the winds to have any conſiderable agency in this matter, ſince we find that blowing upon vapour is ſo far from condenſing it, that it unites it more cloſely with the air, and wind is found to be a great promoter of evaporation.

According to Rohault, the great cauſe of rain is the heat of the air; which, after continuing for ſome time near the earth, is raiſed on high by a wind, and there thawing the ſnowy villi or flocks of half-frozen veſiculæ, reduces them to drops; which, coaleſcing, deſcend. Here, however, we ought to be informed by what means theſe veſiculæ are ſuſpended in their half frozen ſtate; ſince the thawing of them can make but little difference in their ſpecific gravity, and it is certain that they aſcended through the air not in a frozen but in an aqueous ſtate.

Dr. Clarke and others aſcribe this deſcent of the rain rather to an alteration of the atmoſphere than of the veſiculæ; and ſuppoſe it to ariſe from a diminution of the elaſtic force of the air. This elaſticity, which, they ſay, depends chiefly or wholly upon terrene exhalations, being weakened, the atmoſphere ſinks under its burden, and the clouds fall. Now, the little veſicles being once upon the deſcent, will continue therein, notwithſtanding the increaſe of reſiſtance they every moment meet with. For, as they all tend to the centre of the earth, the further they fall, the more coalitions they will make; and the more coalitions, the more matter will there be under the ſame ſurface; the ſurface increaſing only as the ſquares, but the ſolidity as the cubes; and the more matter under the ſame ſurface, the leſs reſiſtance will there be to the ſame matter. Thus, if the cold, wind, &c. act early enough to precipitate the aſcending veſicles before they are arrived at any conſiderable height, the coalitions being but few, the drops will be proportionably ſmall; and thus is formed a dew. If the vapours be more copious, and riſe a little higher, we have a miſt or fog. A little higher ſtill, and they produce a ſmall rain; if they neither meet with cold nor wind, they form a heavy thick dark ſky. This hypotheſis is equally unſatisfactory with the others; for, granting that the deſcent and condenſation of the vapours are owing to a diminution of the atmoſphere's elaſticity, by what is this diminution occaſioned? To ſay that it is owing to terrene exhalations, is only ſolving one difficulty by another; ſince we are totally unacquainted both with the nature and operation of theſe exhalations. Beſides, let us ſuppoſe the cauſe to be what it will, if it acts equally and at once upon all the vapour in the air, then all that vapour muſt be precipitated at once; and thus, inſtead of gentle ſhowers continuing for a conſiderable length of time, we ſhould have the moſt violent water-ſpouts, continuing only for a few minutes, or perhaps ſeconds, which, inſtead of refreſhing the earth, would drown and lay waſte every thing before them.

Since philoſophers have admitted the electric fluid to ſuch a large ſhare in the operations of nature, almoſt all the natural phenomena have been accounted for by the action of that fluid; and rain, among others, has been reckoned an affect of electricity. But this word, unleſs it be explained, makes us no wiſer than we were before; the phenomena of artificial electricity having been explained on principles which could ſcarce apply in any degree to the electricity of nature: and therefore all the ſolution we can obtain of the natural appearances of which we ſpeak, comes to this, that rain is occaſioned by a moderate electrification, hail and ſnow by one more violent, and thunder by the moſt violent of all; but in what manner this electrification is occaſioned, hath not yet been explained. Throughout the various parts of this work where electricity has been occaſionally mentioned, the principles of artificial ELECTRICITY, laid down in the treatiſe appropriated to that ſubject, have been applied to the ſolution of the phenomena of nature; thoſe which are neceſſary to be attended to here are the following: 1. The electric fluid and ſolar light are the ſame ſubſtance in two different modifications. 2. Electricity is the motion of the fluid when running, or attempting to run, in a continued ſtream from one place to another: heat is when the fluid has no tendency but to vibrate outwards and inwards to and from a centre; or at leaſt when its ſtreams converge to a point or focus. 3. The fluid acting as electricity, like water, or any other fluid, always tends to the place where there is leaſt reſiſtance.

On theſe three principles may the phenomena of atmoſpherical electricity, and the deſcent of rain by its means, be explained as follows:

1. The light or heat of the ſun, acting in that peculiar manner which we call *heat*, unites itſelf with the moiſture of the earth, and forms it into vapour, which thus becomes ſpecifically lighter than air, and of conſequence aſcends in the atmoſphere to a certain height.

2. Beſides the quantity of light which is thus united to the water, and forms it into vapour, a very conſiderable quantity enters the earth, where it aſſumes the nature of electric fluid.

3. As the earth is always full of that fluid, every quantity which enters muſt diſplace an equal quantity which is already there.

4. This quantity which is diſplaced muſt eſcape either at a diſtance from the place where the other enters, or very near it.

5. At whatever place a quantity of electric matter eſcapes it muſt electriſy the air above that place where it has eſcaped; and as a conſiderable quantity of light muſt always be reflected from the earth into the atmoſphere, where it does not combine with the aqueous vapour, we have thence another ſource of electricity to the air; as this quantity muſt undoubtedly aſſume the action of electric fluid, eſpecially after the action of the ſun has ceaſed. Hence the reaſon why in ſerene weather the atmoſpherical electricity is always ſtrongeſt, and rather more ſo in the night than in the day.

6. From theſe conſiderations, we ſee an evident reaſon why there muſt commonly be a difference between the electricity of the earth and that of the atmoſphere, excepting when an earthquake is about to enſue. The conſequence of this muſt be, that as the action of the ſolar light continues to bring down the electric matter, and the earth continues to diſcharge an equal quantity of it into the atmoſphere, ſome part of the atmoſphere muſt at laſt become overloaded with it, and attempt to throw it back into the earth. This attempt will be vain, until a vent is found for the electricity at ſome other place; and as ſoon as this happens, the electrified atmoſphere begins to throw off its ſuperfluous electricity, and the earth to receive it. As the atmoſphere itſelf is a bad conductor, and the more ſo the drier it is, the electric matter attacks the ſmall aqueous particles which are detained in it by means of the latent heat. Theſe being unable to bear the impetus of the fluid, throw out the latent heat, which eaſily eſcapes, and thus makes a kind of vacuum in the electrified part of the atmoſphere. The conſequences of this are, that the aqueous particles, being driven together in large quantity, become viſible, and the ſky is covered with clouds; at the ſame time the wind blows againſt theſe clouds, and, if there is no reſiſtance in the atmoſphere, it will drive them away.

7. But if the atmoſphere all round the cloud is exceedingly electrified, and the earth is in no condition to receive the ſuperfluous fluid excepting in that place which is directly under the cloud, then the whole electricity of the atmoſphere for a vaſt way round will tend to that part only, and the cloud will be electrified to an extreme degree. A wind will now blow againſt the cloud from all quarters, more and more of the vapour will be extricated from the air by the electric matter, and the cloud will become darker and thicker, at the ſame time that it is in a manner ſtationary, as being acted upon by oppoſite winds; though its ſize is enlarged with great rapidity by the continual ſupplies of vapour brought by the winds.

8. The vapours which were formerly ſuſpended inviſibly by means of the latent heat are now ſuſpended viſibly by the electric fluid, which will not let them fall to the earth, until it is in a condition to receive the electric matter deſcending with the rain.—It is eaſy to ſee, however, that thus every thing is prepared for a violent ſtorm of thunder and lightning as well as rain. The ſurface of the earth becomes electrified from the atmoſphere: but when this has continued for ſome time, a zone of earth conſiderably below the ſurface acquires an electricity oppoſite to that of the clouds and atmoſphere; of conſequence the electricity in the cloud being violently preſſed on all ſides, will at laſt burſt out towards that zone where the reſiſtance is leaſt, as explained under the article LIGHTNING.—The vapours now having loſt that which ſupported them, will fall down in rain, if there is not a ſufficient quantity of electric matter to keep them in the ſame ſtate in which they were before: but if this happens to be the caſe, the cloud will inſtantly be charged again, while little or no rain will fall; and hence very violent thunder ſometimes takes place without any rain at all, or ſuch as is quite inconſiderable in quantity.

9. When the electricity is leſs violent, the rain will deſcend in vaſt quantity, eſpecially after every flaſh of lightning: and great quantities of electric matter will thus be conveyed to the

earth, inſomuch that ſometimes the drops have been obſerved to ſhine as if they were on fire, which has given occaſion to the reports of fiery rain having fallen on certain occaſions. If the quantity of electric matter is ſmaller, ſo that the rain can convey it all gradually to the ground, there will be rain without any thunder; and the greater the quantity of electricity the more violent will be the rain.

From this account of the cauſes of rain, we may ſee the reaſon why in warm climates the rains are exceſſive, and for the moſt part accompanied with thunder; for there the electricity of the atmoſphere is immenſely greater than it is with us. We may alſo ſee why in certain places, according to the ſituation of mountains, ſeas, &c. the rains will be greater than in others, and likewiſe why ſome parts of the world are exempted from rain altogether; but as a particular diſcuſſion of theſe would neceſſarily include an explanation of the cauſes and phenomena of THUNDER, we ſhall for this reaſon refer the whole to be treated of under that article.

Whether this theory be juſt, however, it would be too aſſuming in us to ſay. It may admit of diſpute, for we muſt grant that in the very beſt ſyſtems, though an occurrence ſo frequent, the theory of rain is but very imperfectly underſtood. Dr. James Hutton, fellow of the Royal Society of Edinburgh, whoſe ſpeculations are always ingenious, though generally extraordinary, and much out of the common way, gives us a new theory of rain in the firſt volume of the Tranſactions of that ſociety. It is well known that atmoſpheric air is capable of diſſolving with a certain degree of heat, a given quantity of water. The Doctor aſcertains the ratio of the diſſolving power of air, in relation to water, in different degrees of heat; and ſhows, that by mixing a portion of tranſparent humid warm air with a portion of cold air, the mixture becomes opake, and part of the water will be precipitated; or, in other words, the vapour will be condenſed into rain. The ratio which he ſtates, however, does not appear to us to be ſupported by experience. Whether the electricity of the air changes in conſequence of its depoſiting the water diſſolved in it, or the change is the cauſe of this depoſition, muſt remain uncertain; but, in either view, there muſt be an agent different from heat and cold, ſince the changes in theſe reſpects do not in other operations change the ſtate of electricity. Dr. Hutton ſuppoſes that heat and ſolution do not increaſe by equal increments; but that, in reality, if heat be ſuppoſed to increaſe by equal increments along a ſtraight line, ſolution will be expreſſed by ordinates to a curve whoſe convex ſide is turned towards that line. That the power of ſolution is not increaſed in the ſame ratio with heat, is, however, hypothetical, except when we riſe pretty high in the ſcale, when its proportional increaſe is a little doubtful; and it is not, in this paper, ſupported by experiment. The condenſation of the breath in air is not an obſervation in point, except in air already ſaturated with vapour. It can amount, in any view, to no more than this, that, to render it viſible, the heat muſt be diminiſhed in a greater proportion than can be compenſated by the power of ſolution in the body of air, in which the portion expired is at firſt immerſed. To explain rain from this cauſe, we muſt always ſuppoſe a conſtant diminution of heat to take place at the moment of the condenſation of the vapour; but we actually find that the change from a ſtate of vapour to the fluid ſtate is attended with heat; ſo that rain muſt at once oppoſe its own cauſe, and continued rains would be impoſſible, without calling in the aid of other cauſes. From his own ſyſtem, Dr. Hutton endeavours to explain the regular and irregular ſeaſons of rain, either reſpecting the generality of its appearance, or the regularity of its return. And, to obviate the apparent exceptions of the theory, from the generality of rain, he explains the proportional quantities of rain, and adds a comparative eſtimate of climates, in relation to rain, with the meteorological obſervations made in our own climate. As his principle is at leaſt inſufficient, and we think erroneous, it would be uſeleſs, even were this a proper place for it, to purſue theſe various branches, which muſt partake of the errors of the ſyſtem. In theſe branches we ought to obſerve that there are ſeveral juſt obſervations, mixed with errors, becauſe evaporation and condenſation muſt at laſt be the great baſis of every theory: the miſtakes ariſe from not being aware of all the cauſes, and miſrepreſenting the operation of thoſe which do exiſt.

In a work entitled Thoughts on Meteorology, volume II. M. de Luc conſiders very particularly the grand phenomenon of rain, and the numerous circumſtances connected with it. He examines the ſeveral hypotheſes with conſiderable care; but thinks them, even if admiſſible, utterly inſufficient to account for the formation of rain. The grand queſtion in this inquiry is, What becomes of the water that riſes in vapour into the atmoſphere? or what ſtate it ſubſiſts in there, between the time of its evaporation and its falling down again in rain? If it continues in the ſtate of watery vapour, or ſuch as is the immediate product of evaporation, it muſt poſſeſs the diſtinctive characters eſſential to that fluid: it muſt make the hygrometer move towards humidity, in proportion as the vapour is more or leſs abundant in the air: on a diminution of heat, the humidity, as ſhown by the hygrometer, muſt increaſe; and, on an increaſe of the heat, the humidity muſt diminiſh; and the introduction of other hygroſcopic ſubſtances, drier than the air, muſt have the ſame effect as an augmentation of heat. Theſe are the properties of watery vapour, on every hypotheſis of evaporation; and therefore all the water that exiſts in the atmoſphere without poſſeſſing theſe properties, is no longer vapour, but muſt have changed its nature. M. de Luc ſhows, that the water which forms rain, though it has ever been conſidered and reaſoned upon as producing humidity, does not poſſeſs theſe properties, and muſt therefore have paſſed into another ſtate. See a full account of his reaſoning, and the ſteps by which he proceeded, in the article METEOROLOGY. As he thinks that the vapour paſſes into an inviſible ſtate in the interval between evaporation and its falling again in rain, and that in that ſtate it is not ſenſible to the hygrometer, he conſiders the laws of hygrology as inſufficient for explaining the formation of rain; but he does not pretend to have diſcovered the immediate cauſe of the formation of clouds and rain. If it is not in the immediate product of evaporation that rain has its ſource; if the vapours change their nature in the atmoſphere, ſo as no longer to be ſenſible to the hygrometer, or to the eye; if they do not become vapour again till clouds appear; and if, when the clouds are formed, no alteration is perceived in the quality of the air—we muſt acknowledge it to be very probable, that the intermediate ſtate of vapour is no other than air—and that the clouds do not proceed from any diſtinct fluid contained in the atmoſphere, but from a decompoſition of a part of the air itſelf, perfectly ſimilar to the reſt.

It appears, to us at leaſt, that M. de Luc's mode of reaſoning on this ſubject agrees better with the phenomena than Dr. Hutton's. The Doctor, however, thinks differently, and publiſhed anſwers to the objections of M. de Luc with regard to his theory of rain; to which M. de Luc replied in a letter which was printed in the Appendix to the 81ſt volume of the Monthly Review: but it would extend our article beyond its due bounds, to give a view of this controverſy. See VAPOUR, WATER, WEATHER, and WIND.

As to the general quantity of rain that falls, and its proportion in ſeveral places at the ſame time, and in the ſame place at ſeveral times, we have many obſervations, journals, &c. in the Memoirs of the French Academy, the Philoſophical Tranſactions, &c. Upon meaſuring, then, the rain falling yearly, its depth, at a medium, and its proportion in ſeveral places, is found as in the following table :

	Inches.
At Townley, in Lancaſhire, obſerved by Mr. Townley	42½
Upminſter, in Eſſex, by Mr. Derham - -	19¼
Zurich, in Swiſſerland, by Dr. Scheuchzer -	32¼
Piſa, in Italy, by Dr. Mich. Ang. Tilli -	43¼
Paris in France, by M. de la Hire - -	19
Liſle, in Flanders, by M. de Vauban - -	24

At Upminſter.			At Paris.	
1700	19 Inches	.03	21 Inches	.37
1701	18	.69	27	.77
1702	20	.38	17	.45
1703	23	.99	18	.51
1704	15	.80	21	.20
1705	16	.93	14	.82

From the Meteorological Journal of the Royal Society, kept by order of the preſident and council, it appears that the whole quantity of rain at London, in each of the years ſpecified below, was as follows, viz.

			Inches.	
1774	-	-	26	.328
1775	-	-	24	.083
1776	-	-	20	.354
1777	-	-	25	.371
1778	-	-	20	.772
1779	-	-	26	.785
1780	-	-	17	.313

The quantity of rain in the four following years at London was,

			Inches.	
In 1789	-	-	21	.976
1790	-	-	16	.052
1791	-	-	15	.310
1792	-	-	19	.489

Proportion of the Rain of the ſeveral Seaſons to one another.

1708	Depth at Piſa Inch.	Depth at Upminſ. Inch.	Depth at Zurich. Inch.	1708	Depth at Piſa. Inch.	Depth at Upminſ. Inch.	Depth at Zurich. Inch.
Jan.	6 .41	2 .88	1 .64	July	0 .00	1 .11	3 .50
Feb.	3 .28	0 .46	1 .65	Aug.	2 .27	2 .94	3 .15
Mar.	2 .65	2 .03	1 .51	Sept.	7 .21	1 .46	3 .02
April	1 .25	0 .96	4 .69	Oct.	5 .33	0 .23	2 .44
May	3 .33	2 .02	1 .91	Nov.	2 .13	0 .86	0 .62
June	4 .90	2 .32	5 .91	Dec.	0 .00	1 .97	2 .62
Half Year	21 .82	10 .67	17 .31	Half Year	14 .94	8 .57	15 .35

See Philoſophical Tranſactions abridged, vol. iv. p. ii. p. 81, &c. and alſo Meteorological Journal of the Royal Society, publiſhed annually in the Philoſophical Tranſactions.

As to the uſe of rain, we may obſerve, that it moiſtens and ſoftens the earth, and thus fits it for affording nouriſhment to plants ; by falling on high mountains, it carries down with it many particles of looſe earth, which ſerve to fertilize the ſurrounding valleys, and purifies the air from noxious exhalations, which tend in their return to the earth to meliorate the ſoil ; it moderates the heat of the air ; and is one means of ſupplying fountains and rivers. However, vehement rains in many countries are found to be attended with barrenneſs and poorneſs of the lands ; and miſcarriage of the crops in the ſucceeding year : and the reaſon is plain ; for theſe exceſſive ſtorms waſh away the fine mould into the rivers, which carry it into the ſea, and it is a long time before the land recovers itſelf again. The remedy to the famine which ſome countries are ſubject to from this ſort of miſchief, is the planting large orchards and groves of ſuch trees as bear eſculent fruit ; for it is an old obſervation, that in years when grain ſucceeds worſt, theſe trees produce moſt fruit of all. It may partly be owing to the thorough moiſtening of the earth, as deep as their roots go by theſe rains, and partly to their trunks ſtopping part of the light mould carried down by the rains, and by this means furniſhing themſelves with a coat of new earth.

Preternatural RAINS. We have numerous accounts, in the hiſtorians of our own as well as other countries, of preternatural rains ; ſuch as the raining of ſtones, of duſt, of blood, nay, and of living animals, as young frogs, and the like. We are not to doubt the truth of what thoſe who are authors of veracity and credit relate to us of this kind, ſo far as to ſuppoſe that the falling of ſtones and duſt never happened ; the whole miſtake is, the ſuppoſing them to have fallen from the clouds : but as to the blood and frogs, it is very certain that they never fell at all, but the opinion has been a mere deception of the eyes. Men are extremely fond of the marvellous in their relations ; but the judicious reader is to examine ſtrictly whatever is reported of this kind, and is not to ſuffer himſelf to be deceived.

There are two natural methods by which quantities of ſtones and duſt may fall in certain places, without their having been generated in the clouds or fallen as rain. The one is by means of hurricanes : the wind which we frequently ſee tearing off the tiles of houſes, and carrying them to conſiderable diſtances, being equally able to take up a quantity of ſtones, and drop them again at ſome other place. But the other, which is much the moſt powerful, and probably the moſt uſual way, is for the eruptions of volcanoes and burning mountains to toſs up, as they frequently do, a vaſt quantity of ſtones, aſhes, and cinders, to an immenſe height in the air : and theſe, being hurried away by the hurricanes and impetuous winds which uſually accompany thoſe eruptions, and being in themſelves much lighter than common ſtones, as being half calcined, may eaſily be thus carried to vaſt diſtances ; and their falling in places where the inhabitants know nothing of the occaſion, they cannot but be ſuppoſed by the vulgar to fall on them from the clouds. It is well known, that, in the great eruptions of Ætna and Veſuvius, ſhowers of aſhes, duſt, and ſmall cinders, have been ſeen to obſcure the air, and overſpread the ſurface of the ſea for a great way, and cover the decks of ſhips ; and this at ſuch a diſtance, as it ſhould appear ſcarce conceivable that they ſhould have been carried to : and probably, if the accounts of all the ſhowers of theſe ſubſtances mentioned by authors be collected, they will all be found to have fallen within ſuch diſtances of volcanoes ; and if compared as to the time of their falling, will be found to correſpond in that alſo with the eruptions of thoſe mountains. We have known inſtances of the aſhes from Veſuvius having been carried thirty, nay, forty leagues, and peculiar accidents may have carried them yet further. It is not to be ſuppoſed that theſe ſhowers of ſtones and duſt fall for a continuance in the manner of ſhowers of rain, or that the fragments or pieces are as frequent as drops of water ; it is ſufficient that a number of ſtones, or a quantity of duſt, fall at once on a place where the inhabitants can have no knowledge of the part from whence they came, and the vulgar will not doubt their dropping from the clouds. Nay, in the canton of Berne in Swiſſerland, the inhabitants accounted it a miracle that it rained earth and ſulphur upon them at a time that a ſmall volcano terrified them : and, even while the wind was ſo boiſterous, and hurricanes ſo frequent, that they ſaw almoſt every moment the duſt, ſand, and little ſtones torn up from the ſurface of the earth in whirlwinds, and carried to a conſiderable height in the air, they never conſidered that both the ſulphur thrown up by the volcano, and the duſt, &c. carried from their feet muſt fall ſoon after ſomewhere. It is very certain that in ſome of the terrible ſtorms of large hail, where the hail-ſtones have been many inches round, on breaking them there have been found what people have called *ſtones in their middle*; but theſe obſervers needed only to have waited the diſſolving of one of theſe hail-ſtones, to have ſeen the ſtone in its centre diſunite alſo, it being only formed of the particles of looſe earthy matter, which the water, exhaled by the ſun's heat, had taken up in extremely ſmall moleculæ with it; and this only having ſerved to give an opake hue to the inner part of the congelation, to which the freezing of the water alone gave the apparent hardneſs of ſtone.

The raining of *blood* has ever been accounted a more terrible ſight and a more fatal omen than the other preternatural rains already mentioned. It is very certain that nature forms blood nowhere but in the veſſels of animals; and therefore ſhowers of it from the clouds are by no means to be credited. Thoſe who ſuppoſe that what has been taken for blood has been actually ſeen falling through the air, have had recourſe to flying inſects for its origin, and ſuppoſe it the eggs or dung of certain butterflies diſcharged from them as they were high up in the air. But it ſeems a very wild conjecture, as we know of no butterfly whoſe excrements or eggs are of ſuch a colour, or whoſe abode is ſo high, or their flocks ſo numerous, as to be the occaſion of this.

It is moſt probable that theſe bloody waters were never ſeen falling; but that people ſeeing the ſtanding waters blood-coloured, were aſſured, from their not knowing how it ſhould elſe happen, that it had rained blood into them, A very memorable inſtance of this there was at the Hague in the year 1670. Swammerdam, who relates it, tells us that one morning the whole town was in an uproar on finding their lakes and ditches full of blood, as they thought; and having been certainly full of water the night before, they agreed it muſt have rained blood in the night; but a certain phyſician went down to one of the canals, and taking home a quantity of this blood-coloured water, he examined it by the microſcope, and found that the water was water ſtill, and had not at all changed its colour; but that it was full of prodigious ſwarms of ſmall red animals, all alive, and very nimble in their motions, whoſe colour and prodigious number gave a red tinge to the whole body of the water they lived in, on a leſs accurate inſpection. The certainty that this was the caſe did not however perſuade the Hollanders to part with the miracle: they prudently concluded, that the ſudden appearance of ſuch a number of animals was as great a prodigy as the raining of blood would have been; and are aſſured to this day, that this portent foretold the ſcene of war and deſtruction which Louis XIV. afterwards brought into that country, which had before enjoyed 40 years uninterrupted peace.

The animals which thus colour the water of lakes and ponds are the *pulices arboreſcentes* of Swammerdam, or the water-fleas with branched horns. Theſe creatures are of a reddiſh-yellow or flame colour: they live about the ſides of ditches, under weeds, and among the mud; and are therefore the leſs viſible, except at a certain time, which is in the end or beginning of June: it is at this time that theſe little animals leave their receſſes to float looſe about the water, to meet for the propagation of their ſpecies, and by that means become viſible in the colour they give the water. This is viſible, more or leſs, in one part or other of almoſt all ſtanding waters at this ſeaſon; and it is always at this ſeaſon that the bloody waters have alarmed the ignorant. See PULEX *Monoculus*.

The raining of *frogs* is a thing not leſs wonderful in the accounts of authors who love the marvellous, than that of blood or ſtones; and this is ſuppoſed to happen ſo often, that there are multitudes who pretend to have been eye-witneſſes of it. Theſe rains of frogs always happen after very dry ſeaſons, and are much more frequent in the hotter countries than in the cold ones. In Italy they are very frequent; and it is not uncommon to ſee the ſtreets of Rome ſwarming both with young frogs and toads in an inſtant in a ſhower of rain; they hopping everywhere between the people's legs as they walk, though there was not the leaſt appearance of them before. Nay, they have been ſeen to fall through the air down upon the pavements. This ſeems a ſtrong circumſtance in favour of their being rained down from the clouds; but, when ſtrictly examined, it comes to nothing: for theſe frogs that are ſeen to fall, are always found dead, lamed, or bruiſed by the fall, and never hop about as the reſt; and they are never ſeen to fall, except cloſe under the walls of houſes, from the roofs and gutter of which they have accidentally ſlipped down. Some people, who love to add to ſtrange things yet ſtranger, affirm that they have had the young frogs fall into their hats in the midſt of an open field; but this is idle and wholly falſe.

Others, who cannot agree to their falling from the clouds, have tried to ſolve the difficulty of their ſudden appearance, by ſuppoſing them hatched out of the egg, or ſpawn, by theſe rains. Nay, ſome of them have ſuppoſed them made immediately out of the duſt: but there are unanſwerable arguments againſt all theſe ſuppoſitions. Equivocal generation, or the ſpontaneous production of animals out of duſt, is now wholly exploded. The fall from the clouds muſt deſtroy and kill theſe tender and ſoft-bodied animals: and they cannot be at this time hatched immediately out of eggs; becauſe the young frog does not make its appearance from the egg in form, but has its hinder legs enveloped in a ſkin, and is what we call a *tadpole*; and the young frogs are at leaſt 100 times larger at the time of their appearance, than the egg from which they ſhould be hatched.

It is beyond a doubt, that the frogs which make their appearance at this time were hatched and in being long before; but that the dry ſeaſons had injured them, and kept them ſluggiſhly in holes or coverts; and that all which the rain does, is the enlivening them, giving them new ſpirits, and calling them forth to ſeek new habitations, and enjoy the element they were deſtined in great part to live in. Theophraſtus, the greateſt of all the naturaliſts of antiquity, has affirmed the ſame thing. We find that the error of ſuppoſing theſe creatures to fall from the clouds was as early as that author's time; and alſo that the truth, in regard to their appearance, was as early known; though, in the ages ſince, authors have taken care to conceal the truth, and to hand down to us the error. We find this venerable ſage, in a fragment of his on the generation of animals which appear on a ſudden, bantering the opinion, and aſſerting that they were hatched and living long before. The world owes, however, to the accurate Signior Redi, the great proof of this truth, which Theophraſtus only has affirmed: for this gentleman, diſſecting ſome of theſe new-appearing frogs, found in their ſtomachs herbs and other half digeſted food; and, openly ſhowing this to his credulous countrymen, aſked them whether they thought that nature, which engendered, according to their opinion, theſe animals in the clouds, had alſo been ſo provident as to engender graſs there for their food and nouriſhment.

To the raining of frogs we ought to add the raining of *graſshoppers* and *locuſts*, which have ſometimes appeared in prodigious numbers, and devoured the fruits of the earth. There has not been the leaſt pretence for the ſuppoſing that theſe animals deſcended from the clouds, but that they appeared on a ſudden in prodigious numbers. The naturaliſt, who knows the many accidents attending the eggs of theſe and other the like animals, cannot but know that ſome ſeaſons will prove particularly favourable to the hatching them, and the prodigious number of eggs that many inſects lay could not but every year bring us ſuch abundance of the young, were they not liable to many accidents, and had not provident nature taken care, as in many plants, to continue the ſpecies by a very numerous ſtock of ſeeds, of which perhaps not one in 500 need take root in order to continue an equal number of plants. As it is thus alſo in regard to inſects, it cannot but happen, that if a favourable ſeaſon encourage the hatching of all thoſe eggs, a very ſmall number of which alone were neceſſary to continue the ſpecies, we muſt, in ſuch ſeaſons, have a proportionate abundance of them. There appeared about 50 years ago, in London, ſuch a prodigious ſwarm of the little beetle we call the *lady-cow*, that the very poſts in the ſtreets were everywhere covered with them. But thanks to the progreſs of philoſophy among us, we had nobody to aſſert that it rained cow-ladies, but contented ourſelves with ſaying that it had been a favourable ſeaſon for their eggs. The prodigious number of a ſort of grub which did vaſt miſchief about the ſame period among the corn and graſs by eating off their roots, might alſo have been ſuppoſed to proceed from its having rained grubs by people fond of making every thing a prodigy; but our knowledge in natural hiſtory aſſured us that theſe were only the hexapode worms of the common hedge beetle called the *cock-chafer*.

The raining of *fiſhes* has been a prodigy alſo much talked of in France, where the ſtreets of a town at ſome diſtance from Paris, after a terrible hurricane in the night, which tore up trees, blew down houſes, &c. were found in a manner covered with fiſhes of various ſizes. Nobody here made any doubt of theſe having fallen from the clouds; nor did the abſurdity of fiſh, five or ſix inches long, being generated in the air, at all ſtartle the people, or ſhake their belief in the miracle, till they found, upon inquiry, that a very well ſtocked fiſh-pond, which ſtood on an eminence in the neighbourhood, had been blown dry by the hurricane, and only the great fiſh left at the bottom of it, all the ſmaller fry having been toſſed into their ſtreets.

Upon the whole, all the ſuppoſed marvellous rains have been owing to ſubſtances naturally produced on the earth, and either never having been in the air at all, or only carried thither by accident.

In Sileſia, after a great dearth of wheat in that country, there happened a violent ſtorm of wind and rain, and the earth was afterwards covered, in many places, with ſmall round ſeeds. The vulgar cried out that Providence had ſent them food, and that it had rained *millet*: but theſe were, in reality, only the ſeeds of a ſpecies of veronica, or ſpeedwell, very common in that country; and whoſe ſeeds being juſt ripe at that time, the wind had diſlodged them from their capſules, and ſcattered them about. In our own country, we have hiſtories of rains of this marvellous kind, but all fabulous. It was once ſaid to rain *wheat* in Wiltſhire; and the people were all alarmed at it as a miracle, till Mr. Cole ſhowed them that what they took for wheat was only the ſeeds or kernels of the berries of ivy, which being then fully ripe, the wind had diſlodged from the ſides of houſes, and trunks of trees, on which the ivy that produced them crept.

And we even once had a raining of fiſhes near the coaſt of Kent in a terrible hurricane, with thunder and lighthing. The people who ſaw ſmall ſprats ſtrewed all about afterwards, would have it that they had fallen from the clouds; but thoſe who conſidered how far the high winds have been known to carry the ſea-water, did not wonder that they ſhould be able to carry ſmall fiſh with it ſo ſmall a part of the way.

In the Philoſophical Tranſactions for 1782 we have the following account of a preternatural kind of rain by Count de Gioeni: "The morning of the 24th inſtant there appeared here a moſt ſingular phenomenon. Every place expoſed to the air was found wet with a coloured cretaceous gray water, which, after evaporating and filtrating away, left every place covered with it to the height of two or three lines; and all the iron-work that was touched by it became ruſty. The public, inclined to the marvellous, fancied various cauſes of this rain, and began to fear for the animals and vegetables. In places where rain-water was uſed they abſtained from it: ſome ſuſpecting vitriolic principles to be mixed with it, and others predicting ſome epidemical diſorder. Thoſe who had obſerved the exploſions of Ætna 20 days and more before, were inclined to believe that it originated from one of them. The ſhower extended from N.¼N.E. to S.¼S.W. over the fields, about 70 miles in a right line from the vertex of Ætna.

"There is nothing new in volcanos having thrown up ſand, and alſo ſtones, by the violent expanſive force generated within them, which ſand has been carried by the wind to diſtant regions. But the colour and ſubtilty of the matter occaſioned doubts concerning its origin; which increaſed from the remarkable circumſtance of the water in which it came incorporated; for which reaſons ſome other principle or origin was ſuſpected.

"It became, therefore, neceſſary to aſcertain the nature of this matter, which was effected by a chemical analyſis, and from which it proved to be a mixture of volcanic matter with water.

"Ætna, about its middle regions, is generally ſurrounded with clouds that do not always riſe above its ſummit, which is 2900 paces above the level of the ſea. This matter being thrown out, and deſcending upon the clouds below it, may happen to mix and fall in rain with them in the uſual way. It may alſo be conjectured that the thick ſmoke which the volcanic matter contained might, by its rarefaction, be carried in the atmoſphere by the winds over that tract of country; and then cooling ſo as to condenſe and become ſpecifically heavier than the air, might deſcend in that coloured rain."

Rain, a well built and fortified town of Bavaria, one of the keys of this electorate, on the Lech, 20 miles weſt of Ingolſtadt. N. lat. 48. 51. E. lon. 11. 12.

Rain-*Bird*. See Cuculus.

RAINBOW. See Optics. In the Philoſophical Tranſactions for 1793, we have the following account of two rainbows ſeen by the Rev. Mr. Sturges.

"On the evening of the 9th of July 1792, between ſeven and eight o'clock, at Alverſtoke, near Goſport, on the ſea-coaſt of Hampſhire, there came up, in the ſouth-eaſt, a cloud with a thunder-ſhower; while the ſun ſhone bright, low in the horizon to the north-weſt.

"In this ſhower two primary rainbows appeared, AB and AC, pl. 38, not concentric, but touching each other at A, in the ſouth part of the horizon; with a ſecondary bow to each, DE and DF (the laſt very faint, but diſcernible), which touched likewiſe at D. Both the primary were very vivid for a conſiderable time, and at different times nearly equally ſo; but the bow AB was moſt permanent, was a larger ſegment of a circle, and at laſt, after the other had vaniſhed, became almoſt a ſemicircle; the ſun being near ſetting. It was a perfect calm, and the ſea was as ſmooth as glaſs.

"If I might venture to offer a ſolution of this appearance, it would be as follows. I conſider the bow AB as the true one, produced by the ſun itſelf; and the other, AC, as produced by the reflection of the ſun from the ſea, which, in its perfectly ſmooth ſtate, acted as a ſpeculum. The direction of the ſea, between the Iſle of Wight and the land, was to the north-weſt in a line with the ſun, as it was then ſituated. The image reflected from the water, having its rays iſſuing from a point lower than the real ſun, and in a line coming from beneath the horizon, would conſequently form a bow higher than the true one AB. And the ſhores, by which that narrow part of the ſea is bounded, would before the ſun's actual ſetting intercept its rays from the ſurface of the water, and cauſe the bow AC, which I ſuppoſe to be produced by the reflection, to diſappear before the other."

The marine or ſea bow is a phenomenon which may be frequently obſerved in a much agitated ſea, and is occaſioned by the wind ſweeping part of the waves, and carrying them aloft; which when they fall down are refracted by the ſun's rays, which paint the colours of the bow juſt as in a common ſhower. Theſe bows are often ſeen when a veſſel is ſailing with conſiderable force, and daſhing the waves around her, which are raiſed partly by the action of the ſhip and partly by the force of the wind, and, falling down, they form a rainbow; and they are alſo often occaſioned by the daſhing of the waves againſt the rocks on ſhore.

In the Philoſophical Tranſactions, it is obſerved by F. Bourzes, that the colours of the marine rainbow are leſs lively, leſs diſtinct, and of ſhorter continuance, than thoſe of the common bow; that there are ſcarce above two colours diſtinguiſhable, a dark yellow on the ſide next the ſun, and a pale green on the oppoſite ſide. But they are more numerous, there being ſometimes 20 or 30 ſeen together.

To this claſs of bows may be referred a kind of white or colourleſs rainbows, which Mentzelius and others affirm to have ſeen at noon-day. M. Marlotte, in his fourth *Eſſai de Phyſique*, ſays, theſe bows are formed in miſts, as the others are in ſhowers; and adds, that he has ſeen ſeveral both after ſun-riſing and in the night. The want of colours he attributes to the ſmallneſs of the vapours which compoſe the miſt; but perhaps it is rather from the exceeding tenuity of the little veſiculæ of the vapour, which being only little watery pellicles bloated with air, the rays of light undergo but little refraction in paſſing out of air into them; too little to ſeparate the differently-coloured rays, &c. Hence the rays are reflected from them, compounded as they came, that is, white. Rohault mentions (*Trait. de Phyſique,*) coloured rainbows on the graſs; formed by the refractions of the ſun's rays in the morning dew. Rainbows have been alſo produced by the reflection of the ſun from a river; and in the Philoſophical Tranſactions, vol. 50. p. 294. we have an account of a rainbow, which muſt have been formed by the exhalations from the city of London, when the ſun had been ſet 20 minutes, and conſequently the centre of the bow was above the horizon. The colours were the ſame as in the common rainbow, but fainter.

It has often been made a ſubject of inquiry among the curious how there came to be no rainbow before the flood, which is thought by ſome to have been the caſe from its being made a ſign of the covenant which the Deity was pleaſed to make with man after that event. Mr. Whitehurſt in his *Inquiry into the Original State and Formation of the Earth*, p. 173, &c. endeavours to eſtabliſh it as a matter of great probability at leaſt, that the antediluvian atmoſphere was ſo uniformly temperate as never to be ſubject to ſtorms, tempeſts, or rain, and of courſe it could never exhibit a rainbow. For our own part, we cannot ſee how the earth at that period could do without rain any more than at preſent; and it appears to us from Scripture equally probable that the rainbow was ſeen before the flood as after it. It was then, however, made a token of a certain covenant; and it would unqueſtionably do equally well for that purpoſe if it had exiſted before as if it had not.

Lunar RAINBOW. The moon ſometimes alſo exhibits the phenomenon of an iris or rainbow by the refraction of her rays in drops of rain in the night-time. This phenomenon is very rare. In the Philoſophical Tranſactions for 1783, however, we have an account of three ſeen in one year, and all in the ſame place, communicated in two letters by Marmaduke Tunſtall, Eſq. The firſt was ſeen 27th February 1782, at Greta Bridge, Yorkſhire, between ſeven and eight at night, and appeared "in tolerably diſtinct colours, ſimilar to a ſolar one, but more faint: the orange colour ſeemed to predominate. It happened at full moon; at which time alone they are ſaid to have been always ſeen. Though Ariſtotle is ſaid to have obſerved two, and ſome others have been ſeen by Suellius, &c. I can only find two deſcribed with any accuracy; viz. one by Plot, in his Hiſtory of Oxfordſhire, ſeen by him in 1675, though without colours; the other ſeen by a Derbyſhire gentleman at Glapwell, near Cheſterfield, deſcribed by Thoreſby, and inſerted in No. 331 of the Philoſophical Tranſactions: this was about Chriſtmas, 1710, and ſaid to have had all the colours of the Iris Solaris, The night was windy; and though there was then a drizzling rain and dark cloud, in which the rainbow was reflected, it proved afterwards a light froſt."

Two others were afterwards ſeen by Mr. Tunſtall; one on July the 30th, about 11 o'clock, which laſted about a quarter of an hour, without colours. The other, which appeared on Friday October 18, was "perhaps the moſt extraordinary one of the kind ever ſeen. It was firſt viſible about nine o'clock, and continued, though with very different degrees of brilliancy, till paſt two. At firſt, though a ſtrongly marked bow, it was without colours; but afterwards they were very conſpicuous and vivid in the ſame form as the ſolar, though fainter; the red, green, and purple were moſt diſtinguiſhable. About twelve it was the moſt ſplendid in appearance; its arc was conſiderably a ſmaller ſegment of a circle than a ſolar; its ſouth-eaſt limb firſt began to fail, and a conſiderable time before its final extinction: the wind was very high, nearly due weſt, moſt part of the time accompanied with a drizzling rain. It is a ſingular circumſtance, that three of theſe phenomena ſhould have been ſeen in ſo ſhort a time in one place, as they have been eſteemed ever ſince the time of Ariſtotle, who is ſaid to have been the firſt obſerver of them, and ſaw only two in 50 years, and ſince by Plot and Thoreſby, almoſt the only two Engliſh authors who have ſpoken of them, to be exceedingly rare. They ſeem evidently to be occaſioned by a refraction in a cloud or turbid atmoſphere, and in general are indications of ſtormy and rainy weather: ſo bad a ſeaſon as the late ſummer having, I believe, ſeldom occurred in England. Thoreſby, indeed, ſays, the one he obſerved was ſucceeded by ſeveral days of fine ſerene weather. One particular, rather ſingular, in the ſecond, viz. of July the 30th, was its being ſix days after the full of the moon; and the laſt, though of ſo long a duration, was three days before the full: that of the 27th of February was exactly at the full, which uſed to be judged the only time they could be ſeen, though in the Encyclopædia there is an account that Weidler obſerved one in 1719, in the 1ſt quarter of the moon, with faint colours, and in very calm weather. No lunar iris, I ever heard or read of, laſted near ſo long as that on the 18th inſtant, either with or without colours."

In the Gentleman's Magazine for Auguſt 1688 we have another account of a lunar rainbow. "On Sunday evening the 17th of Auguſt (ſays the writer), after two days, on both of which, particularly the former, there had been a great deal of rain, together with lightning and thunder, juſt as the clocks were ſtriking nine, 23 hours after full moon, looking through my window, I was ſtruck with the appearance of ſomething in the ſky, which ſeemed like a rainbow. Having never ſeen a rainbow by night, I thought it a very extraordinary phenomenon, and haſtened to a place where there were no buildings to obſtruct my view of the hemiſphere: here I found that the phenomenon was no other than a lunar rainbow; the moon was truly 'walking in brightneſs,' brilliant as ſhe could be; not a cloud was to be ſeen near her; and over againſt her, toward the north-weſt, or perhaps rather more to the north, was a rain-bow, a vaſt arch, perfect in all its parts, not interrupted or broken as rainbows frequently are, but unremittedly viſible from one horizon to the other. In order to give ſome idea of its extent, it is neceſſary to ſay, that as I ſtood toward the weſtern extremity of the pariſh of Stoke Newington, it ſeemed to take its riſe from the weſt of Hampſtead, and to end, perhaps, in the river Lea, the eaſtern boundary of Tottenham; its colour was white, cloudy, or grayiſh, but a part of its weſtern leg ſeemed to exhibit tints of a faint ſickly green. I continued viewing it for ſome time, till it began to rain; and at length the rain increaſing, and the ſky growing more hazy, I returned home about a quarter or 20 minutes paſt nine, and in ten minutes came out again: but by that time all was over, the moon was darkened by clouds, and the rainbow of courſe vaniſhed."

Marine RAINBOW, or *Sea-bow*. See the article RAINBOW.

RAINBOW-*Stone*. See MOON-*Stone*.

RAISINS, grapes prepared by ſuffering them to remain on the vine till they are perfectly ripe, and then drying them in the ſun, or by the heat of an oven. The difference between raiſins dried in the ſun and thoſe dried in ovens, is very obvious: the former are ſweet and pleaſant, but the latter have a latent acidity with the ſweetneſs that renders them much leſs agreeable.

The common way of drying grapes for raiſins, is to tie two or three bunches of them together while yet on the vine, and dip them into a hot lixivium of wood-aſhes, with a little of the oil of olives in it. This diſpoſes them to ſhrink and wrinkle; and after this they are left on the vine three or four days ſeparated on ſticks in an horizontal ſituation, and then dried in the ſun at leiſure, after being cut from the tree. The fineſt and beſt raiſins are thoſe called in ſome places *Damaſcus* and *Jube raiſins*; which are diſtinguiſhed from the others by their ſize and figure: they are flat and wrinkled on the ſurface, ſoft and juicy within, and near an inch long; and, when freſh and growing on the bunch, are of the ſize and ſhape of a large olive.

The raiſins of the ſun, and jar-raiſins, are all dried by the heat of the ſun; and theſe are the ſorts uſed in medicine. However, all the kinds have much the ſame virtues: they are all nutritive and balſamic; they are allowed to be attenuant, are ſaid to be good in nephritic complaints, and are an ingredient in pectoral decoctions: in which caſes, as alſo in all others where aſtringency is not required of them, they ſhould have the ſtones carefully taken out.

RAISIN-*Wine*. See WINE.

RAKKATH (anc. geog.) a town of Upper Galilee, thought to be Tiberias, (Talmud): but this is denied by Reland, who ſays that Rakkath was a town of the tribe of Naphthali.

RAKE is a well-known inſtrument with teeth, by which the ground is divided. See HUSBANDRY.

RAKE alſo means a looſe, diſorderly, vicious, and thoughtleſs fellow.

RAKE *of a Ship*, is all that part of her hull which hangs over both ends of her keel. That which is before is called the *fore rake*, or *rake forward*, and that part which is at the ſetting on of the ſtern-poſt is called the *rake aft*, or *afterward*.

RALEIGH (Sir WALTER), fourth ſon of Walter Raleigh, Eſq; of Fardel, in the pariſh of Cornwood in Devonſhire, was born in 1552 at Hayes, in the pariſh of Budley, a farm belonging to his father. About the year 1568, he was ſent to Oriel college in Oxford, where he continued but a ſhort time; for in the following year he embarked for France, being one of the hundred volunteers, commanded by Henry Champernon, who, with other Engliſh troops, were ſent by queen Elizabeth to aſſiſt the queen of Navarre in defending the Proteſtants. In this ſervice he continued for five or ſix years; after which he returned to London, and probably reſided in the Middle Temple. But his enterpriſing genius would not ſuffer him to remain long in a ſtate of inactivity. In 1577 or 1578, he embarked for the Low Countries with the troops ſent by the queen to aſſiſt the Dutch againſt the Spaniards, and probably ſhared the glory of the deciſive victory over Don John of Auſtria in 1578. On his return to England, a new enterpriſe engaged his attention. His half-brother, Sir Humphrey Gilbert, having obtained a patent to plant and inhabit ſome parts of North America, Mr. Raleigh embarked in this adventure; but, meeting with a Spaniſh fleet, after a ſmart engagement they returned without ſucceſs in 1795.

The following year, the king of Spain, in conjunction with the pope, having projected a total conqueſt of the Engliſh dominions, ſent troops to Ireland to aſſiſt the Deſmonds in the Munſter rebellion. Raleigh obtained a captain's commiſſion under Lord Grey of Wilton, then deputy of Ireland, and embarked for that kingdom: where, by his conduct and reſolution, he was principally inſtrumental in putting an end to the rebellious attempt. He returned to England; and attracted the notice of queen Elizabeth, owing, as we are told in Nauton's *Fragmenta Regalia*, to the following accidental piece of gallantry. The queen, as ſhe was one day taking a walk, being ſtopped by a *ſplaſhy* place in the road, our gallant young ſoldier took off his new pluſh mantle, and ſpread it on the ground. Her Majeſty trod gently over the fair foot-cloth, ſurpriſed and pleaſed with the adventure. He was a handſome man, and remarkable for his gentility of addreſs.

The queen admitted him to her court, and employed him firſt as an attendant on the French ambaſſador Samier on his return home, and afterward to eſcort the duke of Anjou to Antwerp. During this excurſion he became perſonally known to the prince of Orange: from whom, at his return, he brought ſpecial acknowledgements to the queen, who now frequently converſed with him. But the inactive life of a courtier did not ſuit the enterpriſing ſpirit of Mr. Raleigh. In the year 1583, he embarked with his brother, Sir Humphrey Gilbert, on a ſecond expedition to Newfoundland, in a ſhip called the *Raleigh*, which he built at his own expenſe; but was obliged to return on account of an infectious diſtemper on board. He was, however, ſo little affected by this diſappointment, that he now laid before the queen and council a propoſal for exploring the continent of North America; and in 1584 obtained a patent empowering him to poſſeſs ſuch countries as he ſhould diſcover in that part of the globe. Accordingly Mr. Raleigh fitted out two ſhips at his own expenſe, which ſailed in the month of April and returned to England about the middle of September, reporting that they had diſcovered and taken poſſeſſion of a fine country called *Windangocoa*, to which the queen gave the name of *Virginia*. About this time he was elected knight of the ſhire for the county of Devon, and ſoon after received the honour of knighthood: and to enable him to carry on his deſigns abroad, the queen granted him a patent for licenſing the venders of wine throughout the kingdom. In 1585 he ſent a fleet of ſeven ſhips to Virginia, commanded by his relation Sir Richard Greenville, who left a colony at Roanah of 107 perſons, under the government of Mr. Lane; and by the eſtabliſhment of this colony he firſt imported tobacco into England. See NICOTIANA. In the ſame year Sir Walter Raleigh obtained a grant of 12,000 acres of the forfeited lands in the county of Cork in Ireland. —About the ſame time he was made ſeneſchal of the duchy of Cornwall, and warden of the ſtanneries; and grew into ſuch favour with the queen, that even Leiceſter was jealous of his influence.

In 1587, he ſent another colony of 150 men to Virginia, with a governor, Mr. John White, and 12 aſſiſtants. About this time we find our knight diſtinguiſhed by the titles of *Cap-*

tain of the queen's guards, and *lieutenant-general of Cornwall.* From this period to the year 1594, he was continually engaged in projecting new expeditions, ſending ſuccours to colonies abroad, defending the kingdom from the inſults of the Spaniards, and tranſacting parliamentary buſineſs, with equal ability and reſolution. Whilſt thus employed, he was publicly charged, in a libel written by the infamous Jeſuit Parſons, with being an atheiſt; a groundleſs and ridiculous imputation. In 1594, he obtained from the queen a grant of the manor of Sherborne in Dorſetſhire, where he built a magnificent houſe: but Sir Walter fell under the queen's diſpleaſure on account of an intrigue with the daughter of Sir Nicholas Throgmorton, one of the maids of honour; however, he married the lady, and lived with her in great conjugal harmony. During his diſgrace at court, he projected the conqueſt of Guiana in South America, and in 1595 ſailed for that country; of which having taken poſſeſſion, after defeating the Spaniards who were ſettled there, he returned to England the ſame year, and ſoon after publiſhed an account of his expedition. In the following year he was one of the admirals in the ſucceſsful expedition againſt Cadiz, under the command of Howard and the earl of Eſſex; and in 1597 he ſailed with the ſame commanders againſt the Azores. Soon after theſe expeditions, we find him aſſiduouſly engaged in parliamentary buſineſs, and a diſtinguiſhed perſonage in jouſts and tournaments. In 1600 he was ſent on a joint embaſſy with Lord Cobham to Flanders, and at his return made governor of Jerſey.

Queen Elizabeth died in the beginning of the year 1603: and with her Raleigh's glory and felicity ſunk, never to riſe again. Upon the acceſſion of James, Sir Walter loſt his intereſt at court, was ſtripped of his preferments, and accuſed of a plot againſt the king. He was arraigned at Wincheſter, and, on his trial, inſulted by the moſt ſhocking brutality by the famous Coke, attorney-general, whoſe ſophiſtical vociferation influenced the jury to convict him without the leaſt proof of guilt. After a month's impriſonment, however, in daily expectation of his execution, he was reprieved, and ſent to the Tower; and his eſtates were given to Car, earl of Somerſet, the king's favourite. During this confinement, he wrote many of his moſt valuable pieces, particularly his Hiſtory of the World. In March 1615, after 16 years impriſonment, he obtained his liberty, and immediately began to prepare for another voyage to Guiana. In Auguſt 1616 the king granted him a very ample commiſſion for that purpoſe; and in July the year following, he ſailed from Plymouth: but, ſtrange as it may appear, it is moſt certain that the whole ſcheme was revealed to the Spaniards by the king himſelf, and thus neceſſarily rendered abortive.

He returned to England in 1618, where he was ſoon after ſeized, impriſoned, and beheaded; not for any pretended miſdemeanor on the late expedition, but in conſequence of his former attainder. The truth of the matter is, he was ſacrificed by the puſillanimous monarch to appeaſe the Spaniards; who, whilſt Raleigh lived, thought every part of their dominions in danger. He was executed in Old Palace Yard, and buried in St Margaret's adjoining, in the 66th year of his age. His behaviour on the ſcaffold was manly, unaffected, chearful and eaſy. Being aſked by the executioner which way he would lay his head, he anſwered, "So the heart be right, it is no matter which way the head lies." He was a man of admirable parts, extenſive knowledge, undaunted reſolution, and ſtrict honour and honeſty. He was the author of a great many works, ſome of which have not been printed.

RALLUS, the Rail, in ornithology; a genus belonging to the order of grallæ. The beak is thickeſt at the baſe, compreſſed, equal, acute, and ſomewhat ſharp on the back near the point; the noſtrils are oval; the feet have four toes, without any web; and the body is compreſſed. Mr. Latham, in his *Index Ornithologicus*, enumerates 24 ſpecies, beſides ſome varieties. They are chiefly diſtinguiſhed by their colour. "Theſe birds (ſays Buffon) conſtitute a large family, and their habits are different from thoſe of the other ſhore-birds, which reſide on ſands and gravel. The rails, on the contrary, inhabit only the ſlimy margins of pools and rivers, eſpecially low grounds covered with flags and other large marſh plants. This mode of living is habitual and common to all the ſpecies of water-rails. The land-rail frequents meadows, and from the diſagreeable cry, or rather rattling in the throat of this bird, is derived the generic name. In all the rails, the body is ſlender, and ſhrunk at the ſides; the tail extremely ſhort; the head ſmall; the bill pretty like that of the gallinaceous kind, though much longer, and not ſo thick; a portion of the leg above the knee is bare; the three fore-toes without membranes, and very long: they do not, like other birds, draw their feet under their belly in flying, but allow them to hang down: their wings are ſmall and very concave, and their flight is ſhort.—They ſeem to be more diffuſed than varied; and nature has produced or tranſported them over the moſt diſtant lands. Captain Cook found them at the Straits of Magellan, in different iſlands of the ſouthern hemiſphere, at Anamoka, at Tanna, and at the iſle of Norfolk. In the Society Iſlands there are two ſpecies of rails; a little black ſpotted one, (*pooanée*), and a little red eyed one (*moi-ho*). It appears that the two acolins of Fernandez, which he denominates *water-quails*, are of a ſpecies of rails peculiar to the great lake of Mexico. The colins, which might be confounded with theſe, are a kind of partridges." The principal are,

1. The *aquaticus*, or water-rail, is a bird of a long ſlender body, with ſhort concave wings. It delights leſs in flying than running: which it does very ſwiftly along the edges of brooks covered with buſhes: as it runs, it every now and then flirts up its tail, and in flying hangs down its legs; actions it has in common with the water-hen. Its weight is four ounces and a half. The length to the end of the tail is 12 inches; the breadth 16. The bill is ſlender, ſlightly incurvated, one inch three quarters long: the upper mandible black, edged with red; the lower, orange-coloured; the head, hind part of the neck, the back, and coverts of the wings and tail, are black, edged with olive-brown; the throat, breaſt, and upper part of the belly, are aſh-coloured: the ſides under the wings as far as the rump, finely varied with black and white bars. The tail is very ſhort, conſiſts of 12 black feathers; the ends of the two middle tipt with ruſt-colour; the feathers immediately beneath the tail, white. The legs are placed far behind, and are of a duſky fleſh-colour. The toes very long, and divided to their very origin; though the feet are not webbed it takes the water, will ſwim on it with much eaſe, but is often obſerved to run along the ſurface. "Water rails (ſays Buffon) are ſeen near the perennial fountains during the greateſt part of the winter, yet like the land-rails they have their regular migrations. They paſs Malta in the ſpring and autumn. The viſcount de Querhoent ſaw ſome 50 leagues off the coaſts of Portugal on the 17th of April. They were ſo fatigued, that they ſuffered themſelves to be caught by the hand *. Gmelin found theſe birds in the countries watered by the Don. Belon calls them *black rails*, and ſays they are everywhere known, and that the

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* 'I tried (ſays M. de Querhoent) to raiſe ſome: they thrived wonderfully at firſt, but after a fortnight's confinement their long legs grew paralytic, and the birds could only crawl on their knees; at laſt they expired.' Geſner ſays, that having long fed one, he found it to be peeviſh and quarrelſome.

ſpecies is more numerous than the red-rail or land-rail. The fleſh of the water-rail is not ſo delicate as that of the land-rail, and has even a marſhy taſte, nearly like that of the gallinule. It continues the whole year in England."

2. The *porzana*, or gallinule, is not very frequent in Great Britain, and is ſaid to be migratory. Inhabits the ſides of ſmall ſtreams, concealing itſelf among the buſhes. Its length is nine inches; its breadth 15; it weighs four ounces five drachms. The head is brown, ſpotted with black; the neck a deep olive, ſpotted with white: the feathers of the back are black next their ſhafts, then olive-coloured, and edged with white; the ſcapulars are olive, finely marked with two ſmall white ſpots on each web: the legs of a yellowiſh green. "Its habits (ſays Buffon) wild, its inſtinct ſtupid, the porzana is unſuſceptible of education, nor is even capable of being tamed. We raiſed one, however, which lived a whole ſummer on crumbs of bread and hemp ſeed; when by itſelf, it kept conſtantly in a large bowl of water; but if a perſon entered the cloſet where it was ſhut, it ran to conceal itſelf in a ſmall dark corner, without venting cries or murmurs. In the ſtate of liberty, however, it has a ſharp piercing voice, much like the ſcream of a young bird of prey; and though it has no propenſity to ſociety, as ſoon as one cries, another repeats the ſound, which is thus conveyed through all the reſt in the diſtrict. Like all the rails, it is ſo obſtinately averſe to riſe, that the ſportſman often ſeizes it with his hand, or fells it with a ſtick. If it finds a buſh in its retreat, it climbs upon it, and from the top of its aſylum beholds the dogs bruſhing along in fault: this habit is common to it and to the water-rail. It dives, ſwims, and even ſwims under water, when hard puſhed.

"Theſe birds diſappear in the depth of winter, but return early in the ſpring; and even in the month of February they are common in ſome provinces of France and Italy. Their fleſh is delicate, and much eſteemed: thoſe, in particular, which are caught in the rice-fields in Piedmont are very fat, and of an exquiſite flavour."

3. The crex, crake, or corn-crek, has been ſuppoſed by ſome to be the ſame with the water-rail, and that it differs only by a change of colour at a certain ſeaſon of the year: this error is owing to inattention to their characters and nature, both which differ entirely. The bill of this ſpecies is ſhort, ſtrong, and thick; formed exactly like that of the water-hen, and makes a generical diſtinction. It never frequents watery places; but is always found among corn, graſs, broom, or furze. It quits the kingdom before winter; but the water-rail endures our ſharpeſt ſeaſons. They agree in their averſion to flight; and the legs, which are remarkably long for the ſize of the bird, hang down whilſt they are on the wing; they truſt their ſafety to their ſwiftneſs on foot, and ſeldom are ſprung a ſecond time but with great difficulty. The land-rail lays from 12 to 20 eggs, of a dull white colour, marked with a few yellow ſpots; notwithſtanding this, they are very numerous in this kingdom. Their note is very ſingular; and, like the quail, it is decoyed into a net by the imitation of its cry, *crek crek crek*, by rubbing hard the blade of a knife on an indented bone. Moſt of the names given in different languages to this bird are evidently formed to imitate this ſingular cry. Hence Turner and ſome other naturaliſts have ſuppoſed it to be the crex of the ancients; but that term appears to have been applied by the ancients to other birds. Philus gives the crex the epithet of βραδυπτερος, or *ſluggiſh-winged*, which would indeed ſuit the land-rail. Ariſtophanes repreſents it as migrating from Libya: Ariſtotle ſays that it is quarrelſome, which may have been attributed to it from the analogy to the quail; but he adds, that the crex ſeeks to deſtroy the neſts of the blackbird, which cannot apply to the rail, ſince it never inhabits the woods. Still leſs is the crex of Herodotus a rail, for he compares its ſize to that of the ibis, which is ten times larger. The avoſet, too, and the teal, have ſometimes the cry *crex, crex*: and the bird which Belon heard repeating that cry on the banks of the Nile is, according to his account, a ſpecies of godwit. Thus the ſound repreſented by the word *crex*, belonging to ſeveral ſpecies, is not ſufficiently preciſe to diſtinguiſh the land-rail.

They are in greateſt plenty in Angleſea, where they appear about the 20th of April, ſuppoſed to paſs over from Ireland, where they abound: at their firſt arrival it is common to ſhoot ſeven or eight in a morning. They are found in moſt of the Hebrides, and the Orkneys. On their arrival they are very lean, weighing only ſix ounces; but before they leave this iſland, grow ſo fat as to weigh above eight. The feathers on the crown of the head and hind part of the neck are black, edged with bay-colour; the coverts of the wings of the ſame colour, but not ſpotted; the tail is ſhort, and of a deep bay; the belly white; the legs aſh-coloured.

RALPH (James), a late ingenious hiſtorical and political writer, was born, we know not when or where, being firſt known as a ſchoolmaſter in Philadelphia in North America. He came to England about the beginning of the reign of George I. and wrote ſome things in the dramatic way, which were not received with great applauſe: but though he did not ſucceed as a poet, he was a very ingenious proſe-writer. He wrote A Hiſtory of England, commencing with the Stuarts, which is much eſteemed; as were his political eſſays and pamphlets, ſome of which were looked upon as maſter pieces. His laſt publication, The Caſe of Authors by Profeſſion, is an excellent and entertaining performance. He died in 1762.

RAM, in zoology. See Ovis.

Battering Ram, in antiquity, a military engine uſed to batter down the walls of beſieged places. See Battering *Ram.*

Ram's *Head*, in a ſhip, is a great block belonging to the fore and main haulyards. It has three ſhives in it, in which the haulyards are put; and in a hole at the end are reeved the ties.

RAMADAN, a ſolemn ſeaſon of faſting among the Mahometans. See Mahometanism.

RAMAH (anc. geog.), a town of Benjamin, near Gibea, (Judges), called *Rama of Saul* (1 Sam. xxii.), ſix miles from Jeruſalem to the north; memorable for the ſtory of the Levite and his concubine: taken and fortified by Baaſa king of Iſrael, in order to annoy the kingdom of Judah. This Rama is mentioned Iſa. x. Jer. xxxi. and Matth. ii. and is to be diſtinguiſhed from *Rama of Samuel*, 1 Sam. xix. called alſo *Ramatha*, 1 Sam. i. 19. and *Ramathaim Zophim*, ibid. i. 1. which lay a great way to the weſt, towards Joppa, near Lydda, 1 Maccab. ii. the birth-place of Samuel; adjoining to the mountains of Ephraim, and the place of his reſidence, 1 Sam. xv. &c. (Joſephus). Called *Ramula* in the lower age, (Gul. Tyrius). There is here a convent of the Fathers of the Holy Land, inhabited only by Portugueſe, Spaniards, and Italians.

RAMATH-mizpe, (Joſhua xii.); *Ramoth-Maſphe*, (Septuagint, Vulgate); *Ramoth in Gilead*, or *Remmath Galaad*, (Septuagint); a town in that tract of Gilead called *Maſpha*, or *Mizpe*, one of the cities of refuge.

RAMAZZINI (Bernardin), an Italian phyſician, born at Carpi near Modena in 1633. He was profeſſor of phyſic in the univerſity of Modena for 18 years; and in 1700 accepted an invitation from Padua, where he was made rector of the college; and died in 1714. His works were collected and publiſhed in London, 1716; of which his treatiſe *De Morbis Artificum*, "Of the peculiar maladies of artificers," will always be eſteemed uſeful and curious.

RAMEKINS, a fortreſs of the United Netherlands, on the ſouth coaſt of the iſland of Walcherin, in the province of Zealand. One of the cautionary towns given to queen Elizabeth for the repayment of the charges ſhe had been at for the defence of this republic in its infancy. Four miles eaſt of Fluſhing; in N. lat. 51. 34. E. lon. 4. 24.

RAMESES, (anc. geog.); a town built by the Iſraelites during their bondage in Egypt, and from which the Exodus took place, and which muſt have been towards and not far from the Arabian Gulph, ſeeing in the third ſtation the Iſraelites arrived on its ſhore.

Rameses, king of the Lower Egypt when Jacob went thither with his family, in the 1706th year before the Chriſtian æra. Ancient authors mention ſeveral other kings of Egypt of the ſame name; and it is thought that one of thoſe princes erected, in the temple of the ſun at Thebes, the magnificent obeliſk which the emperor Conſtantine cauſed to be removed to Alexandria in the year 334; and that prince dying, his ſon Conſtantius had the obeliſk tranſported from Alexandria to Rome in 352, where it was erected in the grand Circus. Its height was 132 feet. When the Goths ſacked the city of Rome in 409, they overthrew this obeliſk, which continued buried in the ſand till the time of Sixtus V. in 1587, when it was found broken in three pieces; which being joined together, it was ſet up in the ſquare of St. John de Lateran. On the four ſides of this wonderful obeliſk are a number of figures and hieroglyphical characters, which, according to the explication of Ammianus Marcellinus, contain the praiſes of Rameſes.

RAMIFICATION, the production of boughs or branches, or of figures reſembling branches.

RAMILLIES, a town of Auſtrian Brabant, remarkable for the great victory obtained by the duke of Marlborough over the French, on Whitſunday 1706. It is 10 miles N. of Namur, and 24 S. E. of Bruſſels. E. lon. 4. 50. N. lat. 50. 39.

RAMLA, the modern name of Arimathea. See Arimathea.

RAMMER, an inſtrument uſed for driving down ſtones or piles into the ground; or for beating the earth, in order to render it more ſolid for a foundation.

Rammer *of a Gun*, the *Gun-ſtick*; a rod uſed in charging of a gun, to drive home the powder, as alſo the ſhot, and the wad which keeps the ſhot from rolling out.

RAMPANT, in heraldry, a term applied to a lion, leopard, or other beaſt that ſtands on its hind legs, and rears up his forefeet in the poſture of climbing, ſhowing only half his face, as one eye, &c. It is different from ſaliant, in which the beaſt ſeems ſpringing forward as if making a ſally.

RAMPART, in fortification, is an elevation of earth round a place capable of reſiſting the cannon of an enemy; and formed into baſtions, curtins, &c.

RAMPHASTOS, the Toucan, in ornithology. See Rhamphastos.

RAMSAY (Allan), the Scots paſtoral poet, was a barber in Edinburgh in the early part of the preſent century. His taſte in poetry, however, has juſtly raiſed him to a degree of fame that may in ſome meaſure be conſidered as a recompenſe for the frowns of fortune. His ſongs are in univerſal eſteem; as is alſo the only dramatic performance attributed to him, viz. *Patie and Roger*, or *The Gentle Shepherd*, a Scots paſtoral. He died in 1743; and was father to the ingenious Mr. Ramſay, a celebrated painter of the preſent age, and who has likewiſe diſtinguiſhed himſelf by ſome well-written tracts on various branches of polite literature, particularly the *Inveſtigator*.

Ramsay, (Andrew Michael), generally known by the name of the *Chevalier Ramſay*, was a Scots writer, born at Ayr in 1686. His good parts and learning recommended him to be tutor to the ſon of the earl of Wemyſs; after which, conceiving a diſguſt at the religion in which he had been educated, he in the ſame ill humour reviewed other Chriſtian churches; and, finding none to his liking, reſted for a while in deiſm. While he was in this uncertain ſtate of mind, he went to Leyden; where falling into the company of one Poiret a myſtic divine, he received the infection of myſticiſm: which prompted him to conſult M. Fenelon, the celebrated archbiſhop of Cambray, who had imbibed principles of the ſame nature; and who gained him over to the Catholic religion in 1709. The ſubſequent courſe of his life received its direction from his friendſhip and connections with this prelate; and being appointed governor to the duke de Chateau Thierry, and the prince de Turenne, he was made a knight of the order of St. Lazarus. He was ſent for to Rome by the chevalier de St. George, to undertake the education of his children; but he found ſo many intrigues and diſſenſions on his arrival there in 1724, that he obtained the Chevalier's leave to return to Paris. He died in 1743 in the office of intendant to the duke of Bouillon, prince de Turenne. The moſt capital work of his writing is the *Travels of Cyrus*, which has been ſeveral times printed in Engliſh.

RAMSDEN's Machine *for Dividing* Mathematical Instruments, is an uſeful invention, by which theſe diviſions can be performed with exceeding great accuracy, ſuch as would formerly have been deemed incredible. On diſcovering the method of conſtructing this machine, its inventor, Mr. Ramſden of Piccadilly, received 615 l. from the commiſſioners of longitude; engaging himſelf to inſtruct a certain number of perſons, not exceeding ten, in the method of making and uſing this machine from the 28th October 1775, to 28th October 1777: alſo binding himſelf to divide all octants and ſextants by the ſame engine, at the rate of three ſhillings for each octant, and ſix ſhillings for each braſs ſextant, with Nonius's diviſions to half minutes, for as long time as the commiſſioners ſhould think proper to let the engine remain in his poſſeſſion. Of this ſum of 615l. paid to Mr. Ramſden, 300l. was given him as a reward for the improvement made by him in diſcovering the engine, and the remaining 315l. for his giving up the property of it to the commiſſioners. The following deſcription of the engine, is that given upon oath by Mr. Ramſden himſelf.

"This engine conſiſts of a large wheel of bell-metal, ſupported on a mahogany ſtand, having three legs, which are ſtrongly connected together by braces, ſo as to make it perfectly ſteady. On each leg of the ſtand is placed a conical friction-pulley, whereon the dividing wheel reſts: to prevent the wheel from ſliding off the friction pulleys, the bell-metal centre under it turns in a ſocket on the top of the ſtand.

"The circumference of the wheel is ratched or cut (by a method which will be deſcribed hereafter) into 2160 teeth, in which an endleſs ſcrew acts. Six revolutions of the ſcrew will move the wheel a ſpace equal to one degree.

"Now a circle of braſs being fixed on the ſcrew arbor, having its circumference divided into 60 parts, each diviſion will conſequently anſwer to a motion of the wheel of 10 ſeconds, ſix of them will be equal to a minute, &c.

"Several different arbors of tempered ſteel are truly ground into the ſocket in the centre of the wheel. The upper parts of the arbors that ſtand upon the plane are turned of various ſizes, to ſuit the centres of different pieces of work to be divided.

"When any inſtrument is to be divided, the centre of it is very exactly fitted on one of theſe arbors; and the inſtrument is fixed down to the plane of the dividing wheel, by means of ſcrews, which fit into holes made in the radii of the wheel for that purpoſe.

"The inſtrument being thus fitted on the plane of the wheel, the frame which carries the dividing point is connected at one end by finger-ſcrews with the frame which carries the endleſs ſcrew; while the other end embraces that part of the ſteel arbor which ſtands above the inſtrument to be divided, by an angular notch in a piece of hardened ſteel; by this means both ends of the frame are kept perfectly ſteady and free from any ſhake.

"The frame carrying the dividing-point or tracer, is made to ſlide on the frame which carries the endleſs ſcrew to any diſtance from the centre of the wheel as the radius of the inſtrument to be divided may require, and may be there faſtened by tightening two clamps; and the dividing-point or tracer being connected with the clamps by the double-jointed frame, admits a free and eaſy motion towards or from the centre for cutting the diviſions, without any lateral ſhake.

"From what has been ſaid, it appears that an inſtrument thus fitted on the dividing-wheel may be moved to any angle by the ſcrew and divided circle on its arbor, and that this angle may be marked on the limb of the inſtrument with the greateſt exactneſs by the dividing-point or tracer, which can only move in a direct line tending to the centre, and is altogether freed from thoſe inconveniences that attend cutting by means of a ſtraight edge. This method of drawing lines will alſo prevent any error that might ariſe from an expanſion or contraction of the metal during the time of dividing.

"The ſcrew frame is fixed on the top of a conical pillar, which turns freely round its axis, and alſo moves freely towards or from the centre of the wheel, ſo that the ſcrew-frame may be entirely guided by the frame which connects it with the centre: by this means any eccentricity of the wheel and the arbor would not produce any error in the dividing; and by a particular contrivance (which will be deſcribed hereafter), the ſcrew when preſſed againſt the teeth of the wheel always moves parallel to itſelf; ſo that a line joining the centre of the arbor and the tracer continued, will always make equal angles with the ſcrew.

"Figure 1. in pl. 39. repreſents a perſpective view of the engine.

"Fig. 2. in plate 40 is a plan, of which fig. 3. repreſents a ſection on the line ΠΔ.

"The large wheel A is 45 inches in diameter, and has ten radii, each being ſupported by edge-bars, as repreſented in fig. 3. Theſe bars and radii are connected by the circular ring B, 24 inches in diameter and 3 deep; and for greater ſtrength, the whole is caſt in one piece in bell-metal.

"As the whole weight of the wheel A reſts on its ring B, the edge bars are deepeſt where they join it; and from thence their depth diminiſhes, both towards the centre and the circumference, as repreſented in fig. 3.

"The ſurface of the wheel A was worked very even and flat, and its circumference turned true. The ring C, of fine braſs, was fitted very exactly on the circumference of the wheel; and was faſtened thereon with ſcrews, which, after being ſcrewed as tight as poſſible, were well rivetted. The face of a large chuck being turned very true and flat in the lath, the flattened ſurface A (fig. 3.) of the wheel was faſtened againſt it with hold-faſts; and the two ſurfaces and circumference of the ring C, a hole through the centre and the plane part round [b] it, and the lower edge of the ring B, were turned at the ſame time.

"D is a piece of hard bell metal, having the hole, which receives the ſteel-arbor [d], made very ſtraight and true. This bell-metal was turned very true on an arbor; and the face, which reſts on the wheel at [b], was turned very flat, ſo that the ſteel-arbor [d] might ſtand perpendicular to the plane of the wheel: this bell-metal was faſtened to the wheel by ſix ſteel ſcrews [l].

"A braſs ſocket Z is faſtened on the centre of the mahogany ſtand, and receives the lower part of the bell-metal piece D, being made to touch the bell-metal in a narrow part near the mouth, to prevent any obliquity of the wheel from bending the arbor: good-fitting is by no means neceſſary here; ſince any ſhake in this ſocket will produce no bad effect, as will appear hereafter when we deſcribe the cutting frame.

"The wheel was then put on its ſtand, the lower edge of the ring B (fig. 1, 2, and 3.) reſting on the circumference of three conical friction-pulleys W, to facilitate its motion round its centre. The axis of one of theſe pulleys is in a line joining the centre of the wheel and the middle of the endleſs ſcrew, and the other two placed ſo as to be at equal diſtances from each other.

"F (fig. 1.) is a block of wood ſtrongly faſtened to one of the legs of the ſtand; the piece [g] is ſcrewed to the upper ſide of the block, and has half holes, in which the tranſverſe axis [h] (fig. 4.) turns: the half holes are kept together by the ſcrews [i].

"The lower extremity of the conical pillar P (fig. 1. & 4.) terminates in a cylindrical ſteel-pin [k], (fig. 4.) which paſſes through and turns in the tranſverſe axis [h], and is confined by a cheek and ſcrew.

"To the upper end of the conical pillar is faſtened the frame G, (fig. 4.) in which the endleſs ſcrew turns: the pivots of the ſcrew are formed in the manner of two fruſtums of cones joined by a cylinder, as repreſented at X (fig. 5). Theſe pivots are confined between half poles, which preſs only on the conical parts, and do not touch the cylindric parts: the half holes are kept together by ſcrews [a] which may be tightened at any time, to prevent the ſcrew from ſhaking in the frame.

"On the ſcrew-arbor is a ſmall wheel of braſs K, (fig. 1, 2, 4, 5.) having its outſide edge divided into 60 parts, and numbered at every 6th diviſion with 1, 2, &c. to 10. The motion of this wheel is ſhown by the index [y] (fig. 4 & 5.) on the ſcrew frame G.

"H (fig. 1.) repreſents a part of the ſtand, having a parallel ſlit in the direction towards the centre of the wheel, large enough to receive the upper part of the conical braſs pillar P, which carries the ſcrew and its frame: and as the reſiſtance, when the wheel is moved by the endleſs ſcrew, is againſt the ſide of the ſlit H which is towards the left hand, that ſide of the ſlit is faced with braſs, and the pillar is preſſed againſt it by a ſteel ſpring on the oppoſite ſide: by this means the pillar is ſtrongly ſupported laterally, and yet the ſcrew may be eaſily preſſed from or againſt the circumference of the wheel, and the pillar will turn freely on its axis to take any direction given it by the frame L.

"At each corner of the piece I (fig. 4.) are ſcrews [n] of tempered ſteel, having poliſhed conical points: two of them turn in conical holes in the ſcrew-frame near [o], and the points of the other two ſcrews turn in the holes in the piece Q; the ſcrews [p] are of ſteel, which being tightened, prevent the conical pointed ſcrews from unturning when the frame is moved.

"L (fig. 1, 2, 6.) is a braſs frame, which ſerves to connect the endleſs ſcrew, its frame, &c. with the centre of the wheel: each arm of this frame is terminated by a ſteel ſcrew, that may be paſſed through any of the holes [q] in the piece Q, (fig. 4.) as the thickneſs of work to be divided on the wheel may require, and are faſtened by the finger-nuts [r] (fig. 1 & 2.)

"At the other end of this frame is a flat piece of tempered ſteel [b], (fig. 6.) wherein is an angular notch: when the endleſs ſcrew is preſſed againſt the teeth on the circumference of the wheel, which may be done by turning the finger-ſcrew S, (fig. 1 & 2.) to preſs againſt the ſpring [t], this notch embraces and preſſes againſt the ſteel arbor [d]. This end of the frame may be raiſed or depreſſed by moving the priſmatic ſlide [u], (fig. 2.) which may be fixed at any height by the four ſteel-ſcrews [v] (fig. 1, 2, 6.)

"The bottom of this ſlide has a notch [k], (fig. 1 and 6.) whoſe plane is parallel to the endleſs ſcrew; and by the point of the arbor [d] (fig. 3.) reſting in this notch, this end of the frame is prevented from tilting. The ſcrew S (fig. 1, 2.) is prevented from unturning, by tightening the finger-nut [w].

"The teeth on the circumference of the wheel were cut by the following method:

"Having conſidered what number of teeth on the circumference would be moſt convenient, which in this engine is 2160, or 360 multiplied by 6, I made two ſcrews of the ſame dimenſions, of tempered ſteel, in the manner hereafter deſcribed, the interval between the threads being ſuch as I knew by calculation would come within the limits of what might be turned off the circumference of the wheel: one of theſe ſcrews, which was intended for ratching or cutting the teeth, was notched acroſs the threads, ſo that the ſcrew, when preſſed againſt the edge of the wheel and turned round, cut in the manner of a ſaw. Then having a ſegment of a circle a little greater than 60 degrees, of about the ſame radius with the wheel, and the circumference made true, from a very fine centre, I deſcribed an arch near the edge, and ſet off the chord of 60 degrees on this arch. This ſegment was put in the place of the wheel, the edge of it was ratched, and the number of revolutions and parts of the ſcrew contained between the interval of the 60 degrees were counted. The radius was corrected in the proportion of 360 revolutions, which ought to have been in 60 degrees, to the number actually found; and the radius, ſo corrected, was taken in a pair of beam-compaſſes: while the wheel was on the lath, one foot of the compaſſes was put in the centre, and with the other a circle was deſcribed on the ring; then half the depth of the threads of the ſcrew being taken in dividers, was ſet from this circle outwards, and another circle was deſcribed cutting this point; a hollow was then turned on the edge of the wheel of the ſame curvature as that of the ſcrew at the bottom of the threads: the bottom of this hollow was turned to the ſame radius or diſtance from the centre of the wheel, as the outward of the two circles before mentioned.

"The wheel was now taken off the lath; and the bell-metal piece D (fig. 3.) was ſcrewed on as before directed, which after this ought not to be removed.

"From a very exact centre a circle was deſcribed on the ring C, (fig. 1, 2, 3.) about $\frac{4}{10}$ of an inch within where the bottom of the teeth would come. This circle was divided with the greateſt exactneſs I was capable of, firſt into five parts, and each of theſe into three. Theſe parts were then biſected four times: (that is to ſay) ſuppoſing the whole circumference of the wheel to contain 2160 teeth, this being divided into five parts, each would contain 432 teeth; which being divided into three parts, each of them would contain 144; and this ſpace biſected four times would give 72, 36, 18, and 9: therefore each of the laſt diviſions would contain nine teeth. But, as I was apprehenſive ſome error might ariſe from quinqueſection and triſection, in order to examine the accuracy of the diviſions, I deſcribed another circle on the ring C, (fig. 7.) $\frac{1}{10}$ inch within the former, and divided it by continual biſections, as 2160, 1080, 540, 270, 135, $67\frac{1}{2}$, and $33\frac{3}{4}$; and as the fixed wire (to be deſcribed preſently) croſſed both the circles, I could examine their agreement at every 135 revolutions; (after ratching, could examine it at every $33\frac{3}{4}$): but, not finding any ſenſible difference between the two ſets of diviſions, I, for ratching, made choice of the former; and, as the coincidence of the fixed wire with an interſection could be more exactly determined than with a dot or diviſion, I therefore made uſe of interſections in both circles before deſcribed.

"The arms of the frame L (fig. 7.) were connected by a thin piece of braſs of $\frac{3}{4}$ of an inch broad, having a hole in the middle of $\frac{4}{10}$ of an inch in diameter; acroſs this hole a ſilver wire was fixed exactly in a line to the centre of the wheel: the coincidence of this wire with the interſections was examined by a lens $\frac{7}{10}$ inch focus, fixed in a tube which was attached to one of the arms L*. Now a handle or winch being fixed on the end of the ſcrew, the diviſion marked 10 on the circle K was ſet to its index, and, by means of a clamp and adjuſting ſcrew for that purpoſe, the interſection marked 1 on the circle C was ſet exactly to coincide with the fixed wire; the ſcrew was then carefully preſſed againſt the circumference of the wheel, by turning the finger-ſcrew S; then, removing the clamp, I turned the ſcrew by its handle 9 revolutions, till the interſection marked 240 came nearly to the wire; then, unturning the finger-ſcrew S, I releaſed the ſcrew from the wheel, and turned the wheel back till the interſection marked 2 exactly coincided with the wire; and, by means of the clamp before-mentioned, the diviſion 10 on the circle being ſet to its index, the ſcrew was preſſed againſt the edge of the wheel by the finger-ſcrew S; the clamps were removed, and the ſcrew turned nine revolutions till the interſection marked 1 nearly coincided with the fixed wire; the ſcrew was releaſed from the wheel by unturning the finger-ſcrew S as before; the wheel was turned back till the interſection 3 coincided with the fixed wire; the diviſion 10 on the circle being ſet to its index, the ſcrew was preſſed againſt the wheel as before, and the ſcrew was turned 9 revolutions, till the interſection 2 nearly coincided with the fixed wire, and the ſcrew was releaſed: and I proceeded in this manner till the teeth were marked round the whole circumference of the wheel. This was repeated three times round, to make the impreſſion of the ſcrew deeper. I then ratched the wheel round continually in the ſame direction without ever diſengaging the ſcrew; and, in ratching the wheel about 300 times round, the teeth were finiſhed.

"Now it is evident, if the circumference of the wheel was even one tooth or ten minutes greater than the ſcrew would require, this error would in the firſt inſtance be reduced to $\frac{1}{240}$ part of a revolution, or two ſeconds and a half; and theſe errors or inequalities of the teeth were equally diſtributed round the wheel at the diſtance of nine teeth from each other. Now, as the ſcrew in ratching had continually hold of ſeveral teeth at the ſame time, and theſe conſtantly changing, the above-mentioned inequalities ſoon corrected themſelves, and the teeth were reduced to a perfect equality. The piece of braſs which carries the wire was now taken away, and the cutting ſcrew was alſo removed, and a plain one (hereafter deſcribed) put in its place: on one end of the ſcrew is a ſmall braſs circle, having its edge divided into 60 equal parts, and numbered at every ſixth diviſion, as before mentioned. On the other end of the ſcrew is a ratchet-wheel C, having 60 teeth, covered by the hollowed circle [d], (fig. 5.) which carries two clicks that catch upon the oppoſite ſides of the ratchet when the ſcrew is to be moved forwards. The cylinder S turns on a ſtrong ſteel arbor F, which paſſes through and is firmly ſcrewed to the piece Y: this piece, for greater firmneſs, is attached to the ſcrew-frame G (fig. 4.) by the braces [v]: a ſpiral groove or thread is cut on the outſide of the cylinder S, which ſerves both for holding the ſtring, and alſo giving motion to the lever J on its centre by means of a ſteel tooth [n], that works between the threads of the ſpiral. To the lever is attached a ſtrong ſteel pin [m], on which a braſs ſocket [r] turns: this ſocket paſſes through a ſlit in the piece [p], and may be tightened in any part of the ſlit by the finger-nut [t]: this piece ſerves to regulate the number of revolutions of the ſcrew for each tread of the treadle R.

"T (fig. 1.) is a braſs box containing a ſpiral ſpring; a ſtrong gut is faſtened and turned three or four times round the circumference of this box; the gut then paſſes ſeveral times round the cylinder S, and from thence down to the treadle R (fig. 1.). Now, when the treadle is preſſed down, the ſtring pulls the cylinder S round its axis, and the clicks catching hold of the teeth on the ratchet carry the ſcrew round with it, till, by the tooth [n] working in the ſpiral groove, the lever J (fig. 4.) is brought near the wheel [d], and the cylinder ſtopped by the ſcrew-head [x] ſtriking on the top of the lever J; at the ſame time the ſpring is wound up by the other end of the gut paſſing round the box T (fig. 1.). Now, when the foot is taken off the treadle, the ſpring unbending itſelf pulls back the cylinder, the clicks leaving the ratchet and ſcrew at reſt till the piece [t] ſtrikes on the end of the piece [p] (fig. 1:): the number of revolutions of the ſcrew at each tread is limited by the number of revolutions the cylinder is allowed to turn back before the ſtop ſtrikes on the piece [p].

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* The interſections are marked for the ſake of illuſtration, though properly inviſible, they lying under the braſs plate.

"When the endleſs ſcrew was moved round its axis with a conſiderable velocity, it would continue that motion a little after the cylinder S (fig. 1. and 4.) was ſtopped: to prevent this, the angular lever η was made; that when the lever J comes near to ſtop the ſcrew [x], it, by a ſmall chamfer, preſſes down the piece κ of the angular lever; this brings the other end η of the ſame lever forwards, and ſtops the endleſs ſcrew by the ſteel pin μ ſtriking upon the top of it: the foot of the lever is raiſed again by a ſmall ſpring preſſing on the brace [v].

"D, two clamps, connected by the piece α, ſlide one on each arm of the frame L, (fig. 1, 2, 6) and may be fixed at pleaſure by the four finger-ſcrews ε, which preſs againſt ſteel ſprings to avoid ſpoiling the arms: the piece [q] is made to turn without ſhake between two conical pointed ſcrews [f], which are prevented from unturning by tightening the finger-nuts N.

"The piece M (fig. 6.) is made to turn on the piece [q], by the conical pointed ſcrews [ſ] reſting in the hollow centres [e].

"As there is frequent occaſion to cut diviſions on inclined planes, for that purpoſe the piece γ, in which the tracer is fixed, has a conical axis at each end, which turn in half holes: when the tracer is ſet to any inclination, it may be fixed there by tightening the ſteel ſcrews β.

Deſcription of the Engine by which the endleſs Screw of the Dividing Engine was cut.

"Fig. 9. repreſents this engine of its full dimenſions ſeen from one ſide.

"Fig. 8. the upper ſide of the ſame as ſeen from above.

"A repreſents a triangular bar of ſteel, to which the triangular holes in the pieces B and C are accurately fitted, and may be fixed on any part of the bar by the ſcrews D.

"E is a piece of ſteel whereon the ſcrew is intended to be cut; which, after being hardened and tempered, has its pivots turned in the form of two fruſtums of cones, as repreſented in the drawings of the dividing engine (fig. 5.) Theſe pivots were exactly fitted to the half holes F and F, which were kept together by the ſcrews Z.

"H repreſents a ſcrew of untempered ſteel, having a pivot I, which turns in the hole K. At the other end of the ſcrew is a hollow centre, which receives the hardened conical point of the ſteel pin M. When this point is ſufficiently preſſed againſt the ſcrew, to prevent its ſhaking, the ſteel pin may be fixed by tightening the ſcrews Y.

"N is a cylindric nut, moveable on the ſcrew H; which, to prevent any ſhake, may be tightened by the ſcrews O. This nut is connected with the ſaddle-piece P by means of the intermediate univerſal joint W, through which the arbor of the ſcrew H paſſes. A front view of this piece, with a ſection acroſs the ſcrew arbor, is repreſented at X. This joint is connected with the nut by means of two ſteel ſlips S, which turn on pins between the cheeks T on the nut N. The other ends of theſe ſlips S turn in like manner on pins (a). One axis of this joint turns in a hole in the cock (b), which is fixed to the ſaddle-piece; and the other turns in a hole (d), made for that purpoſe in the ſame piece on which the cock (b) is fixed. By this means, when the ſcrew is turned round, the ſaddle-piece will ſlide uniformly along the triangular bar A.

"K is a ſmall triangular bar of well-tempered ſteel, which ſlides in a groove of the ſame form on the ſaddle-piece P. The point of this bar or cutter is formed to the ſhape of the thread intended to be cut on the endleſs ſcrew. When the cutter is ſet to take proper hold of the intended ſcrew, it may be fixed by tightening the ſcrews (e), which preſs the two pieces of braſs G upon it.

"Having meaſured the circumference of the dividing-wheel, I found it would require a ſcrew about one thread in a hundred coarſer than the guide-ſcrew H. The wheels on the guide-ſcrew arbor H, and that on the ſteel E, on which the ſcrew was to be cut, were proportioned to each other to produce that effect, by giving the wheel L 198 teeth, and the wheel Q 200. Theſe wheels communicated with each other by means of the intermediate wheel R, which aſo ſerved to give the threads on the two ſcrews the ſame direction.

"The ſaddle-piece P is confined on the bar A by means of the pieces (g), and may be made to ſlide with a proper degree of tightneſs by the ſcrews (n)."

RAMSEY, a town in Huntingdonſhire, with a market on Saturday. It is ſeated in the fens, near the meres of Ramſey and Whitleſey; and had formerly a rich and celebrated abbey. It is 12 miles N. E. of Huntingdon, and 69 N. of London. W. lon. 0. 19. N. lat. 52. 26.

Ramsey, an iſland on the coaſt of Pembrokeſhire, two miles long and one and a half broad. Near it is a group of dangerous rocks, frequented in the breeding ſeaſon by vaſt multitudes of ſea-fowl, and known by the name of the Biſhop and his Clerks. This iſland is four miles W. of St. David's, and 17 N. W. of Milford Haven. W. lon 5. 20. N. lat. 51. 55.

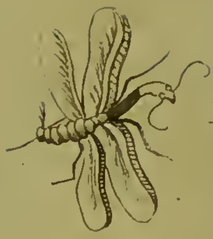
Ramsey, in the Iſle of Man, to the north, a moſt noted and ſpacious haven, in which the greateſt fleet may ride at anchor with ſafety enough from all winds but the north-eaſt, and in that caſe they need not be embayed. This town ſtanding upon a beach of looſe ſand, or ſhingle, is in danger, if not timely prevented, of being waſhed away by the ſea.

RAMSGATE, a ſea-port town of Kent, in the iſle of Thanet, five miles from Margate, where a very fine pier has been lately built for the ſecurity of ſhips that come into the harbour, being ſeated near the Downs, between the north and ſouth Foreland, 10 miles north eaſt of Canterbury. The town is ſituated in the cove of a chalky cliff. It was formerly but an obſcure fiſhing-village, but ſince the year 1688 has been improved and enlarged by a ſucceſsful trade to Ruſſia and the eaſt country. But what renders it moſt worthy of notice, and attracts multitudes of ſtrangers, is the new harbour, which is one of the moſt capacious in England, if not in Europe. It was begun in the year 1750, but delayed by various interruptions. It conſiſts of two piers; that to the eaſt is built wholly of Purbeck ſtone, and extends itſelf into the ocean near 800 feet before it forms an angle; its breadth on the top is 26 feet, including a ſtrong parapet wall, which runs along the outſide of it. The other to the weſt is conſtructed of wood as far as the low-water mark, but the reſt is of ſtone. The angles, of which there are five in each pier, conſiſt of 160 feet each, with octagons at the end of 60 feet diameter, leaving an entrance of 200 feet into the harbour, the depth of which admits of a gradual increaſe of 18 to 36 feet. E. lon. 1. 30. N. lat. 51. 22.

RAMTRUT, a deity worſhipped by the Ranazins of Hindoſtan, where he has a celebrated temple at Onor. He is repreſented as more reſembling a monkey than a man.

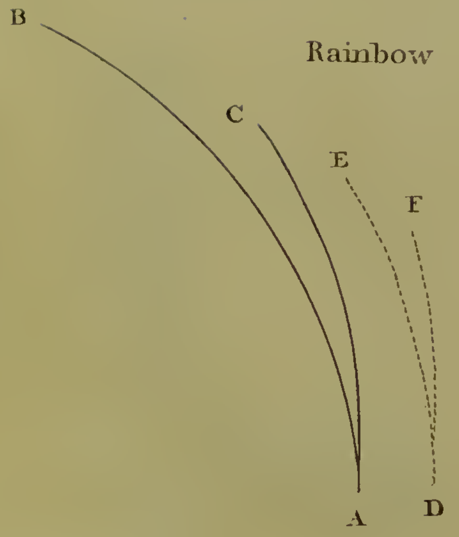
RAMUS, in general, denotes a branch of any thing, as of a tree, an artery, &c. In the anatomy of plants it means the

Rhamphaſtos Tucan



Raphidia

Rainbow



Reduction

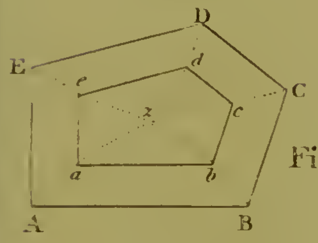


Fig.1.

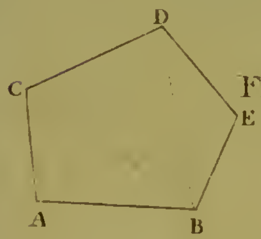


Fig.2.

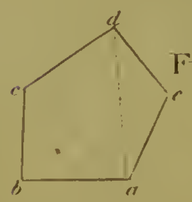


Fig.3.

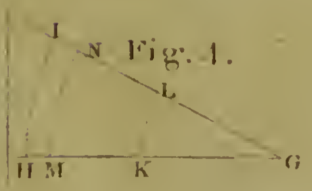
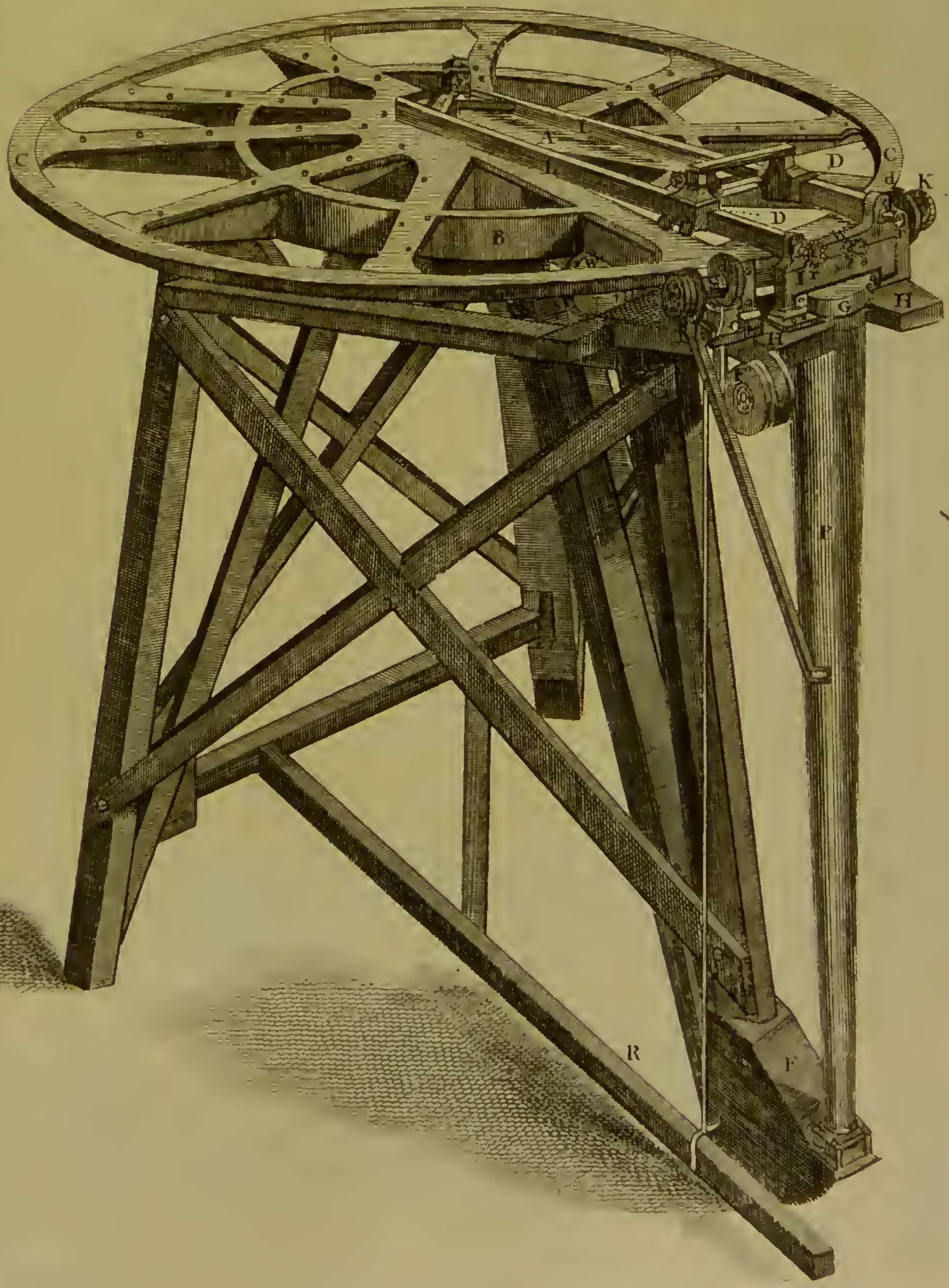


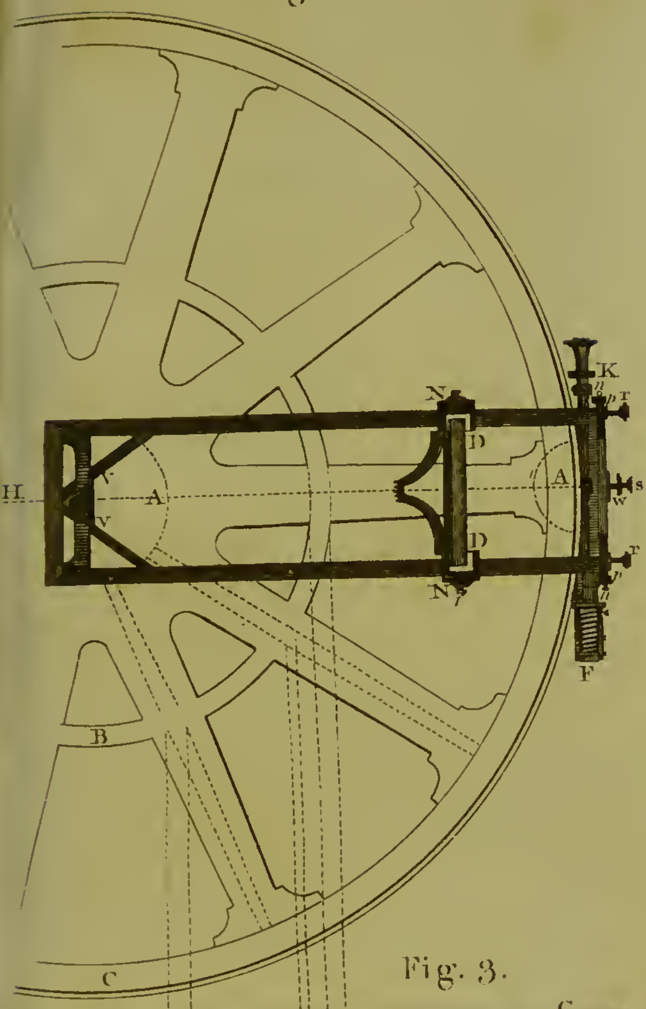
Fig.4.



Ramsdens Machine for dividing Mathematical Inſtruments.

RAMSDEN's *Engine*.

Fig. 2.



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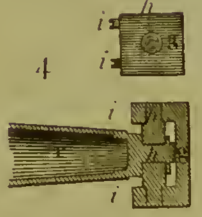


Fig. 4.

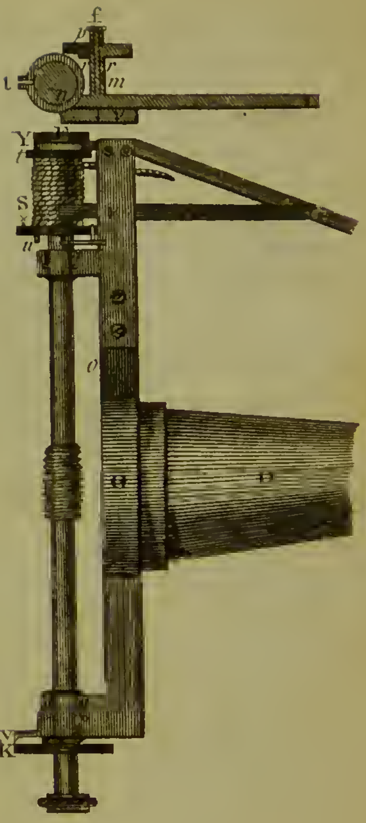


Fig. 3.

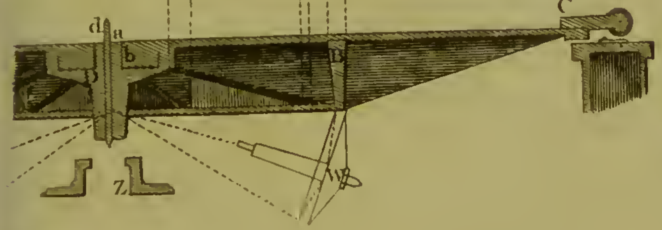


Fig. 5.

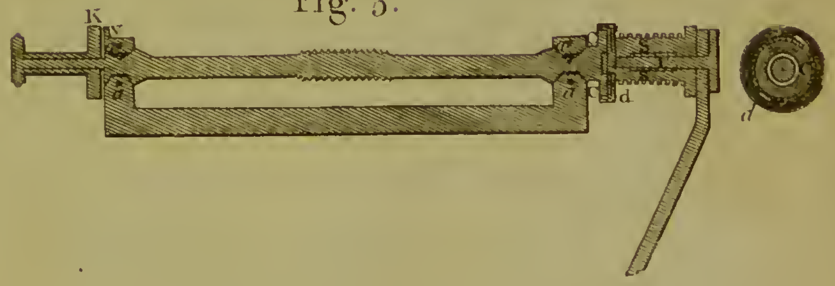


Fig. 7.

Fig. 9.

Fig. 8.

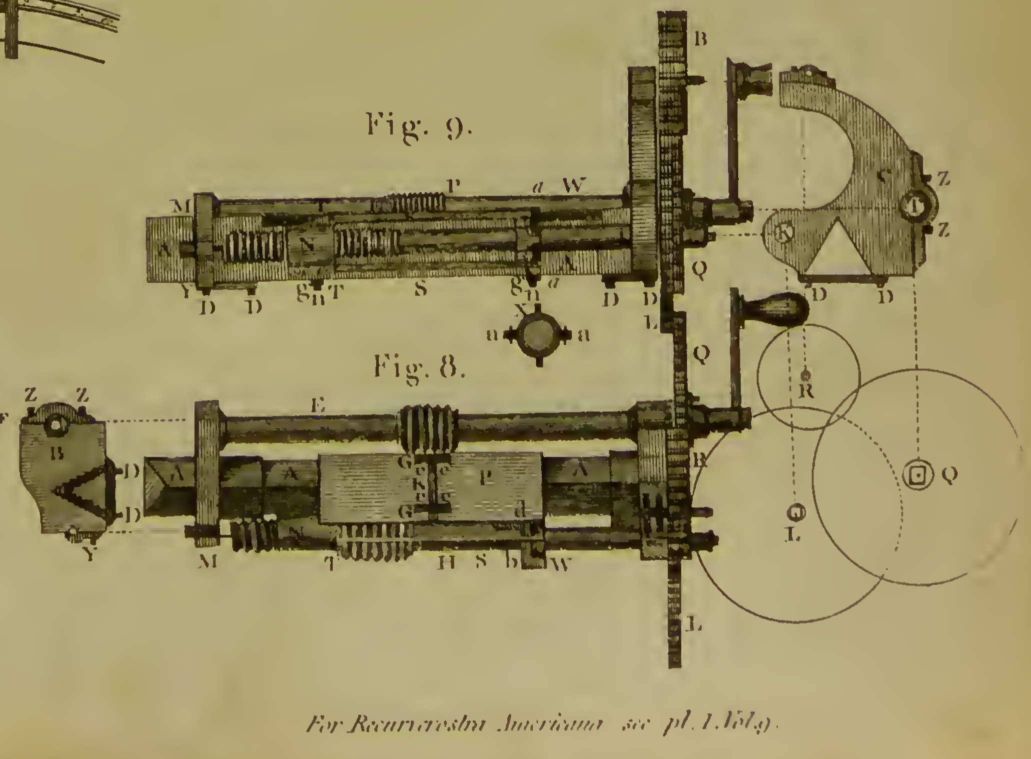
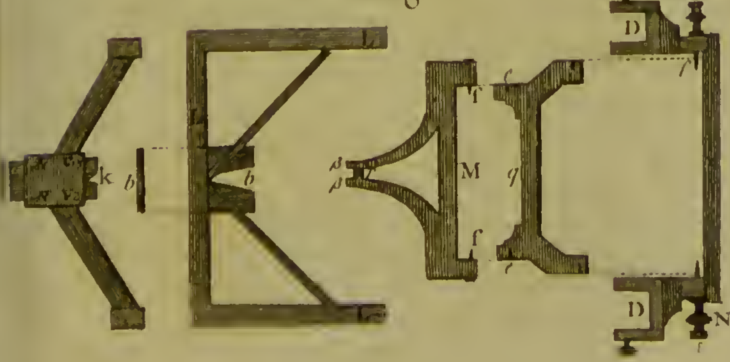


Fig. 6.



For Recurvirostra Americana see pl. I. Vol. 9.

Barlow sculp.

firſt or lateral branches, which go off from the petiolum, or middle rib of a leaf. The ſubdiviſions of theſe are called *ſurculi*; and the final diviſions into the moſt minute of all, are by ſome called *capillamenta*; but both kinds are generally denominated *ſurculus*.

Ramus (Peter), was one of the moſt famous profeſſors of the 16th century. He was born in Picardy in 1515. A thirſt for learning prompted him go to Paris when very young, and he was admitted a ſervant in the college of Navarre. Spending the day in waiting on his maſters, and the greateſt part of the night in ſtudy, he made ſuch ſurpriſing progreſs, that, when he took his maſter of arts degree, he offered to maintain a quite oppoſite doctrine to that of Ariſtotle. This raiſed him many enemies; and the two firſt books he publiſhed, *Inſtitutiones Dialecticæ*, and *Ariſtotelicæ Animadverſiones*, occaſioned great diſturbances in the univerſity of Paris: and the oppoſition againſt him was not a little heightened by his deſerting the Romiſh religion, and profeſſing that of the Reformed. Being thus forced to retire from Paris, he viſited the univerſities of Germany, and received great honours wherever he came. He returned to France in 1571, and loſt his life miſerably in the horrid maſſacre of St. Bartholomew's day. He was a great orator, a man of univerſal learning, and endowed with very fine moral qualities. He publiſhed many books, which Teſſier enumerates. Ramus's merit in his oppoſition to Ariſtotle; and his firmneſs in undermining his authority, is unqueſtionably great. But it has been doubted, and with much reaſon, whether he was equally ſucceſsful in his attempts after a new logical inſtitute. We have the following general outline of his plan in Dr. Enfield's Hiſtory of Philoſophy. "Conſidering dialectics as the art of deducing concluſions from premiſes, he endeavours to improve this art by uniting it with that of rhetoric. Of the ſeveral branches of rhetoric, he conſiders invention and diſpoſition as belonging equally to logic. Making Cicero his chief guide, he divides his treatiſe on dialectics into two parts, the firſt of which treats of the invention of arguments, the ſecond of judgments. Arguments he derives not only from what the Ariſtotelians call middle terms, but from any kind of propoſition, which, connected with another, may ſerve to prove any aſſertion. Of theſe he enumerates various kinds. Judgments he divides into axioms, or ſelf-evident propoſitions, and *dianoëa*, or deductions by means of a ſeries of arguments. Both theſe he divides into various claſſes; and illuſtrates the whole by examples from the ancient orators and poets.

"In the logic of Ramus, many things are borrowed from Ariſtotle, and only appear under new names; and many others are derived from other Grecian ſources, particularly from the dialogues of Plato, and the logic of the Stoics. The author has the merit of turning the art of reaſoning from the futile ſpeculations of the ſchools to forenſic and common uſe; but his plan is defective in confining the whole dialectic art to the ſingle object of diſputation, and in omitting many things which reſpect the general culture of the underſtanding and the inveſtigation of truth. Notwithſtanding the defects of his ſyſtem, we cannot, however, ſubſcribe to the ſevere cenſure which has been paſſed upon Ramus by lord Bacon and others; for much is, we think, due to him for having with ſo much firmneſs and perſeverance aſſerted the natural freedom of the human underſtanding. The logic of Ramus obtained great authority in the ſchools of Germany, Great Britain, Holland, and France; and long and violent conteſts aroſe between his followers and thoſe of the Stagyrite, till his fame vaniſhed before that of Deſcartes."

RAN, in the old Engliſh writers, means open or public robbery, ſo manifeſt as not to be denied. Ran *dicitur aperta rapina quæ negari non poteſt*. Lamb. 125. Leg. Canut. cap. 58. Hence it is now commonly ſaid of one who takes the goods of another injuriouſly and violently, that he has taken or ſnatched all he could *rap* and *ran*.

RANA, or Ranula. See Ranula.

RANA, the frog, in zoology; a genus belonging to the order of amphibia reptilia. The body is naked, furniſhed with four feet, and without any tail. There are 17 ſpecies. The moſt remarkable are,

1. The *temporaria*, or common frog. This is an animal ſo well known, that it needs no deſcription; but ſome of its properties are very ſingular. Its ſpring, or power of taking large leaps, is remarkably great, and it is the beſt ſwimmer of all four-footed animals. Nature hath finely adapted its parts for thoſe ends, the fore members of the body being very lightly made, the hind legs and thighs very long, and furniſhed with very ſtrong muſcles. While in a tadpole ſtate, it is entirely a water animal; the work of generation is performed in that element, as may be ſeen in every pond during ſpring, when the female remains oppreſſed by the male for a number of days.

The work of propagation is extremely ſingular, it being certain that the frog has not a *penis intrans*. There appears a ſtrong analogy in this caſe between a certain claſs of the vegetable kingdom and thoſe animals; for it is well known, that when the female frog depoſits its ſpawn, the male inſtantaneouſly impregnates it with what we may call a *farina fœcundans*, in the ſame manner as the palm tree conveys fructification to the flowers of the female, which would otherwiſe be barren.

As ſoon as the frogs are releaſed from their tadpole ſtate, they take to land; and if the weather has been hot, and there fall any refreſhing ſhowers, you may ſee the ground for a conſiderable ſpace perfectly blackened by myriads of theſe animalcules, ſeeking for ſome ſecure lurking-places. Some philoſophers, not giving themſelves time to examine into this phenomenon, imagined them to have been generated in the clouds, and ſhowered on the earth; but had they, like our Derham, only traced them to the next pool, they would have found a better ſolution of the difficulty. See *Preternatural* Rains.

As frogs adhere cloſe to the backs of their own ſpecies, ſo we know they will do the ſame by fiſh.—Walton mentions a ſtrange ſtory of their deſtroying pike; but that they will injure if not entirely kill carp, is a fact indiſputable, from the following relation. Not many years ago, on fiſhing a pond belonging to Mr. Pitt, of Encomb, Dorſetſhire, great numbers of the carp were found each with a frog mounted on it, the hind legs clinging to the back, and the fore legs fixed in the corner of each eye of the fiſh, which were thin and greatly waſted, teaſed by carrying ſo diſagreeable a load. Theſe frogs Mr. Pennant ſuppoſes to have been males diſappointed of a mate.

The croaking of frogs is well known; and, from that, in fenny countries they are diſtinguiſhed by ludicrous titles: thus they are ſtyled *Dutch nightingales*, and *Boſton waites*. Yet there is a time of the year when they become mute, neither croaking nor opening their mouths for a whole month: this happens in the hot ſeaſon, and that is in many places known to the country people by the name of the *paddock moon*. It is ſaid, that during that period their mouths are ſo cloſed, that no force (without killing the animal) will be capable of opening them. Theſe, as well as other reptiles, feed but a ſmall ſpace of the year. The food of this genus is flies, inſects and ſnails. Toads are ſaid to feed alſo on bees, and to do great injury to thoſe uſeful inſects.

During winter, frogs and toads remain in a torpid ſtate: the laſt will dig into the earth, and cover themſelves, with almoſt the ſame agility as the mole. See Physiology.

2. The *eſculenta*, or edible frog, differs from the former, in

having a high protuberance in the middle of the back, forming a very ſharp angle. Its colours are alſo more vivid, and its marks more diſtinct; the ground colour being a pale or yellowiſh green, marked with rows of black ſpots from the head to the rump.—This, and (Mr. Pennant thinks) the former, are eaten. He has ſeen in the markets at Paris whole hampers full, which the venders were preparing for the table, by ſkinning and cutting off the fore-parts, the loins and legs only being kept; but his ſtrong diſlike to theſe reptiles prevented a cloſe examination into the ſpecies.

3. In the country of Pennſylvania, and ſome other parts of North America, there is a very large ſpecies of frogs called the *bull-frog*, or *rana ocellata*. Their irides are of a duſky red, ſurrounded with a yellow ring. The auricles are covered with a thin circular ſkin, which forms a ſpot behind each eye. They have four toes on the fore feet, and five palmated toes behind. Their colour is a duſky brown, mixed with yellowiſh green, and ſpotted with black. The belly is yellowiſh, and faintly ſpotted. Theſe make a monſtrous roaring noiſe like a bull, only ſomewhat more hoarſe. Their ſize is ſuperior to that of any other of the genus, and they can ſpring forward three yards at a leap. By this means they will equal in ſpeed a very good horſe in its ſwifteſt courſe. Their places of abode are ponds, or bogs with ſtagnant water; but they never frequent ſtreams. When many of them are together, they make ſuch a horrid noiſe, that two people cannot underſtand each other's ſpeech. They croak all together, and then ſtop for a little and begin again. It ſeems as if they had a captain among them: for, when he begins to croak, all the others follow; and when he ſtops, they alſo become ſilent. When this captain gives the ſignal for ſtopping, you hear a note like *ſoop* coming from him. In the day-time they ſeldom make any great noiſe, unleſs the ſky is covered; but in the night-time they may be heard at the diſtance of a mile and a half. When they croak they are commonly near the ſurface of the water under the buſhes, and have their heads out of the water. By going ſlowly, therefore, one may get up almoſt quite cloſe to them before they go away. As ſoon as they are quite under water, they think themſelves ſafe, though it be ever ſo ſhallow. Theſe creatures kill and eat young ducklings and goſlings, and ſometimes carry off chickens that come too near the water; when beaten, they cry out almoſt like little children. As ſoon as the air begins to grow a little cool in autumn, they hide themſelves under the mud in the bottom of ſtagnant waters, and lie there torpid during the winter. As ſoon as the weather grows mild towards ſummer, they begin to get out of their holes and croak. They are ſuppoſed by the people of Virginia to be the purifiers of waters, and are reſpected as the genii of the fountains. Some of them were brought to England alive ſeveral years ago.

4. The *bufo*, or toad, is the moſt deformed and hideous of all animals. The body is broad; the back flat, and covered with a pimply duſky hide; the belly large, ſwagging, and ſwelling out; the legs ſhort, and its pace laboured and crawling; its retreat gloomy and filthy: in ſhort, its general appearance is ſuch as to ſtrike one with diſguſt and horror. Yet it is ſaid by thoſe who have reſolution to view it with attention, that its eyes are fine; to this it ſeems that Shakſpeare alludes, when he makes his Juliet remark, "*Some ſay the lark and loathed toad change eyes;*" as if they would have been better beſtowed on ſo charming a ſongſter than on this raucous reptile.

But the hideous appearance of the toad is ſuch as to make this one advantageous feature overlooked, and to have rendered it in all ages an object of horror, and the origin of moſt tremendous inventions. Ælian makes its venom ſo potent, that, baſiliſk-like, it conveyed death by its very look and breath; but Juvenal is content with making the Roman ladies who were weary of their huſbands form a potion from its entrails, in order to get rid of the good man. This opinion begat others of a more dreadful nature; for in after-times ſuperſtition gave it preternatural powers, and made it a principal ingredient in the incantations of nocturnal hags.

This animal was believed by ſome old writers to have a ſtone in its head fraught with great virtues medical and magical: it was diſtinguiſhed by the name of the reptile, and called the *toad-ſtone*, *bufonites*, *crapaudine*, *krottenſtein*; but all its fancied powers vaniſhed on the diſcovery of its being nothing but the foſſil-tooth of the ſea wolf, (ſee Anarrhicas) or of ſome other flat-toothed fiſh, not unfrequent in our iſland as well as ſeveral other countries.

But theſe fables have been long exploded. And as to the notion of its being a poiſonous animal, it is probable that its exceſſive deformity, joined to the faculty it has of emitting a juice from its pimples, and a duſky liquid from its hind parts, is the foundation of the report.

That it has any noxious qualities there ſeem to have been no proofs in the ſmalleſt degree ſatisfactory, though we have heard many ſtrange relations on that point.—On the contrary, there have been many who have taken them in their naked hands, and held them long without receiving the leaſt injury: it is alſo well known that quacks have eaten them, and have beſides ſqueezed their juices into a glaſs, and drank them with impunity. We may ſay alſo, that theſe reptiles are a common food to many animals; to buzzards, owls, Norfolk plovers, ducks, and ſnakes, who would not touch them were they in any degree noxious.

So far from having venomous qualities, they have of late been conſidered as if they had beneficent ones; particularly in the cure of the moſt terrible of diſeaſes, the *cancer*, by ſuction: (See *Britiſh Zoology*, vol. iii. Append. p. 389, *et ſeq.*) But, from all circumſtances, as Mr. Pennant obſerves, they ſeem only to have rendered a horrible complaint more loathſome.

The moſt full information concerning the nature and qualities of this animal is contained in the following letters from Mr. Arſcott and Mr. Pittfield to Dr. Milles: "It would give me great pleaſure (ſays Mr. Arſcott) to be able to inform you of any particulars worthy Mr. Pennant's notice, concerning the toad who lived ſo many years with us, and was ſo great a favourite. The greateſt curioſity in it was its becoming ſo remarkably tame. It had frequented ſome ſteps before the hall-door ſome years before my acquaintance commenced with it, and had been admired by my father for its ſize (which was of the largeſt I ever met with), who conſtantly paid it a viſit every evening. I knew it myſelf above 30 years; and by conſtantly feeding it brought it to be ſo tame, that it always came to the candle, and looked up as if expecting to be taken up and brought upon the table, where I always fed it with inſects of all ſorts; it was fondeſt of fleſh maggots, which I kept in bran; it would follow them, and, when within a proper diſtance, would fix its eye, and remain motionleſs for near a quarter of a minute, as if preparing for the ſtroke, which was an inſtantaneous throwing its tongue at a great diſtance upon the inſect, which ſtuck to the tip by a glutinous matter: the motion is quicker than the eye can follow *.

"I always imagined that the root of its tongue was placed in the forepart of its under jaw, and the tip towards its throat, by which the motion muſt be a half circle; by which, when its tongue recovered its ſituation, the inſect at the tip would be brought to the place of deglutition. I was confirmed in this by never obſerving any internal motion in its mouth, excepting one ſwallow the inſtant its tongue returned. Poſſibly I might be miſtaken; for I never diſſected one, but contented myſelf with opening its mouth, and ſlightly inſpecting it.

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* This rapid capture of its prey might give occaſion to the report of its faſcinating powers. Linnæus ſays, *Inſecta in fauces faſcino revocat.*

"You may imagine that a toad, generally deteſted (although one of the moſt inoffenſive of all animals), ſo much taken notice of and befriended, excited the curioſity of all comers to the houſe, who all deſired to ſee it fed; ſo that even ladies ſo far conquered the horrors inſtilled into them by nurſes as to deſire to ſee it. This produced innumerable and improbable reports, making it as large as the crown of a hat, &c. &c.

The following are anſwers from the ſame gentleman to ſome queries propoſed by Mr. Pennant.

"*Firſt*, I cannot ſay how long my father had been acquainted with the toad before I knew it; but when I firſt was acquainted with it, he uſed to mention it as the old toad I have known ſo many years; I can anſwer for 36 years.

"*Secondly*, No toads that I ever ſaw appeared in the winter ſeaſon. The old toad made its appearance as ſoon as the warm weather came, and I always concluded it retired to ſome dry bank to repoſe till the ſpring. When we new-layed the ſteps, I had two holes made in every third ſtep, with a hollow of more than a yard long for it, in which I imagine it ſlept, as it came from thence at its firſt appearance.

"*Thirdly*, It was ſeldom provoked: neither that toad, nor the multitudes I have ſeen tormented with great cruelty, ever ſhowed the leaſt deſire of revenge, by ſpitting or emitting any juice from their pimples.—Sometimes, upon taking it up, it would let out great quantity of clear water, which, as I have often ſeen it do the ſame upon the ſteps when quite quiet, was certainly its urine, and no more than a natural evacuation.

"*Fourthly*, A toad has no particular enmity for the ſpider; he uſed to eat five or ſix with his millepedes (which I take to be its chief food) that I generally provided for it before I found out that fleſh maggots, by their continual motion, was the moſt tempting bait; but when offered, it ate blowing flies and humble bees that come from the rat tailed maggot in gutters, or in ſhort any inſect that moved. I imagine, if a bee was to be put before a toad, it would certainly eat it to its coſt; but as bees are ſeldom ſtirring at the ſame time that toads are, they can ſeldom come in their way, as they ſeldom appear after ſun riſing or before ſun-ſet. In the heat of the day they will come to the mouth of their hole, I believe, for air. I once from my parlour-window obſerved a large toad I had in the bank of a bowling green, about 12 o'clock at noon, a very hot day, very buſy and active upon the graſs; ſo uncommon an appearance made me go out to ſee what it was, when I found an innumerable ſwarm of winged ants had dropped round his hole, which temptation was as irreſiſtible as a turtle would be to a luxurious alderman.

"*Fifthly*, Whether our toad ever propagated its ſpecies, I know not; rather think not, as it always appeared well, and not leſſened in bulk, which it muſt have done, I ſhould think, if it had diſcharged ſo large a quantity of ſpawn as toads generally do. The females that are to propagate in the ſpring, I imagine, inſtead of retiring to dry holes, go into the bottom of ponds, and lie torpid among the weeds: for, to my great ſurpriſe, in the middle of the winter, having for amuſement put a long pole into my pond, and twiſted it till it had gathered a large volume of weed, on taking it off I found many toads; and having cut ſome aſunder with my knife, by accident, to get off the weed, found them full of ſpawn not thoroughly formed. I am not poſitive, but think there were a few males in March; I know there are 30 males * to one female, 12 or 14 of whom I have ſeen clinging round a female: I have often diſengaged her, and put her to a ſolitary male, to ſee with what eagerneſs he would ſeize her. They impregnate the ſpawn as it is drawn † out in long ſtrings, like a necklace, many yards long, not in a large quantity of jelly, like frogs' ſpawn.

"*Sixthly*, Inſects being their food, I never ſaw any toad ſhow any liking or diſlike to any plant ‡.

"*Seventhly*, I hardly remember any perſons taking it up except my father and myſelf; I do not know whether it had any particular attachment to us.

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* Mr. John Hunter has aſſured me, that during his reſidence at Belleiſle, he diſſected ſome hundreds of toads, yet never met with a ſingle female among them.

† I was incredulous as to the *obſtetrical* offices of the male toad; but ſince the end is ſo well accounted for, and the fact eſtabliſhed by ſuch good authority, belief muſt take place.

Mr. Demours, in the Memoirs of the French Academy, as tranſlated by Dr. Templeman, vol. i. p. 371, has been very particular in reſpect to the male toad as acting the part of an *accoucheur*. His account is curious, and claims a place here.

"In the evening of one of the long days in ſummer, Mr. Demours, being in the king's garden, perceived two toads *coupled together* at the edge of a hole, which was formed in part by a great ſtone at the top.

"Curioſity drew him to ſee what was the occaſion of the motions he obſerved, when two facts equally new ſurpriſed him. The *firſt* was the extreme difficulty the female had in laying her eggs, inſomuch that ſhe did not ſeem capable of being delivered of them without ſome aſſiſtance. The *ſecond* was, that the male was mounted on the back of the female, and exerted all his ſtrength with his hinder feet in pulling out the eggs, whilſt his fore feet embraced her breaſt.

"In order to apprehend the manner of his working in the delivery of the female, the reader muſt obſerve, that the paws of theſe animals, as well thoſe of the fore-feet as of the hinder, are divided into ſeveral toes, which can perform the office of fingers.

"It muſt be remarked likewiſe, that the eggs of this ſpecies of toads are included each in a membranous coat that is very firm; in which is contained the embryo; and that theſe eggs, which are oblong and about two lines in length, being faſtened one to another by a ſhort but very ſtrong cord, form a kind of chaplet, the beads of which are diſtant from each other about the half of their length. It is by drawing this cord with his paw that the male performs the function of a midwife, and acquits himſelf in it with a dexterity that one would not expect from ſo lumpiſh an animal.

"The preſence of the obſerver did not a little diſcompoſe the male: for ſome time he ſtopped ſhort, and threw on the *curious impertinent* a fixed look that marked his diſquietneſs and fear; but he ſoon returned to his work with more precipitation than before, and a moment after he appeared undetermined whether he ſhould continue it or not. The female likewiſe diſcovered her uneaſineſs at the ſight of the ſtranger, by motions that interrupted ſometimes the male in his operation. At length, whether the ſilence and ſteady poſture of the ſpectator had diſſipated their fear, or that the *caſe* was urgent, the male reſumed his work with the ſame vigour, and ſucceſsfully performed his function."

‡ This queſtion aroſe from an aſſertion of Linnæus, that the toad delighted in filthy herbs. *Delectatur cotula, actæa, ſtachyde fœtida.* The unhappy deformity of this animal ſeems to be the only ground of this as well as another miſrepreſentation of its conveying a poiſon with its pimples, its touch, and even its breath. *Verrucæ lactiſcentes venenatæ inſuſæ tactu, anhelitu.*

"*Eighthly*, In reſpect to its end, I anſwer this laſt query. Had it not been for a tame raven, I make no doubt but it would have been now living; who one day ſeeing it at the mouth of its hole, pulled it out, and although I reſcued it, pulled out one eye, and hurt it ſo, that, notwithſtanding its living a twelvemonth, it never enjoyed itſelf, and had a difficulty of taking its food, miſſing the mark for want of its eye: before that accident it had all the appearance of perfect health.

5. The *rubeta*, or natter-jack, frequents dry and ſandy places: it is found on Putney common, and alſo near Reveſby abbey, Lincolnſhire. It never leaps, neither does it crawl with the ſlow pace of a toad, but its motion is liker to running. Several are found commonly together, and like others of the genus they appear in the evenings. The upper part of the body is of a dirty yellow, clouded with brown, and covered with porous pimples of unequal ſizes: on the back is a yellow line. The upper ſide of the body is of a paler hue, marked with black ſpots, which are rather rough. On the fore-feet are four divided toes; on the hind five, a little webbed. The length of the body is two inches and a quarter; the breadth one and a quarter: the length of the fore-legs, one inch one-ſixth; of the hind-legs, two inches. We are indebted to Sir Joſeph Banks for this account.

6. The *pipal*, or Surinam toad, is more ugly than even the common one. The body is flat and broad; the head ſmall; the jaws, like thoſe of a mole, are extended, and evidently formed for rooting in the ground: the ſkin of the neck forms a ſort of wrinkled collar: the colour of the head is of a dark cheſnut, and the eyes are ſmall: the back which is very broad, is of a lightiſh gray, and ſeems covered over with a number of ſmall eyes, which are round, and placed at nearly equal diſtances. Theſe eyes are very different from what they ſeem: they are the animal's eggs, covered with their ſhells, and placed there for hatching. Theſe eggs are buried deep in the ſkin, and in the beginning of incubation but juſt appear; and are very viſible when the young animal is about to burſt from its confinement. They are of a reddiſh, ſhining yellow colour; and the ſpaces between them are full of ſmall warts, reſembling pearls.

This is their ſituation previous to their coming forth; but nothing ſo much demands our admiration as the manner of their production. The eggs, when formed in the ovary, are ſent, by ſome internal canals, which anatomiſts have not hitherto deſcribed, to lie and come to maturity under the bony ſubſtance of the back: in this ſtate they are impregnated by the male, whoſe ſeed finds its way by pores very ſingularly contrived, and pierces not only the ſkin but the perioſteum: the ſkin, however, is ſtill apparently entire, and forms a very thick covering over the whole brood; but, as they advance to maturity, at different intervals, one after another, the egg ſeems to ſtart forward, and burgeons from the back, becomes more yellow, and at laſt breaks; when the young one puts forth its head: it ſtill however keeps its ſituation until it has acquired a proper degree of ſtrength, and then it leaves the ſhell, but ſtill continues to keep upon the back of the parent. In this manner the pipal is ſeen travelling with her wonderous family on her back, in all the different ſtages of maturity. Some of the ſtrange progeny, not yet come to ſufficient perfection, appear quite torpid, and as yet without life, in the egg: others ſeem juſt beginning to riſe through the ſkin; here peeping forth from the ſhell, and there having entirely forſaken their priſon: ſome are ſporting at large upon the parent's back, and others deſcending to the ground to try their own fortune below. The male pipal is every way larger than the female, and has the ſkin leſs tightly drawn round the body. The whole body is covered with puſtules, reſembling pearls; and the belly, which is of a bright yellow, ſeems as if it were ſewed up from the throat to the vent, a ſeam being ſeen to run in that direction. This animal, like the reſt of the frog kind, is moſt probably harmleſs.

7. The *water frog* of Cateſby has large black eyes, yellow irides, and long limbs: the upper part of the head and body is of a duſky green, ſpotted with black; and from each eye to the noſe is a white line; and alſo a yellow line along the ſides to the rump. They frequent rivulets and ditches, which they do not quit for the dry land. It is ſaid they will ſpring five or ſix yards at a leap.

8. The *rana arborea*, or green tree frog of Cateſby, is of a ſlender ſhape and bright green colour, marked on each ſide with a line of yellow: the eyes are black; the irides yellow; they have four toes before and five behind; at the end of each toe there is a round membrane, concave beneath, and not unlike the mouth of a leech. They lurk under the lower ſides of leaves, even of the talleſt trees, and adhere firmly, by means of the membranes at the ends of their toes, ſticking to the ſmootheſt ſurface: a looking-glaſs was held before one, at four yards diſtance; it reached it at one leap, and ſtuck cloſely to it. At night theſe frogs make an inceſſant chirping, and leap from ſpray to ſpray, in ſearch of inſects. This ſpecies is common to America and the warmer parts of Europe.

9. The *land frog* of Cateſby has much the appearance of a toad: above it is gray or brown, ſpotted with duſky; below white, faintly ſpotted; the irides are red; and the legs ſhort. They frequent the high-lands, and are ſeen moſt frequently in wet weather and in the hotteſt time of the day: they leap, feed on inſects, particularly the fire-fly and ant. Sometimes the Americans bake and reduce this ſpecies to powder, which, mixed with orrice root, is taken as a cure for a tympany.

10. The *cinereous frog* has a gibbous, cinereous, and ſmooth back; the belly is yellow and granulated: on each ſide, from the noſe to the rump, there is a white line; and there is the ſame on the outſide of the thighs and legs; the toes are bullated at their ends. They inhabit Carolina.

RANAI, one of the Sandwich iſlands diſcovered by Captain Cook, is about nine miles diſtant from MOWEE and MOROTOI, and is ſituated to the ſouthweſt of the paſſage between thoſe two iſles. The country towards the ſouth is elevated and craggy; but the other parts of the iſland had a better appearance, and ſeemed to be well inhabited. It abounds in roots, ſuch as ſweet potatoes, *taro*, and yams; but produces very few plantains and bread-fruit trees. The ſouth point of Ranai is in the latitude of 20° 46′ north, and in the longitude of 203° 8′ eaſt.

RANCID, denotes a fatty ſubſtance that is become rank or muſty, or that has contracted an ill ſmell by being kept cloſe.

RANDIA, in botany: A genus of the monogynia order, belonging to the pentandria claſs of plants; and in the natural method ranking with thoſe of which the order is doubtful. The calyx is monophyllous; the corolla ſalver-ſhaped; the berry unilocular, with a capſular rind. There are two ſpecies, viz. the mitis and aculeata.

RANDOLPH (THOMAS), an eminent Engliſh poet in the 17th century, was born in Northamptonſhire 1605. He was educated at Weſtminſter and Cambridge, and very early diſtinguiſhed for his excellent genius; for at about nine or ten years of age he wrote the Hiſtory of the Incarnation of our Saviour in verſe. His ſubſequent writings eſtabliſhed his character, and gained him the eſteem and friendſhip of ſome of the greateſt men of that age, particularly of Ben Jonſon, who adopted him one of his ſons in the muſes. He died in 1634, and was honourably interred. He wrote, 1. The

Muſes' Looking-glaſs, a comedy. 2. Amyntas, or the Impoſſible Dowry, a paſtoral, which was acted before the king and queen. 3. Ariſtippus, or the Jovial Philoſopher. 4. The Conceited Pedlar. 5. The Jealous Lovers, a comedy. And, 6. Hey for Honeſty, down with Knavery, a comedy; and ſeveral poems.

RANDOM SHOT, in gunnery, is a ſhot made when the muzzle of a gun is raiſed above the horizontal line, and is not deſigned to ſhoot directly or point-blank.

The utmoſt random of any piece is about ten times as far as the bullet will go point-blank. The bullet will go furtheſt when the piece is mounted to about 45° above the level range. See GUNNERY and PROJECTILES.

RANGE, in gunnery, the path of a bullet, or the line it deſcribes from the mouth of the piece to the point where it lodges. If the piece lie in a line parallel to the horizon, it is called the *right* or *level range*: if it be mounted to 45°, it is ſaid to have the *utmoſt range*; all others between 00 and 45° are called the *intermediate ranges*.

RANGER, a ſworn officer of a foreſt, appointed by the king's letters patent; whoſe buſineſs is to walk through his charge, to drive back the deer out of the purlieus, &c. and to preſent all treſpaſſes within his juriſdiction at the next foreſt-court.

RANK, the order or place aſſigned a perſon ſuitable to his quality or merit.

RANK, is a ſtraight line made by the ſoldiers of a battalion or ſquadron, drawn up ſide by ſide: this order was eſtabliſhed for the marches, and for regulating the different bodies of troops and officers which compoſe an army.

RANK *and Precedence*, in the army and navy, are as follow:

Engineers' RANK. Chief, as colonel; director, as lieutenant-colonel; ſub-director, as major; engineer in ordinary, as captain; engineer extraordinary, as captain-lieutenant; ſub-engineer, as lieutenant; practitioner engineer, as enſign.

Navy-RANK. Admiral, or commander in chief of his majeſty's fleet, has the rank of a field-marſhal; admirals with their flags on the main-top maſt head, rank with generals of horſe and foot; vice admirals, with lieutenant-generals; rear-admirals, as major-generals; commodores, with broad pendants, as brigadier-generals; captains of poſt-ſhips, after three years from the date of their firſt commiſſion, as colonels; other captains, as commanding poſt ſhips, as lieutenant-colonels; captains, not taking poſt, as majors; lieutenants, as captains.

RANK between the Army, Navy, and Governors.

ARMY.	NAVY.	GOVERNORS.
General in chief	Admiral in chief	Commander in chief of the forces in America
Generals of horſe	Admiral with a flag at the main-top-maſt	Captain-general of provinces
Lieutenant-generals	Vice-admirals	Lieutenant-generals of provinces
Major-generals	Rear-admirals	Lieutenant-governors and preſidents
Colonels	Poſt-captains of 3 years	Lieutenant-governors not commanding
Lieutenant-colonels	Poſt-captains	Governors of charter colonies
Majors	Captains	Deputy-governors
Captains	Lieutenants	Eſtabliſhed by the king, 1760

Doubling of the RANKS, is the placing two ranks in one, frequently uſed in the manœuvres of a regiment.

RANKS *and Files*, are the horizontal and vertical lines of ſoldiers when drawn up for ſervice.

RANSOM a ſum of money paid for the redemption of a ſlave, or the liberty of a priſoner of war. In our law books, ranſom is alſo uſed for a ſum paid for the pardon of ſome great offence, and to obtain the offender's liberty.

RANULA, a tumor under a child's tongue, which like a ligature, hinders it from ſpeaking or ſucking.

RANUNCULUS, CROWFOOT: A genus of the polygamia order, belonging to the polyandria claſs of plants; and in the natural method ranking under the 26th order, *Multiſiliquæ*. The calyx is pentaphyllous; there are five petals, each with a melliferous pore on the inſide of the heel; the ſeeds naked.

There are near 40 different *ſpecies* of this genus; ſix or eight of which claim general eſteem as flowery plants for ornamenting the gardens, and a great number are common weeds in the fields, waters, and paſture ground, not having merit for garden culture. Of the garden kinds, the principal ſort is the Aſiatic or Turkey and Perſian ranunculus, which compriſes many hundred varieties of large, double, moſt beautiful flowers of various colours: but ſeveral other ſpecies having varieties with fine double flowers, make a good appearance in a collection, though as thoſe of each ſpecies conſiſt only of one colour, ſome white, others yellow, they are inferior to the Aſiatic ranunculus, which is large, and diverſified a thouſand ways in rich colours, in different varieties. However, all the garden kinds in general effect a very agreeable diverſity in aſſemblage in the flower compartments, &c. and they being all very hardy, ſucceed in any open beds and borders, &c.

The Aſiatic ſpecies in all its varieties will ſucceed in any light, rich, garden earth; but the floriſts often prepare a particular compoſt for the fine varieties, conſiſting of good garden mould or paſture-earth, ſward and all, a fourth part of rotted cow-dung, and the like portion of ſea-ſand; and with this they prepare beds four feet wide and two deep: however, in default of ſuch compoſt, uſe beds of any good light earth of your garden; or, if neceſſary, it may be made light and rich with a portion of drift-ſand and rotten dung, cow-dung is moſt commonly recommended; but they will alſo thrive in beds of well-wrought kitchen garden earth, and they often proſper well in the common flower-borders.

The ſeaſon for planting the roots is both in autumn and ſpring; the autumn plantings generally flower ſtrongeſt and ſooneſt by a month at leaſt, and are ſucceeded by the ſpring planting in May and June. Perform the autumnal planting in October and the early part of November: ſome, however, plant towards the latter end of September in order to have a very early bloom; but thoſe planted in that month and the beginning of October often come up with rank leaves ſoon after, in winter, ſo as to require protection in hard froſts; thoſe, however, planted about the middle or latter end of October, and beginning of November, rarely ſhoot up ſtrong till towards ſpring, and will not require ſo much care of covering during winter; and the ſpring planting may be performed at the end of January or beginning of February, or as ſoon as the weather is ſettled; they will not require any trouble of covering, and will ſucceed the autumnal plants regularly in bloom, and will flower in good perfection. Thus by two or three different plantings you may obtain a ſucceſſion of theſe beautiful flowers in conſtant bloom from April till the middle of June; but the autumnal plants, for the general part, not only flower ſtrongeſt, but the roots increaſe more in ſize, and furniſh the beſt off-ſets for propagation: it is, however, proper to plant both in ſpring and autumn.

Prepare for the choicer ſorts four-feet beds of light earth, and rake the ſurface ſmooth: then plant the roots in rows lengthwiſe of the beds, either by drilling them two inches deep, and ſix inches diſtant in the row, and the rows ſix or eight aſunder; or you may plant them by bedding-in, or by dibble-planting, the ſame depth and diſtance.

Thoſe deſigned for the borders ſhould be planted generally towards the ſpring, in little clumps or patches, three, four, or five roots in each, putting them in, either with a dibble or trowel, two or three inches deep, and three or four aſunder in each patch, and the patches at the diſtance of from about three to five or ten feet placing them rather forward in the border.

All the varieties of the Aſiatic ranunculus propagate abundantly by off-ſets from the root; and new varieties are gained by ſeed.—1. By off-ſets. The time for ſeparating the off-ſets is in ſummer when the flower is paſt, and the leaves and ſtalks are withered: then, taking up all the roots in dry weather, ſeparate the off-ſets from each main-root, and after drying the whole gradually in ſome ſhady airy room, put them up in bags till the autumn and ſpring ſeaſons of planting; then plant them as before, placing all the off-ſets in ſeparate beds: many of them will blow the firſt year, but in the ſecond they will all flower in the greateſt perfection. 2. By ſeed. Save a quantity of ſeed from the fineſt ſemi-double flowers, and ſow it either in Auguſt, or in March, or April, though, to ſave the trouble of winter covering, ſome prefer the ſpring: it ſhould be ſowed in light rich mould, either in pots or in an eaſt border, drawing very ſhallow flat drills five or ſix inches aſunder, in which ſow the ſeeds thinly, and cover them lightly with earth, giving frequent refreſhments of water in dry weather, and in a month or ſix weeks the plants will riſe with ſmall leaves; obſerving to continue the light waterings in dry weather, to preſerve the ſoil moiſt during their ſummer's growth to increaſe the ſize of the roots; and in June when the leaves decay, take up the roots and preſerve them till the ſeaſon for planting, then plant them in common beds, as before directed, and they will flower the ſpring following, when all the doubles of good properties ſhould be marked, and the ſingles thrown away.

The juice of many ſpecies of ranunculus is ſo acrid as to raiſe bliſters on the ſkin, and yet the roots may be eaten with ſafety when boiled.

RAPE, in law, the carnal knowledge of a woman forcibly and againſt her will. This, by the Jewiſh law, was puniſhed with death, in caſe the damſel was betrothed to another man; and, in caſe ſhe was not betrothed, then a heavy fine of fifty ſhekels was to be paid to the damſel's father, and ſhe was to be the wife of the raviſher all the days of his life; without that power of divorce, which was in general permitted by the Moſaic law.

The civil law puniſhes the crime of raviſhment with death and confiſcation of goods: under which it includes both the offence of forcible abduction, or taking away a woman from her friends; and alſo the preſent offence of forcibly diſhonouring her; either of which, without the other, is in that law ſufficient to conſtitute a capital crime. Alſo the ſtealing away a woman from her parents or guardians, and debauching her, is equally penal by the emperor's edict, whether ſhe conſent or be forced. And this, in order to take away from women every opportunity of offending in this way; whom the Roman laws ſuppoſe never to go aſtray without the ſeduction and arts of the other ſex; and therefore, by reſtraining and making ſo highly penal the ſolicitations of the men, they meant to ſecure effectually the honour of the women. But our Engliſh law does not entertain quite ſuch ſublime ideas of the honour of either ſex, as to lay the blame of a mutual fault upon one of the tranſgreſſors only; and therefore makes it a neceſſary ingredient in the crime of rape, that it muſt be againſt the woman's will.

Rape was puniſhed by the Saxon laws, particularly thoſe of king Athelſtan, with death; which was alſo agreeable to the old Gothic or Scandinavian conſtitution. But this was afterwards thought too hard: and in its ſtead another ſevere, but not capital, puniſhment was inflicted by William the Conqueror, viz. caſtration and loſs of eyes; which continued till after Bracton wrote, in the reign of Henry III. But in order to prevent malicious accuſations, it was then the law, (and, it ſeems, ſtill continues to be ſo in appeals of rape), that the woman ſhould, immediately after, go to the next town, and there make diſcovery to ſome credible perſons of the injury ſhe has ſuffered; and afterwards ſhould acquaint the high conſtable of the hundred, the coroners, and the ſheriff, with the outrage. This ſeems to correſpond in ſome degree with the laws of Scotland and Arragon, which require that complaint muſt be made within 24 hours: though afterwards by ſtatute Weſtm. 1. c. 13. the time of limitation in England was extended to 40 days. At preſent there is no time of limitation fixed: for, as it is uſually now puniſhed by indictment at the ſuit of the king, the maxim of law takes place, that "nullum tempus occurrit regi:" but the jury will rarely give credit to a ſtale complaint. During the former period alſo it was held for law, that the woman (by the conſent of the judge and her parents) might redeem the offender from the execution of his ſentence, by accepting him for her huſband; if he alſo was willing to agree to the exchange, but not otherwiſe.

In the 3 Edw. I. by the ſtatute Weſtm. 1. c. 13. the puniſhment of rape was much mitigated: the offence itſelf, of raviſhing a damſel within age, (that is, twelve years old) either with her conſent or without, or of any other woman againſt her will, being reduced to a treſpaſs, if not proſecuted by appeal within 40 days, and ſubjecting the offender only to two years impriſonment, and a fine at the king's will. But this lenity being productive of the moſt terrible conſequences, it was, in ten years afterwards, 13 Edw. I. found neceſſary to make the offence of forcible rape felony by ſtatute Weſtm. 2. c. 34. And by ſtatute 18 Eliz. c. 7, it is made felony without benefit of clergy: as is alſo the abominable wickedneſs of carnally knowing or abuſing any woman-child under the age of ten years; in which caſe the conſent or non-conſent is immaterial, as by reaſon of her tender years ſhe is incapable of judgment and diſcretion. Sir Matthew Hale is indeed of opinion, that ſuch profligate actions committed on an infant under the age of twelve years, the age of female diſcretion by the common law, either with or without conſent, amount to rape and felony; as well ſince as before the ſtatute of queen Elizabeth: but that law has in general been held only to extend to infants under ten; though it ſhould ſeem that damſels between ten and twelve are ſtill under the protection of the ſtatute Weſtm. 1. the law with reſpect to their ſeduction not having been altered by either of the ſubſequent ſtatutes.

A male infant, under the age of fourteen years, is preſumed by law incapable to commit a rape, and therefore it ſeems cannot be found guilty of it. For though in other felonies "malitia ſupplet ætatem;" yet, as to this particular ſpecies of felony, the law ſuppoſes an imbecility of body as well as mind.

The civil law ſeems to ſuppoſe a proſtitute or common harlot incapable of any injuries of this kind: not allowing any puniſhment for violating the chaſtity of her, who hath indeed no chaſtity at all, or at leaſt hath no regard to it. But the law of England does not judge ſo hardly of offenders as to cut off all opportunity of retreat even from common ſtrumpets, and to treat them as never capable of amendment. It therefore holds it to be a felony to force even a concubine or harlot; becauſe the woman may have forſaken that unlawful courſe of life: for, as Bracton well obſerves, "licet meretrix fuerit antea, certe tunc temporis non fuit, cum reclamando nequitiæ ejus conſentire noluit."

As to the material facts requiſite to be given in evidence and proved upon an indictment of rape, they are of ſuch a nature, that, though neceſſary to be known and ſettled, for the conviction of the guilty and preſervation of the innocent, and therefore are to be found in ſuch criminal treatiſes as diſcourſe of theſe matters in detail, yet they are highly improper to be publicly diſcuſſed, except only in a court of juſtice. We ſhall therefore merely add upon this head a few remarks from Sir Matthew Hale, with regard to the competency and credibility of witneſſes; which may, *ſalvo pudore,* be conſidered.

And, firſt, the party raviſhed may give evidence upon oath, and is in law a competent witneſs; but the credibility of her teſtimony, and how far forth ſhe is to be believed, muſt be left to the jury upon the circumſtances of fact that concur in that teſtimony. For inſtance: if the witneſs be of good fame; if ſhe preſently diſcovered the offence, and made ſearch for the offender; if the party accuſed fled for it; theſe and the like are concurring circumſtances, which give greater probability to her evidence. But, on the other ſide, if ſhe be of evil fame, and ſtand unſupported by others; if ſhe concealed the injury for any conſiderable time after ſhe had opportunity to complain; if the place, where the fact was alleged to be committed, was where it was poſſible ſhe might have been heard, and ſhe made no outcry: theſe and the like circumſtances carry a ſtrong, but not concluſive, preſumption, that her teſtimony is falſe or feigned.

Moreover, if the rape be charged to be committed on an infant under 12 years of age, ſhe may ſtill be a competent witneſs, if ſhe hath ſenſe and underſtanding to know the nature and obligations of an oath; and, even if ſhe hath not, it is thought by Sir Matthew Hale, that ſhe ought to be heard without oath, to give the court information; though that alone will not be ſufficient to convict the offender. And he is of this opinion, firſt, Becauſe the nature of the offence being ſecret, there may be no other poſſible proof of the actual fact; though afterwards there may be concurrent circumſtances to corroborate it, proved by other witneſſes: and, ſecondly, Becauſe the law allows what the child told her mother, or other relations, to be given in evidence, ſince the nature of the caſe admits frequently of no better proof; and there is much more reaſon for the court to hear the narration of the child herſelf, than to receive it at ſecondhand from thoſe who ſwear they heard her ſay ſo. And indeed it ſeems now to be ſettled, that in theſe caſes infants of any age are to be heard; and, if they have any idea of an oath, to be alſo ſworn: it being found by experience, that infants of very tender years often give the cleareſt and trueſt teſtimony. But in any of theſe caſes, whether the child be ſworn or not, it is to be wiſhed, in order to render her evidence credible, that there ſhould be ſome concurrent teſtimony of time, place, and circumſtances, in order to make out the fact; and that the conviction ſhould not be grounded ſingly on the unſupported accuſation of an infant under years of diſcretion. There may be, therefore, in many caſes of this nature, witneſſes who are competent, that is, who may be admitted to be heard; and yet, after being heard, may prove not to be credible, or ſuch as the jury is bound to believe. For one excellence of the trial by jury is, that the jury are triers of the credit of the witneſſes, as well as of the truth of the fact.

"It is true (ſays this learned judge), that rape is a moſt deteſtable crime, and therefore ought ſeverely and impartially to be puniſhed with death; but it muſt be remembered, that it is an accuſation eaſy to be made, hard to be proved, but harder to be defended by the party accuſed, though innocent." He then relates two very extraordinary caſes of malicious proſecution for this crime, that had happened within his own obſervation; and concludes thus: "I mention theſe inſtances, that we may be the more cautious upon trials of offences of this nature, wherein the court and jury may with ſo much eaſe be impoſed upon, without great care and vigilance; the heinouſneſs of the offence many times tranſporting the judge and jury with ſo much indignation, that they are over-haſtily carried to the conviction of the perſons accuſed thereof, by the confident teſtimony of ſometimes falſe and malicious witneſſes."

RAPHAEL (D'Urbino), the greateſt, moſt ſublime, and moſt excellent painter that has appeared ſince the revival of the fine arts, was the ſon of an indifferent painter named *Sanzio,* and was born at Urbino on Good Friday 1482. The popes Julius II. and Leo X. who employed him, loaded him with wealth and honour; and it is ſaid that cardinal De St. Bibiana had ſuch a value for him, that he offered him his niece in marriage. His genius is admired in all his pictures; his contours are free, his ordonnances magnificent, his deſigns correct, his figures elegant, his expreſſions lively, his attitudes natural, his heads graceful; in fine, every thing is beautiful, grand, ſublime, juſt, and adorned with graces. Theſe various perfections he derived not only from his excellent abilities, but from his ſtudy of antiquity and anatomy; and from the friendſhip he contracted with Arioſto, who contributed not a little to the improvement of his taſte. His pictures are principally to be found in Italy and Paris. That of the Transfiguration, preſerved at Rome in the church of St. Peter Monterio, paſſes for his maſter-piece. He had a handſome perſon, was well proportioned, and had great ſweetneſs of temper; was polite, affable, and modeſt. He, however, lived in the utmoſt ſplendor; moſt of the eminent maſters of his time were ambitious of working under him; and he never went out without a crowd of artiſts and others, who followed him purely through reſpect. He was not only the beſt painter in the world, but perhaps the beſt architect too; on which account Leo X. charged him with building St. Peter's church at Rome: but he was too much addicted to pleaſure, which occaſioned his death at 37 years of age. He left a great number of diſciples; among whom were Julio Romano and John Francis Penni, who were his heirs. Many able engravers, as Raimondi, George Mantuan, and Bloemart, engraved after Raphael. See Painting.

RAPHAIM, or Rephaim, (Moſes), a name ſignifying *Giants*, as they really were, and an actual people too, ſituated in Baſan or Batanea, beyond Jordan, ſeparated from the Zamzummim by the river Jabbok. Alſo a valley near Jeruſalem; Joſhua x.

RAPHANUS, radish; a genus of the ſiliquoſa order, belonging to the tetradynamia claſs of plants; and in the natural method ranking under the 39th order, *Siliquoſæ*. The calyx is cloſe: the ſiliqua toroſe, or ſwelling out in knots, ſubarticulated, and round. There are two melliferous glandules between the ſhorter ſtamina and the piſtil, and two between the longer ſtamina and the calyx. There is only one ſpecies, viz. the *ſativus*. or common garden radiſh; of which there are ſeveral varieties. They are annual plants, which being ſowed in the ſpring, attain perfection in two or three months, and ſhoot up ſoon after into ſtalk for flower and ſeed, which, ripening in autumn, the whole plant, root and top, periſhes; ſo that a freſh ſupply muſt be raiſed annually from ſeed in the ſpring, performing the ſowings at ſeveral different times, from about Chriſtmas until May, in order to continue a regular ſucceſſion of young tender radiſhes throughout the ſeaſon: allowing only a fortnight or three weeks interval between the ſowings; for one crop will not continue good longer than that ſpace of time, before they will either run to ſeed, or become tough, ſticky, and too hot to eat.

RAPHANIDOSIS, a puniſhment inflicted at Athens upon adulterers. The manner of it was this: The hair was plucked off from the privities of the offender, hot aſhes laid upon the place, and a radiſh or mullet thruſt up his fundament, as has been mentioned under Adultery. To this Juvenal alludes, *Sat*. x. ver. 317. *Quoſdam mœchos et mugilis intrat*. Perſons who had been thus puniſhed were called *ευπροικτοι*. The word *raphaniđoſis* is derived from *ραφανις*, a radiſh.

RAPHIDIA, in zoology; a genus of inſects, of the neuroptera order; the characters of which are theſe. The head is of a horny ſubſtance, and depreſſed or flattened: the mouth is armed with two teeth, and furniſhed with four palpi: the ſtemmata are three in number: the wings are deflected: the antennæ are filiform, as long as the thorax; the anterior part of which is lengthened out, and of a cylindrical form: the tail of the female is terminated by an appendix, reſembling a flexible crooked briſtle.—There are three ſpecies. The moſt remarkable is the *ophiopſis*; which for its ſhape is one of the moſt ſingular that can be ſeen (ſee pl. 39.) It has an oblong head, ſhaped like a heart, with its point joined to the thorax, and the broad part before. It is ſmooth, black, flattened, continually ſhaking, with ſhort antennæ, yellowiſh maxillæ, and four palpi. Towards the middle of the upper part of the head, between the eyes, are three ſtemmata, placed in a triangle. The thorax, to which this head is faſtened, is narrow, long, and cylindrical. The abdomen, broader, is black like the reſt of the body, with the ſegments margined yellow. The feet are of a yellowiſh caſt. The wings, which are faſtigiated, are white, diaphanous, veined, and as it were covered with a very fine net-work of black. This inſect, in the figure of its head, reſembles a ſnake. It is found but ſeldom, and in woods only. Its larva, chryſalis, and habitatation, are abſolutely unknown.

RAPIER, formerly ſignified a long old-faſhioned ſword, ſuch as thoſe worn by the common ſoldiers; but it now denotes a ſmall ſword, as contradiſtinguiſhed from a back-ſword.

RAPIN (Rene), a Jeſuit and eminent French writer, was born at Tours in 1621. He taught polite literature in the ſociety of the Jeſuits with great applauſe, and was juſtly eſteemed one of the beſt Latin poets and greateſt wits of his time. He died at Paris in 1687. He wrote, 1. A great number of Latin poems, which have rendered him famous throughout all Europe; among which are his *Hortorum libri quatuor*, which is reckoned his maſter-piece. 2. Reflections on Eloquence, Poetry, Hiſtory, and Philoſophy. 3. Compariſons between Virgil and Homer, Demoſthenes and Cicero, Plato and Ariſtotle, Thucydides and Titus Livius. 4. The Hiſtory of Janſeniſm. 5. Several works on religious ſubjects. The beſt edition of his Latin poems is that of Paris in 1723, in 3 vols. 12mo.

Rapin *de Thoyras* (Paul de), a celebrated hiſtorian, was the ſon of James de Rapin lord of Thoyras, and was born at Caſtres in 1661. He was educated at firſt under a tutor in his father's houſe; and afterwards ſent to Puylaurens, and thence to Saumur. In 1697 he returned to his father, with a deſign to apply himſelf to the ſtudy of the law, and was admitted an advocate: but ſome time after, reflecting that his being a Proteſtant would prevent his advancement at the bar, he reſolved to quit the profeſſion of the law, and apply himſelf to that of the ſword; but his father would not conſent to it. The revocation of the edict of Nantes in 1685, and the death of his father, which happened two months after, made him reſolve to come to England; but as he had no hopes of any ſettlement here, his ſtay was but ſhort. He therefore ſoon after went to Holland, and liſted himſelf in the company of French volunteers at Utrecht, commanded by M. Rapin his couſin-german. He attended the prince of Orange into England in 1688: and the following year the lord Kingſton made him an enſign in his regiment, with which he went into Ireland, where he gained the eſteem of his officers at the ſiege of Carrickfergus, and had ſoon a lieutenant's commiſſion. He was preſent at the battle of the Boyne, and was ſhot through the ſhoulder at the ſiege of Limerick. He was ſoon after captain of the company in which he had been enſign; but, in 1693, reſigned his company to one of his brothers, in order to be tutor to the earl of Portland's ſon. In 1699, he married Marianne Teſtard; but this marriage neither abated his care of his pupil, nor prevented his accompanying him in his travels. Having finiſhed this employment, he returned to his family, which he had ſettled at the Hague; and here he continued ſome years. But as he found his family increaſe, he reſolved to retire to ſome cheap country; and accordingly removed, in 1707, to Weſel, where he wrote his Hiſtory of England, and ſome other pieces. Though he was of a ſtrong conſtitution, yet ſeventeen years application (for ſo long was he in compoſing the hiſtory juſt mentioned) entirely ruined his health. He died in 1725. He wrote in French, 1. A Diſſertation on the Whigs and Tories. 2. His Hiſtory of England, printed at the Hague in 1726 and 1727, in 9 vols. 4to, and reprinted at Trevoux in 1728, in 10 vols. 4to. This laſt edition is more complete than that of the Hague. It has been tranſlated into Engliſh, and improved with notes, by the Rev. Mr. Tindal, in 2 vols. folio. This performance, though the work of a foreigner, is deſervedly eſteemed as the fulleſt and moſt impartial collection of Engliſh political tranſactions extant. The readers of wit and vivacity, however, may be apt to complain of him for being ſometimes rather tedious and dull.

RAPINE, in law, the taking away another's goods, &c. by violence.

RAPPERSWIL, a town of Swiſſerland, on the confines of the canton of Zurich, and of the territory of Gaſter, with an old caſtle. It is ſtrong by ſituation, being ſeated on a neck of land which advances into the lake of Zurich, and over which there is a bridge 850 paces long. It is ſubject to the cantons of Zurich and Berne. E. lon. 8. 57. N. lat. 47. 20.

RAPOLFSTEIN, or Ribau-Pierre, a town of France, in the department of Upper Rhine and late province of Alſace, eight miles north of Colmer. E. lon. 7. 20. N. lat. 48. 13.

RAPTURE, an ecſtaſy or tranſport of mind. See Extasy.

RARE, in phyſics, ſtands oppoſed to denſe; and denotes a body that is very porous, whoſe parts are at a great diſtance from one another, and which is ſuppoſed to contain but little matter under a large bulk. See the following article.

RAREFACTION, in phyſics, the act whereby a body is rendered rare; that is, brought to poſſeſs more room, or appear under a larger bulk, without acceſſion of any new matter. This is very frequently the effect of fire, as has long been univerſally allowed. In many caſes, however, philoſophers have attributed it to the action of a repulſive principle. However, from the many diſcoveries concerning the nature and properties of the electric fluid and fire, there is the greateſt reaſon to believe that this repulſive principle is no other than elementary fire. See Repulsion.

RAS-el-Feel, one of the frontier provinces of Abyſſinia, of which the late celebrated traveller Mr. Bruce was made governor while in that country. It is but of ſmall extent, and in its moſt proſperous ſtate contained only 39 villages. The climate is extremely hot, in Mr. Bruce's opinion one of the hotteſt in the world. He informs us, that on the firſt day of March, at three o'clock in the afternoon, the thermometer ſtood at 114° in the ſhade, and in the evening at 82°; though at ſunriſe it had been no higher than 61. Notwithſtanding this appearance of extreme heat, however, the ſenſation was by no means intolerable; they could hunt at mid-day, and felt the evenings rather cold. The ſoil is a fat, looſe, black earth, which our author ſays is the ſame from 13° to 16° of north latitude; at leaſt till we come to the deſerts of Atbara, where the tropical rains ceaſe. This country divides that of the Shangalla into two parts, nearly equal. Theſe people inhabit a belt of land about 60 miles broad, all along the northern frontier of Abyſſinia, excepting two large gaps or ſpaces which have been left open for the ſake of commerce, and which are inhabited by ſtrangers, to keep the Shangalla in awe. The latter trade in gold, which they pick up in the ſtreams as it is waſhed down from the mountains; for there are no mines in their country, neither is there any gold in Abyſſinia, excepting what is imported from this or ſome other country. The Shangalla are the natural enemies of the inhabitants of Ras-el-Feel, and much blood has been ſhed in the various incurſions they have made upon one another; though of late thoſe of Ras-el-Feel, by the aſſiſtance of the emperors, have been enabled to keep the Shangalla at bay.

RAS-Sem, a city of Tripoli in Barbary, concerning which a number of fables were told by the Tripoline ambaſſador, all of which were believed in England and other parts of Europe in the beginning of this century. (See Petrified *City*.) Mr. Bruce informs us, that it is ſituated about five days journey ſouth from Bengazi; but has no water excepting one fountain, which has a diſagreeable taſte, and ſeems to be impregnated with alum. Hence it has obtained the name of *Ras-Sem*, or the fountain of poiſon. The only remains of antiquity in this place conſiſt of the ruins of a tower or fortification, which, in the opinion of Mr. Bruce, is as late as the time of the Vandals; but he ſays he cannot imagine what uſe they made of the water, and they had no other within two days journey of the place. Here our traveller ſaw many of the animals called *jerboa*, a kind of mice, which, he ſays, ſeem to partake as much of the nature of a bird as a quadruped.

RASAY, one of the Hebrides Iſlands, is about 13 miles long and 2 broad. It contains 700 inhabitants, has plenty of limeſtone, freeſtone, and feeds great numbers of black cattle; but has neither deers, hares, nor rabbits. The only appearance of a harbour in Raſay is at Clachan Bay, where Mr. Macleod, the proprietor of the iſland, reſides. Raſay preſents a bold ſhore, which riſes to the height of mountains; and here the natives have, with incredible labour, formed many little cornfields and potatoe-grounds. Theſe heights decreaſe at the ſouth end, where there are ſome farms and a good-looking country. Mr. Macleod is ſole proprietor of this iſland, and of Rona and Fladda at the north end of it, which are only proper for grazing. The houſe of Raſay is pleaſantly ſituated near the ſouth-weſt end of the iſland, which is the moſt level part of it. It has an extenſive and excellent garden, and is ſurrounded with foreſt trees of conſiderable magnitude; another proof that trees will grow upon the edge of the ſea, though it muſt be allowed that the channel here is narrow. Immediately behind the houſe of Raſay are the ruins of an ancient chapel, now uſed as the family burying-place. Dr. Johnſon, in his Tour, expreſſes the higheſt ſatisfaction at the reception he met with, when in Raſay, from Mr. Macleod.

RASCIANS, a poor oppreſſed people who dwelt on both ſides of the Danube, and who, about the year 1594, being weary of the Turkiſh thraldom, firſt took 13 of their veſſels upon that river; and then drawing together a body of fifteen thouſand men between Buda and Belgrade, twice defeated the pâſhâ of Temeſwar with a body of fourteen thouſand Turks. They afterwards took Baczkerek, four miles from Belgrade, and the caſtle of Ottadt; then laying ſiege to that of Beche, on the Theyſſa, the old pâſhâ of Temeſwar marched to relieve it with eleven thouſand men; but the Raſcians encountering them, ſlew near ten thouſand, and took eighteen pieces of cannon. The conſequence of this victory was the reduction of Werſetza and Lutz. Then, ſending to the archduke for aid and gunners, they offered to put themſelves and their country under the emperor's protection.

RASOR-bill. See Alca.

Rasor-*Fiſh*. See Solen.

RASTALL (John), a printer and miſcellaneous writer, was born in London, probably about the end of the 15th century, and educated at Oxford. Returning from the univerſity, he ſettled in the metropolis and commenced printer, "then eſteemed (ſays Wood) a profeſſion fit for any ſcholar or ingenious man." He married the ſiſter of Sir Thomas More, with whom, we are told, he was very intimate, and whoſe writings he ſtrenuouſly defended. From the title-page of one of his books, he appears to have lived in Cheapſide, at the ſign of the Mermaid. He died in the year 1536, and left two ſons, William and John; the firſt of whom became a judge in queen Mary's reign, the latter a juſtice of peace. This John Raſtall, the ſubject of the preſent article, was a zealous papiſt; but Bale ſays, that he changed his religion before his death. He wrote, 1. *Natura naturata.* Pits calls it a copious (*prolixa*) and ingenious comedy, deſcribing Europe, Aſia, and Africa; with cuts. What ſort of a comedy this was, is not eaſy to conceive. Probably it is a coſmographical deſcription, written in dialogue, and therefore ſtyled a *comedy*. 2. The paſtyme of the people; the cronycles of diverſe realmys, and moſt eſpecially of the realm of England, brevely compiled and emprinted in Cheapeſyde, at the ſign of the mearmaid, next Pollyſgate *cum privilegio*, fol. 3. *Eccleſia Johannis Raſtall*, 1542. Was one of the prohibited books in the reign of Henry VIII. 4. *Legum Anglicanarum vocabula explicata.* French and Latin. Lond. 1567, 8vo. And ſome other works.

RASTADT, a town of Germany, in the circle of Suabia and marquiſate of Baden, with a handſome caſtle. It is remarkable for a treaty concluded here between the French and Imperialiſts in 1714; and is ſeated on the river Murg, near the Rhine. E. lon. 9. 14. N. lat. 48. 52.

RASTENBURG, a fine city in Pruſſia, on the Guber, ſurrounded with a wall, and ſince 1629 alſo with a rampart.

RAT, in zoology. See Mus. The following receipt is ſaid to have been found effectual for the deſtruction of rats.

Take of the ſeeds of ſtaveſacre or louſewort, powdered, more or leſs, as the occaſion requires, one part; of oatmeal, three parts; mix them well, and make them up into a paſte with honey. Lay pieces of it in the holes, and on the places where mice and rats frequent; and it will effectually kill or rid the place of thoſe kind of vermin by their eating thereof.

Some time ago, the Society for encouraging arts propoſed a præmium of 50l. for a preparation capable of alluring or faſcinating rats ſo that they might be taken alive. In conſequence of this, a great number of new traps, &c. were invented; and the following methods of alluring the rats to a certain place were publiſhed:

One of thoſe moſt eaſily and efficaciouſly practiſed is the trailing ſome pieces of their moſt favourite food, which ſhould be of the kind that has the ſtrongeſt ſcent, ſuch as toaſted cheeſe or broiled red herrings, from the holes or entrances of the cloſet to their receſſes in every part of the houſe or contiguous building. At the extremities, and in different parts of the courſe of this trailed track, ſmall quantities of meal, or any other kind of their food, ſhould be laid, to bring the greater number into the tracks, and to encourage them to purſue it to the place where they are intended to be taken: at that place, when time admits of it, a more plentiful repaſt is laid for them, and the trailing repeated for two or three nights.

Beſides this trailing and way-baiting, ſome of the moſt expert of the rat-catchers have a ſhorter and perhaps more effectual method of bringing them together; which is the calling them, by making ſuch a whiſtling noiſe as reſembles their own call; and by this means, with the aſſiſtance of the way-baits, they call them out of their holes, and lead them to the repaſt prepared for them at the place deſigned for taking them. But this is much more difficult to be practiſed than the art of trailing; for the learning the exact notes or cries of any kind of beaſts or birds, ſo as to deceive them, is a peculiar talent which is ſeldom attained: though ſome perſons have been known who could call together a great number of cats; and there was a man in London who could bring nightingales, when they were within hearing, about him, and even allure them to perch on his hand, ſo as to be taken.

In practiſing either of thoſe methods, of trailing or calling, great caution muſt be uſed by the operator to ſuppreſs and prevent the ſcent of his feet and body from being perceived; which is done by overpowering that ſcent by others of a ſtronger nature. In order to this, the feet are to be covered with cloths rubbed over with aſafœtida, or other ſtrong-ſmelling ſubſtances; and even oil of rhodium is ſometimes uſed for this purpoſe, but ſparingly, on account of its dearneſs, though it has a very alluring as well as diſguiſing effect. If this caution of avoiding the ſcent of the operator's feet, near the track, and in the place where the rats are propoſed to be collected, be not properly obſerved, it will very much obſtruct the ſucceſs of the attempt to take them; for they are very ſhy of coming where the ſcent of human feet lies very freſh, as it intimates to their ſagacious inſtinct the preſence of human creatures, whom they naturally dread. To the above-mentioned means of alluring by trailing, way-baiting, and calling, is added another of a very material efficacy, which is, the uſe of oil of rhodium, which, like the marum Syriacum in the caſe of cats, has a very extraordinary faſcinating power on theſe animals. This oil is extremely dear, and therefore ſparingly uſed. It is exalted in a ſmall quantity in the place, and at the entrance, of it, where the rats are intended to be taken; particularly at the time when they are to be laſt brought together, in order to their deſtruction; and it is uſed alſo by ſmearing it on the ſurface of ſome of the implements uſed in taking by the method here deſcribed; and the effect it has in taking off their caution and dread, by the delight they appear to have in it, is very extraordinary.

It is uſual, likewiſe, for the operator to diſguiſe his figure as well as ſcent, which is done by putting on a ſort of gown or cloak, of one colour, that hides the natural form, and makes him appear like a poſt or ſome ſuch inanimate thing; which habit muſt likewiſe be ſcented as above, to overpower the ſmell of his perſon; and beſides this, he is to avoid all motion till he has ſecured his point of having all the rats in his power.

When the rats are thus enticed and collected, where time is afforded, and the whole in any houſe and out-buildings are intended to be cleared away, they are ſuffered to regale on what they moſt like, which is ready prepared for them, and then to go away quietly for two or three nights; by which means thoſe that are not allured the firſt night are brought afterwards, either by their fellows, or the effects of the trailing, &c. and will not fail to come duly again, if they are not diſturbed or moleſted. But many of the rat-catchers make ſhorter work, and content themſelves with what can be brought together in one night or two; but this is never effectual, unleſs where the building is ſmall and entire, and the rats but few in number.

The means of taking them, when they are brought together, are various. Some entice them into a very large bag, the mouth of which is ſufficiently capacious to cover nearly the whole floor of the place where they are collected; which is done by ſmearing ſome veſſel, placed in the middle of the bag, with oil of rhodium, and laying in the bag baits of food. This bag, which before lay flat on the ground with the mouth ſpread open, is to be ſuddenly cloſed when the rats are all in. Others drive or fright them, by ſlight noiſes or motions, into a bag of a long form, the mouth of which, after all the rats are come in, is drawn up to the opening of the place by which they entered, all other ways of retreat being ſecured. Others again, intoxicate or poiſon them, by mixing with the repaſt prepared for them the coculus Indicus, or the nux vomica. They direct four ounces of the coculus Indicus, with twelve ounces of oatmeal, and two ounces of treacle or honey, made into a moiſt paſte with ſtrong beer: but if the nux vomica be uſed, a much leſs proportion will ſerve than is here given of the coculus. Any ſimilar compoſition of theſe drugs, with that kind of food the rats are moſt fond of, and which has a ſtrong flavour, to hide that of the drugs, will equally well anſwer the end. If indeed the coculus Indicus be well powdered, and infuſed in ſtrong beer for ſome time, at leaſt half the quantity here directed will ſerve as well as the quantity before-mentioned. When the rats appear to be thoroughly intoxicated with the coculus, or ſick with the nux vomica, they may be taken with the hand, and put into a bag or cage, the door of the place being firſt drawn to, leſt thoſe who have ſtrength and ſenſe remaining eſcape.

Rat-*Iſland*, a ſmall detached part of the iſland of Lundy, off the north coaſt of Devon. Though noted in Donn's map of the county, it is not worth mention here, but as giving opportunity to ſubjoin a further notice of Lundy, which iſland was purchaſed a few years ſince by Mr. Cleveland M. P. for about 1200 guineas, who has a ſmall villa on it: not more than 4.0 acres are cultivated: it is let altogether for 70l. a-year. The ſoil is good, though no trees will grow on the iſland. It has fine ſprings of water: the houſes are ſeven: the inhabitants, men, women, and children, do not exceed 24. The bird called *murr*, whoſe eggs are very large and fine, the Lundy parrot, and rabbits, are the chief produce; theſe abound, and are taken for the feathers, eggs, and ſkins, principally. They have now (1794) 70 bullocks and 400 ſheep, but the latter do not thrive. They pay no taxes; fiſhing ſkiffs often call with neceſſaries: the ſituation is very pleaſant, and the rocks around, which are large, and partly granite, are wild, romantic, and novel. It had probably more inhabitants once, as human bones have been ploughed up. It has no place of worſhip, nor public-houſe; but ſtrangers are always welcome. Eight cannon lie on the battlements on the top of a very ſteep precipice, under which is a curious cavern. Lord Gower, Mr. Benſon, and Sir J. B. Warren, K. B. have been former proprietors. See Lundy.

Rat-*Tails*, or *Arreſts*. See Farriery.

RATAFIA, a fine ſpirituous liquor, prepared from the kernels, &c. of ſeveral kinds of fruits, particularly of cherries and apricots. Ratafia of cherries is prepared by bruiſing the cherries, and putting them into a veſſel wherein brandy has been long kept; then adding to them the kernels of cherries, with ſtrawberries, ſugar, cinnamon, white pepper, nutmeg, cloves; and to 20 pound of cherries 10 quarts of brandy. The veſſel is left open ten or twelve days, and then ſtopped cloſe for two months before it be tapped. Ratafia of apricots is prepared two ways, viz. either by boiling the apricots in white-wine, adding to the liquor an equal quantity of brandy, with ſugar, cinnamon, mace, and the kernels of apricots; infuſing the whole for eight or ten days; then ſtraining the liquor, and putting it up for uſe: or elſe by infuſing the apricots, cut in pieces, in brandy, for a day or two, paſſing it through a ſtraining bag, and then putting in the uſual ingredients.

RATCH, or rash, in clock-work, a ſort of wheel having twelve fangs, which ſerve to lift up the detents every hour, and make the clock ſtrike. See Clock.

RATCHETS, in a watch, are the ſmall teeth at the bottom of the fuſy, or barrel, which ſtops it in winding up.

RATE, a ſtandard or proportion, by which either the quantity or value of a thing is adjuſted.

RATES, in the navy, the orders or claſſes into which the ſhips of war are divided, according to their force and magnitude. The regulation, which limits the rates of men of war to the ſmalleſt number poſſible, ſeems to have been dictated by conſiderations of political economy, or of that of the ſimplicity of the ſervice in the royal dock-yards. The Britiſh fleet is accordingly diſtributed into ſix rates, excluſive of the inferior veſſels that uſually attend on naval armaments; as ſloops of war, armed ſhips, bomb-ketches, fire-ſhips and cutters, or ſchooners commanded by lieutenants. Ships of the firſt rate mount 100 cannon, having 42-pounders on the lower-deck, 24-pounders on the middle-deck, 12-pounders on the upper-deck, and 6 pounders on the quarter-deck and forecaſtle. They are manned with 850 men, including their officers, ſeamen, marines, and ſervants.

In general, the ſhips of every rate, beſides the captain, have the maſter, the boatſwain, the gunner, the chaplain, the purſer, the ſurgeon, and the carpenter; all of whom, except the chaplain, have their mates or aſſiſtants, in which are comprehended the ſail-maker, the maſter at arms, the armourer, the captain's clerk, the gunſmith, &c. The number of other officers is always in proportion to the rate of the ſhip. Thus a firſt rate has ſix lieutenants, ſix maſter's mates, twenty-four midſhipmen, and five ſurgeon's mates, who are conſidered as gentlemen: beſides the following petty officers; quarter-maſters and their mates, fourteen; boatſwain's mates and yeomen, eight; gunner's mates and aſſiſtants, ſix; quarter-gunners, twenty five; carpenter's mates, two, beſides fourteen aſſiſtants; with one ſteward, and ſteward's mate to the purſer.

If the dimenſions of all ſhips of the ſame rate were equal, it would be the ſimpleſt and moſt perſpicuous method to collect them into one point of view in a table: but, as there is no invariable rule for the general dimenſions, we muſt content ourſelves with but a few remarks on ſhips of each rate, ſo as to give a general idea of the difference between them.

The Victory, one of the laſt built of our firſt rates, is 222 feet 6 inches in length, from the head to the ſtern; the length of her keel, 151 feet 3 inches; that of her gun deck, or lower-deck, 186 feet; her extreme breadth is 51 feet 10 inches; her depth in the hold, 21 feet 6 inches; her burthen 2162 tons; and her poop reaches 6 feet before the mizen-maſt.

Ships of the ſecond rate carry 90 guns upon three decks, of which thoſe on the lower battery are 32-pounders; thoſe on the middle, 18-pounders; on the upper-deck, 12-pounders; and thoſe on the quarter-deck, 6-pounders, which uſually amount to four or ſix. Their complement of men is 750, in which there are 6 lieutenants, four maſter's mates, 24 midſhipmen, and four ſurgeon's mates, 14 quarter-maſters and their mates, eight boatſwain's mates and yeomen, ſix gunner's mates and yeomen, with 22 quarter-gunners, two carpenter's mates, with 10 aſſiſtants, and one ſteward and ſteward's mate.

Ships of the third rate carry from 64 to 80 cannon, which are 31, 18, and 9 pounders. The 80-gun ſhips however begin to grow out of repute, and to give way to thoſe of 74, 70, &c. which have only two whole batteries; whereas the former have three, with 28 guns planted on each, the cannon of their upper deck being the ſame as thoſe on the quarter-deck and forecaſtle of the latter, which are 9-pounders. The complement in a 74 is 650, and in a 64, 500 men; having, in peace, four lieutenants, but in war, five; and when an admiral is aboard, ſix. They have three maſter's mates, 16 midſhipmen, three ſurgeon's mates, 10 quarter-maſters and their mates, ſix boatſwain's mates and yeomen, four gunner's mates and yeomen, with 18 quarter-gunners, one carpenter's mate, with eight aſſiſtants, and one ſteward and ſteward's mate under the purſer.

Ships of the fourth rate mount from 60 to 50 guns, upon two decks, and the quarter-deck. The lower tier is compoſed of 24 pounders, the upper tier of 12-pounders, and the cannon on the quarter-deck and forecaſtle are 6 pounders. The complement of a 50-gun ſhip is 350 men, in which there are three lieutenants, two maſter's mates, 10 midſhipmen, two ſurgeon's mates, eight quarter-maſters and their mates, four boatſwain's mates and yeomen, one gunner's mate and one yeoman, with 12 quarter-gunners, one carpenter's mate and ſix aſſiſtants, and a ſteward and ſteward's mate.

All veſſels of war, under the fourth rate, are uſually comprehended under the general name of *frigates*, and never appear in the line of battle. They are divided into the 5th and 6th rates; the former mounting from 40 to 32 guns, and the latter from 28 to 20. The largeſt of the fifth rate have two decks of cannon, the lower battery being of 18-pounders, and that of the upper-deck of 9-pounders; but thoſe of 36 and 32 guns have one complete deck of guns, mounting 12-pounders, beſides the quarter-deck and forecaſtle, which carry 6-pounders. The complement of a ſhip of 44 guns is 280 men; and that of a frigate of 36 guns, 240 men. The firſt has three, and the ſecond two lieutenants; and both have two maſter's mates, ſix midſhipmen, two ſurgeon's mates, ſix quarter-maſters and their mates, two boatſwain's mates and one yeoman, one gunner's mate and one yeoman, with 10 or 11 quarter-gunners, and one purſer's ſteward.

Frigates of the 6th rate, carry 9-pounders, thoſe of 28 guns having 3-pounders on their quarter-deck, with 200 men for their complement; and thoſe of 24, 160 men: the former has two lieutenants, the latter one; and both have two maſter's mates, four midſhipmen, one ſurgeon's mate, four quarter-maſters and their mates, one boatſwain's mate and one yeoman, one gunner's mate and one yeoman, with ſix or ſeven quarter-gunners, and one purſer's ſteward.

The ſloops of war carry from 18 to 8 cannon, the largeſt of which have ſix-pounders; and the ſmalleſt, viz. thoſe of 8 or

10 guns, four-pounders. Their officers are generally the ſame as in the 6th rates, with little variation; and their complements of men are from 120 to 60, in proportion to their force or magnitude. *N.B.* Bomb-veſſels are on the ſame eſtabliſhment as ſloops; but fire-ſhips and hoſpital-ſhips are on that of fifth rates.

Nothing more evidently manifeſts the great improvement of the marine art, and the degree of perfection to which it has arrived in Britain, than the facility of managing our firſt rates; which were formerly eſteemed incapable of government, unleſs in the moſt favourable weather of the ſummer. Ships of the ſecond rate, and thoſe of the third, which have three decks, carry their ſails remarkably well, and labour very little at ſea. They are excellent in a general action, or in cannonading a fortreſs. Thoſe of the third rate, which have two tiers, are fit for the line of battle, to lead the convoys and ſquadrons of ſhips of war in action, and in general to ſuit the different exigencies of the naval ſervice. The fourth-rates may be employed on the ſame occaſions as the third rates, and may be alſo deſtined amongſt the foreign colonies, or on expeditions of great diſtance; ſince theſe veſſels are uſually excellent for keeping and ſuſtaining the ſea. Veſſels of the fifth rate are too weak to ſuffer the ſhock of a line of battle; but they may be deſtined to lead the convoys of merchant ſhips, to protect the commerce in the colonies, to cruize in different ſtations, to accompany ſquadrons, or be ſent expreſs with neceſſary intelligence and orders. The ſame may be obſerved of the ſixth rates. The frigates, which mount from 28 to 38 guns upon one deck, with the quarter-deck, are extremely proper for cruizing againſt privateers, or for ſhort expeditions, being light, long, and uſually excellent ſailers.

RATEEN, or Ratten, in commerce, a thick woollen ſtuff, quilled, woven on a loom with four treddles, like ſerges and other ſtuffs that have the whale or quilling. There are ſome rateens dreſſed and prepared like cloths; others left ſimply in the hair, and others where the hair or knap is frized. Rateens are chiefly manufactured in France, Holland, and Italy, and are moſtly uſed in linings. The frize is a ſort of coarſe rateen, and the drugget is a rateen half linen half woollen.

RATIFICATION, an act approving of and confirming ſomething done by another in our name.

RATIO, in arithmetic and geometry, is that relation of homogeneous things which determines the quantity of one from the quantity of another, without the intervention of a third. Two numbers, lines, or quantities, A and B, being propoſed, their relation one to another may be conſidered under one of theſe two heads: 1. How much A exceeds B, or B exceeds A? And this is found by taking A from B, or B from A, and is called *arithmetic reaſon*, or *ratio*. 2. Or how many times, and parts of a time, A contains B, or B contains A? And this is called *geometric reaſon* or *ratio*; (or, as Euclid defines it, it is the *mutual habitude*, or *reſpect*, of two magnitudes of the ſame kind, according to quantity; that is, as to how often the one contains, or is contained in the other); and is found by dividing A by B, or B by A. And here note, that that quantity which is referred to another quantity is called the *antecedent of the ratio*: and that to which the other is referred is called the *conſequent of the ratio*; as, in the ratio of A to B, A is the antecedent, and B the conſequent. Therefore any quantity, as antecedent, divided by any quantity as a conſequent, gives the ratio of that antecedent to the conſequent.

Thus the ratio of A to B is $\frac{A}{B}$; but the ratio of B to A is $\frac{B}{A}$; and, in numbers, the ratio of 12 to four is $\frac{12}{4} = 3$, or triple; but the ratio of 4 to 12 is $\frac{4}{12} = \frac{1}{3}$, or ſubtriple.

And here note, that the quantities thus compared muſt be of the ſame kind; that is, ſuch as by multiplication may be made to exceed one the other, or as theſe quantities are ſaid to have a ratio between them, which, being multiplied, may be made to exceed one another. Thus a line, how ſhort ſoever, may be multiplied, that is, produced ſo long as to exceed any given right line; and conſequently theſe may be compared together, and the ratio expreſſed: but as the line can never, by any multiplication whatever, be made to have breadth, that is, to be made equal to a ſuperficies, how ſmall ſoever; theſe can therefore never be compared together, and conſequently have no ratio or reſpect one to another, according to quantity; that is, as to how often the one contains, or is contained in the other. See Quantity.

RATIOCINATION, the act of reaſoning. See Reasoning.

RATION, or Ratian, in the army, a portion of ammunition, bread, drink, and forage, diſtributed to each ſoldier in the army, for his daily ſubſiſtence, &c. The horſe have rations of hay and oats when they cannot go out to forage. The rations of bread are regulated by weight. The ordinary ration of a foot ſoldier is a pound and a half of bread per day. The officers have ſeveral rations according to their quality and the number of attendants they are obliged to keep. When the ration is augmented on occaſions of rejoicing, it is called a *double ration*. The ſhip's crews have alſo their rations or allowances of biſket, pulſe, and water, proportioned according to their ſtock.

RATIONALE, a ſolution or account of the principles of ſome opinion, action, hypotheſis, phenomenon, or the like.

RATIBOR, a town of Germany, in Sileſia, and capital of a duchy of the ſame name, with a caſtle. It has been twice taken by the Swedes, and is ſeated on the river Oder, in a country fertile in corn and fruits, 15 miles north-eaſt of Troppaw, and 142 eaſt of Prague. E. lon. 22. 24. N. lat. 50. 14.

RATISBON, an ancient and ſtrong city of Bavaria, ſeated on the Danube, over which is a bridge of 15 arches. It is free and imperial, and an epiſcopal ſee, whoſe biſhop is a prince of the empire. It is full of gentry, and there are very handſome ſtructures, particularly ſix monaſteries. The town-houſe is magnificent, and in its hall the general diets of the empire meet. The inhabitants, in general, are proteſtants, as all the magiſtrates muſt be. It is 55 miles ſouth-eaſt of Nuremburg, 62 north by eaſt of Munich, and 195 weſt by north of Vienna. E. lon. 12. 5. N. lat. 48. 58.

RATLINES, or, as the ſailors call them *ratlins*, thoſe lines which make the ladder ſteps to go up the ſhrouds and puttocks, hence called the *ratlins of the ſhrouds*.

RATOLFZEL, a ſtrong town of Germany, in Suabia, near the weſt end of the lake Conſtance. It is ſeated on that part of it called *Bodenſee*, and belongs to the houſe of Auſtria, who took it from the duke of Wirtemburg, after the battle of Nordlingen. It is 12 miles weſt of the city of Conſtance. It is defended by the impregnable caſtle of Hohen Dwell, on an inacceſſible hill in the middle of a plain, the rock of which is flint, ſo that a few men may hold it out againſt an army.

RATTLESNAKE. See Crotalus.

Rattlesnake-*Root*. See Polygala.

RATZEBURG, or Ratzemburg, an ancient town of Germany, in the circle of Lower Saxony, and in the duchy of Lawenburg, with a biſhop's ſee and a caſtle. The town depends on the duchy of Lawenburg, and the cathedral church on that of Ratzeburg. It is ſeated on an eminence, and almoſt ſurrounded with a lake 25 miles in length, and three in breadth. The duke of Lawenburg ſeized and fortified it in 1689, and the king of Denmark took it in 1693; but it was diſmantled, and reſtored in 1700 to the duke, who re-fortified it. This town has been frequently pillaged, particularly in 1552, by Francis duke of Saxe Lawenburg, becauſe the canons refuſed to elect his ſon Magnus their biſhop. It lies nine miles ſouth of Lubec. This place is noted for its excellent beer. E. lon. 10. 58. N. lat. 53. 47.

RAVA, a town of Great Poland and capital of a palatinate, of the ſame name, with a fortified caſtle, where they keep ſtate priſoners. The houſes are built of wood, and there is a Jeſuits' college. It is ſeated in a moraſs covered with water, which proceeds from the river Rava, with which it is ſurrounded. It is 45 miles ſouth of Bloſko, and 50 ſouth-weſt of Warſaw. The palatinate is bounded on the north by that of Bloſko, on the eaſt by that of Mazovia, on the ſouth by that of Sandomer, and on the weſt by that of Lencieza.

RAVELIN, in fortification, was anciently a flat baſtion placed in the middle of a curtain; but now a detached work compoſed only of two faces, which make a ſaliant angle without any flanks, and raiſed before the counterſcarp of the place. See Fortification.

RAVEN, in ornithology. See Corvus.

Sea Raven, or *corvo marino* of Kongo in Africa, in ichthyology, is about ſix feet long, and big in proportion; but the moſt ſingular circumſtance appertaining to this creature is the ſtone found in its head, to which the natives aſcribe ſome medicinal virtues, and the delicate taſte of its hard roe, which is ſtill much admired, when dried in the ſun, and becomes as hard as a ſtone.

RAVENGLAS, a town of Cumberland in England, ſituated between the rivers Irt, and Eſk, which, with the ſea encompaſs three parts of it. It is a well built place, and has a good road for ſhipping, which brings it ſome trade. E. lon. 0. 5. N. lat. 54. 20.

RAVENNA (anc. geog.), a noble city of Gallia Ciſpadana; a colony of Theſſalians, on the Adriatic, in waſhes or a boggy ſituation, which proved a natural ſecurity to it. The houſes were all of wood, the communication by bridges and boats, and the town kept ſweet and clean by the tides carrying away the mud and ſoil, (Strabo). Anciently it had a port at the mouth of the Bedeſis; Auguſtus added a new port, capacious to hold a fleet, for the ſecurity of the Adriatic, between which and the city lay the Via Cæſaris. In the lower age it was the ſeat of the Oſtrogoths for 72 years; but being recovered by Narſes, Juſtinian's general, it became the reſidence of the exarchs, magiſtrates ſent by the emperor from Conſtantinople, for 175 years, when it was taken by the Longobards. It is ſtill called *Ravenna*, capital of Romania. The ſeat of the weſtern or Roman empire was by Honorius tranſlated to Ravenna about the year 404, and hence the country in which it ſtood was called *Romania*, in the pope's territory. It had a very flouriſhing trade till the ſea withdrew two miles from it, which has been a great detriment. The fortifications are of little importance, and the citadel is gone to ruin. It is now moſt remarkable for the excellent wine produced in its neighbourhood. The mauſoleum of Theodoric is ſtill to be ſeen, remarkable for being covered by a ſingle ſtone 28 feet in diameter and 15 thick. It was at Ravenna that the duke of Nemours fell, after having gained a moſt deciſive victory over the confederate army, in 1511.

RAVENSBURG, a county of Germany in Weſtphalia, bounded on the north by the biſhoprics of Oſnaburg and Minden, on the eaſt by Lemgow, on the ſouth by the biſhopric of Paderborn, and on the weſt by that of Munſter. It belongs to the king of Pruſſia, and has its name from the caſtle of Ravenſburg.

Ravensburg, a free and imperial town of Germany, in Algow, in the circle of Suabia. It is well built, and the public ſtructures are handſome. The inhabitants are partly Proteſtants and partly Papiſts. It is ſeated on the river Chenſs, in E. lon. 9. 46. N. lat. 47. 44.

RAVET, an inſect ſhaped like a may-bug, or cock-chaffel, (ſee Scarabæus), with which the iſland of Guadaloupe is much peſtered. It has a ſtinking ſmell, preys upon paper, books, and furniture, and whatever they do not gnaw is diſcoloured by their ordure. Theſe naſty inſects, which are very numerous, and appear chiefly by night, would be intolerable, were it not for a large ſpider, ſome of them as long as a man's fiſt, which intangles them in its web, and otherwiſe ſurpriſes them. On which account the inhabitants of the iſland are very careful of theſe ſpiders.

RAVILLIAC (Francis), the infamous aſſaſſin of Henry IV. of France, was a native of Angouleſme, and at the time of his execution was about one or two and thirty-years of age. Ravilliac was the ſon of parents who lived upon alms. His father was that ſort of inferior retainer to the law, to which the vulgar give the name of a *pettifogger*, and his ſon had been bred up in the ſame way. Ravilliac had ſet up a claim to an eſtate, but the cauſe went againſt him: this diſappointment affected his mind deeply: he afterwards taught a ſchool, and, as himſelf ſaid, received charitable gifts, though but of a very ſmall value, from the parents of thoſe whom he taught; and yet his diſtreſs was ſo great that he had much ado to live. When he was ſeized for the king's murder, he was very looſely guarded; all were permitted to ſpeak with him who pleaſed; and it was thought very remarkable that a Jeſuit ſhould ſay to him, "Friend, take care, whatever you do, that you don't charge honeſt people." He was removed next day from the houſe of Eſpernon to the Conciergerie, the proper priſon of the parliament of Paris. When he was firſt interrogated, he anſwered with great boldneſs, "That he had done it, and would do it, if it were to do again." When he was told that the king though dangerouſly wounded was living and might recover, he ſaid that he had ſtruck him home, and that he was ſure he was dead. In his ſubſequent examinations he owned that he had long had an intention to kill the king, becauſe he ſuffered two religions in his kingdom; and that he endeavoured to obtain an audience of him, that he might admoniſh him. He alſo ſaid that he underſtood the king's great armament to be againſt the Pope, and that, in his opinion, to make war againſt the Pope, was to make war againſt God. We have no diſtinct account of the three laſt examinations; but he is ſaid to have perſiſted, in the moſt ſolemn aſſeverations, that he had no accomplices, and that nobody had perſuaded him to the fact. He appeared ſurpriſed at nothing ſo much as at the univerſal abhorrence of the people, which, it ſeems, he did not expect. They were forced to guard him ſtrictly from his fellow-priſoners, who would otherwiſe have murdered him. The butchers of Paris deſired to have him put into their hands, affirming that they would flay him alive, and that he ſhould ſtill live 12 days. When he was put to the torture, he broke out into horrid execrations, and always inſiſted that he did the fact from his own motive, and that he could accuſe nobody. On the day of his execution, after he had made the *amende honourable* before the church of Notre Dame, he was carried to the Greve; and, being brought upon a ſcaffold, was tied to a wooden engine in the ſhape of a St. Andrew's croſs. The knife with which he did the murder being faſtened in his right hand. it was firſt burnt in a ſlow fire; then the fleſhy parts of his body were torn with red-hot pincers, and melted lead, oil, pitch, and roſin, poured into the wounds, and through a clay funnel into his bowels by the navel. The people refuſed to pray for him; and when, according to the ſentence pronounced upon him, he came to be dragged to pieces by four horſes, one of thoſe that were brought appearing to be but weak, one of the ſpectators offered his own, with which the criminal was much moved: he is ſaid to have then made a confeſſion, which was ſo written by the greffier Voiſin, that not ſo much as one word of it could ever be read. He was very earneſt for abſolution, which his confeſſor refuſed, unleſs he would reveal his accomplices; "Give it me conditionally (ſaid he); upon condition that I have told the truth," which they did. His body was ſo robuſt, that it reſiſted the force of the horſes; and the executioner was at length obliged to cut him into quarters, which the people dragged through the ſtreets. The houſe in which he was born was demoliſhed, and a column of infamy erected; his father and mother were baniſhed from Angouleſme, and ordered to quit the kingdom upon pain of being hanged if they returned without any form of proceſs; his brothers, ſiſters, uncles, and other relations, were commanded to lay aſide the name of Ravilliac, and to aſſume ſome other. Such was the fate of this execrable monſter, who according to his own account, ſuffered himſelf to be impelled to ſuch a fact by the ſeditious ſermons and books of the Jeſuits, whom Henry, rather out of fear than love, had recalled and careſſed, and to whom he had bequeathed his heart.

Neither the dying words of Ravilliac, nor ſo much of his proceſs as was publiſhed, were credited by his cotemporaries. Regalt the hiſtorian ſays that there were two different opinions concerning this aſſaſſination; one, that it was conducted by ſome grandees, who ſacrificed that monarch to their old reſentments; the other, that it was done by the emiſſaries of the Spaniards. Letters from Bruſſels, Antwerp, Mechlin, and other places, were received before the 15th of May, with a report of the king's death. Though nothing occurs in the examinations of Ravilliac that were firſt publiſhed, in reference to his journeys to Naples and other places; yet as theſe are ſet down as certain truths by good authors, ſo there are probable grounds to believe that they were not fictitious. It appears from Sir Ralph Winwood's Memorials, that Ravilliac had been not long before at Bruſſels. Amongſt other circumſtances that created a very great doubt whether the aſſaſſin ſpoke truth, were the things found in his pocket at the time he was ſeized; amongſt which was a chaplet, the figure of a heart made in cotton, in the centre of which he ſaid there was a bit of the true croſs, but when cut there was none, which he affirmed was given him by a canon at Angouleſme, a piece of paper with the arms of France painted upon it, another full of characters, and a third containing verſes for the meditation of a criminal going to execution. The provoſt of Pluviers, or Petiviers, in Beauce, about ſix miles from Paris, had ſaid openly on the day that Henry IV. was murdered, "This day the king is either ſlain or dangerouſly wounded." After the king's death was known, he was ſeized, and ſent priſoner to Paris; but, before he was examined, he was found hanged in the ſtrings of his drawers. His body was, notwithſtanding, hung up by the heels on the common gibbet on the 19th of June. What increaſed the ſuſpicions grounded on this man's end, was his having two ſons Jeſuits, and his being a dependant on the family of Monſieur d'Entragues.

RAUN, upon the river Miza, a town of ſome ſtrength, remarkable for a bloody ſkirmiſh between the Pruſſians and Auſtrians in Auguſt 1744. The king of Pruſſia, intending to get poſſeſſion of Beraun, ſent thither ſix battalions, with eight cannon, and 800 huſſars; but General Feſtititz being there with a great party of his corps, and M. Lucheſi with 1000 horſe, they not only repulſed the Pruſſians, but attacked them in their turn, and, after a warm diſpute, obliged them to retire with conſiderable loſs.

RAURICUM (anc. geog), a town of the Raurici, ſituated over againſt Abnoba, a mountain from which the Danube takes its riſe. A Roman colony led by L. Manutius Plancus the ſcholar and friend of Cicero; called *Colonia Rauriaca* (Pliny), *Raurica* (Inſcription), *Auguſta Rauricorum*. The town was deſtroyed in Julian's time. It is now commonly called *Augſt*, a village greatly decayed from what it formerly was. It is ſituated on the Rhine, diſtant about two hours to the eaſt of Baſil. The country is now the canton of Baſil.

RAY (JOHN), a celebrated botaniſt, was the ſon of Mr. Roger Ray a blackſmith, and was born at Black Notly in Eſſex in 1628. He received the firſt rudiments of learning at the grammar-ſchool at Braintree; and in 1644 was admitted into Catharine-hall in Cambridge, from whence he afterwards removed to Trinity-college in that univerſity. He took the degree of maſter of arts, and became at length a ſenior fellow of the college; but his intenſe application to his ſtudies having injured his health, he was obliged at his leiſure hours to exerciſe himſelf by riding or walking in the fields, which led him to the ſtudy of plants. He noted from Johnſon, Parkinſon, and the *Phytologia Britannica*, the places where curious plants grew; and in 1658 rode from Cambridge to the city of Cheſter, from whence he went into North Wales, viſiting many places, and among others the famous hill of Snowdon; returning by Shrewſbury and Glouceſter. In 1660 he publiſhed his *Catalogus Plantarum circa Cantabrigiam naſcentium*, and the ſame year was ordained deacon and prieſt. In 1661 he accompanied Francis Willonghby, Eſq. and others in ſearch of plants and other natural curioſities, in the north of England and Scotland; and the next year made a weſtern tour from Cheſter, and through Wales, to Cornwall, Devonſhire, Dorſetſhire, Hampſhire, Wiltſhire, and other counties. He afterwards travelled with Mr. Willoughby and other gentlemen through Holland, Germany, Italy, France, &c. took ſeveral tours in England, and was admitted fellow of the Royal Society. In 1672, his intimate and beloved friend Mr. Willoughby died, in the 37th year of his age, at Middleton Hall, his ſeat in Yorkſhire; "to the infinite and unſpeakable loſs and grief (ſays Mr. Ray) of myſelf, his friends, and all good men." There having been the cloſeſt and ſincereſt friendſhip between Mr. Willoughhy and Mr. Ray, who were men of ſimilar natures and taſtes, from the time of their being fellow collegians, Mr. Willoughby not only confided in Mr. Ray in his life-time, but alſo at his death: for he made him one of the executors of his will, and charged him with the education of his ſons Francis and Thomas, leaving him alſo for life 60l. per annum. The eldeſt of theſe young gentlemen not being four years of age, Mr. Ray, as a faithful truſtee, betook himſelf to the inſtruction of them; and for their uſe compoſed his *Nomenclator Claſſicus*, which was publiſhed this very year, 1672. Francis, the eldeſt, dying before he was of age, the younger became Lord Middleton. Not many months after the death of Mr. Willoughby, Mr. Ray loſt another of his beſt friends, biſhop Wilkins; whom he viſited in London the 18th of November 1672, and found near expiring by a total ſuppreſſion of urine for eight days. As it is natural for the mind, when it is hurt in one part, to ſeek relief from another; ſo Mr. Ray, having loſt ſome of his beſt friends, and being in a manner left deſtitute, conceived thoughts of marriage; and accordingly, in June 1673, did actually marry a gentlewoman of about 20 years of age, the daughter of Mr. Oakley of Launton in Oxfordſhire. Towards the end of this year came forth his "Obſervations Topographical, Moral, &c." made in foreign countries; to which was added his *Catalogus Stirpium in exteris regionibus obſervatarum*: and about the ſame time his *Collection of unuſual or local Engliſh words*, which he had gathered up in his travels through the counties of England. After having publiſhed many books on ſubjects foreign to his profeſſion, he at length reſolved to publiſh in the character of a divine as well as in that of a natural philoſopher: in which view he publiſhed his excellent demonſtration of the being and attributes of God, entitled *The Wiſdom of God manifeſted in the Works of the Creation*, 8vo, 1697. The rudiments of this work were read in ſome college lectures; and another collection of the ſame kind he enlarged and publiſhed under the title of *Three Phyſico-theological Diſcourſes, concerning the Chaos, Deluge, and Diſſolution of the World*, 8vo, 1692. He died in 1705, He was modeſt, affable, and communicative; and was diſtinguiſhed by his probity, charity, ſobriety, and piety. He wrote a great number of works; the principal of which, beſides thoſe already mentioned, are, 1. *Catalogus Plantarum Angliæ*. 2. *Dictionariolum Trilingue ſecundum locos communes*. 3. *Hiſtoria Plantarum, Species, hactenus editas, aliaſque inſuper multas noviter inventas et deſcriptas complectens*, 3 vols. 4. *Methodus Plantarum nova, cum Tabulis*, 8vo, and ſeveral other works on plants. 5. *Synopſis Methodica Animalium quadrupedum et Serpentini generis*, 8vo. 6. *Synopſis Methodica Avium et Piſcium*. 7. *Hiſtoria Inſectorum, opus poſthumum*. 8. *Methodus Inſectarum*. 9. Philoſophical Letters, &c.

RAY, in optics, a beam of light emitted from a radiant or luminous body. See LIGHT and OPTICS.

Inflected RAYS, thoſe rays of light which, on their near approach to the edges of bodies, in paſſing by them, are bent out of their courſe, being turned either from the body or towards it. This property of the rays of light is generally termed *diffraction* by foreigners, and Dr. Hooke ſometimes called it *deflection*.

Reflected RAYS, thoſe rays of light which, after falling upon the body, do not go beyond the ſurface of it, but are thrown back again.

Refracted RAYS, thoſe rays of light which, after falling upon any medium, enter its ſurface, being bent either towards or from a perpendicular to the point on which they fell.

Pencil of RAYS, a number of rays iſſuing from a point of an object, and diverging in the form of a cone.

RAZOR, a well known inſtrument for ſhaving off the hair. As ſhaving to many people is a moſt painful operation, cutlers in different countries have long applied their ſkill to remove that inconvenience. Some have invented ſoaps of a peculiar kind to make the operation more eaſy, and ſome have invented ſtraps. With reſpect to razors, ſome have ſucceeded rather by accident than from any fixed principle; and therefore we have found great inequality in the goodneſs of razors made by the ſame artiſt.

RE, in grammar, an inſeparable particle added to the beginning of words to double or otherwiſe modify their meaning; as in re-action, re-move, re-export, &c.

RE-ACTION, in phyſiology, the reſiſtance made by all bodies to the action or impulſe of others that endeavour to change its ſtate whether of motion or reſt, &c.

READING, the art of delivering written language with propriety, force, and elegance.

" We muſt not judge ſo unfavourably of eloquence or good reading (ſays the illuſtrious Fenelon), as to reckon it only a frivolous art, that a declaimer uſes to impoſe upon the weak imagination of the multitude, and to ſerve his own ends. It is a very ſerious art, deſigned to inſtruct people; to ſuppreſs their paſſions, and reform their manners; to ſupport the laws, direct public councils, and to make men good and happy."

Reaſon and experience demonſtrate, that *delivery in reading ought to be leſs animated than in intereſted ſpeaking*. In every exerciſe of the faculty of ſpeech, and thoſe expreſſions of countenance and geſture, with which it is generally attended, we may be conſidered to be always in one of the two following ſituations: Firſt, delivering our *boſom ſentiments* on circumſtances which relate to ourſelves or others, or, ſecondly, *repeating* ſomething that was ſpoken on a certain occaſion for the amuſement or information of an auditor. Now if we obſerve the deliveries natural to theſe two ſituations, we ſhall find that the firſt may be accompanied with every degree of expreſſion which can manifeſt itſelf in us, from the loweſt of ſympathy to the moſt violent and energetic of the ſuperior paſſions; while the latter, from the ſpeaker's chief buſineſs being to repeat what he heard *with accuracy*, diſcovers only a faint imitation of thoſe ſigns of the emotions which we ſuppoſe agitated him from whom the words were firſt borrowed.— The uſe and neceſſity of this difference of manner is evident; and if we are attentive to theſe natural ſigns of expreſſion, we ſhall find them conforming with the greateſt nicety to the ſlighteſt and moſt minute movements of the breaſt.

This repetition of another's words might be ſuppoſed to paſs through the mouth of a ſecond or third perſon; and in theſe caſes, ſince they were not ear and eye witneſſes of him who firſt ſpoke them, their manner of delivery would want the advantage neceſſarily ariſing from an immediate idea of the original one; hence, on this account, this would be a ſtill leſs lively repreſentation than that of the firſt *repeater*. But as, from a daily obſervation of every variety of ſpeech and its aſſociated ſigns of emotion, mankind ſoon become pretty well acquainted with them, and this in different degrees, according to their diſcernment, ſenſibility, &c. experience ſhows us that theſe latter *repeaters* (as we call them) might conceive and uſe a manner of delivery which, though leſs *characteriſtic* perhaps, would on the whole be no way inferior to the firſt, as to the *common* natural expreſſion proper for their ſituation. It appears, therefore, that repeaters *of every degree* may be eſteemed upon a level as to animation, and that our twofold diſtinction above contains accurately enough the whole variety of ordinary delivery;—we ſay *ordinary*, becauſe

There is another very peculiar kind of delivery ſometimes uſed in the perſon of a *repeater*, of which it will in this place be neceſſary to take ſome notice. What we mean here is *mimicry*; an accompliſhment which, when perfectly and properly diſplayed, never fails of yielding a high degree of pleaſure. But ſince this pleaſure chiefly reſults from the principle of *imitation* reſpecting *manner*, and not from the purport of the *matter* communicated; ſince, comparatively ſpeaking, it is only attainable by few perſons, and practiſed only on particular occaſions;—on theſe accounts it muſt be refuſed a place among the modes of uſeful delivery taught us by *general* nature, and eſteemed a qualification purely anomalous.

Theſe diſtinctions with regard to a ſpeaker's ſituation of mind premiſed, let us ſee to which of them an *author* and his *reader* may moſt properly be referred, and how they are circumſtanced with regard to one another.

The matter of all books is, either what the author ſays in his *own* perſon, or an acknowledged recital of the words of *others*: hence an author may be eſteemed both an *original* ſpeaker and a *repeater*, according as what he writes is of the firſt or ſecond kind. Now a reader muſt be ſuppoſed either actually to perſonate the author, or one whoſe office is barely to communicate what he has ſaid to an auditor. But in the firſt of theſe ſuppoſitions he would, in the delivery of what is the author's own, evidently commence *mimic*; which being, as above obſerved, a character not acknowledged by general nature in this department, ought to be rejected as generally improper. The other ſuppoſition therefore muſt be accounted right; and then, as to the *whole* matter of the book, the reader is found to be exactly in the ſituation of a *repeater*, ſave that he takes what he delivers from the page before him inſtead of his memory. It follows then, in proof of our initial propoſition, that if we are directed by nature and propriety, the manner of our delivery in reading ought to be inferior in warmth and energy to what we ſhould uſe, were the language before us the ſpontaneous effuſions of our own hearts in the circumſtances of thoſe out of whoſe mouths it is ſuppoſed to proceed.

Evident as the purport of this reaſoning is, it has not ſo much as been glanced at by the writers on the ſubject we have now entered upon, or any of its kindred ones; which has occaſioned a manifeſt want of accuracy in ſeveral of their rules and obſervations. Among the reſt, this precept has been long reverberated from author to author as a perfect ſtandard for propriety in reading—" Deliver yourſelves in the ſame manner you would do, were the matter your own original ſentiments uttered directly from the heart." As all kinds of delivery muſt have many things in common, the rule will in many articles be undoubtedly right; but, from what has been ſaid above, it muſt be as certainly faulty in reſpect to ſeveral others; as it is certain nature never confounds by like ſigns two things ſo very different, as a *copy* and an *original*, an emanation darted immediately from the ſun, and its weaker appearance in the lunar reflection.

The precepts we have to offer for improving the abovementioned rule, ſhall be delivered under the heads of *accent*, *emphaſis*, *modulation*, *expreſſion*, *pauſes*, &c.

I. *Accent.* In attending to the affections of the voice when we ſpeak, it is eaſy to obſerve, that, independent of any other conſideration, one part of it differs from another, in *ſtreſs*, *energy*, or *force* of utterance. In words we find one ſyllable differing from another with reſpect to this mode; and in ſentences one or more words as frequently vary from the reſt in a ſimilar manner. This ſtreſs with regard to *ſyllables* is called *accent*, and contributes greatly to the variety and harmony of language. Reſpecting *words*, it is termed *emphaſis;* and its chief office is to aſſiſt the ſenſe, force, or perſpicuity of the ſentence—of which more under the next head.

" Accent (as deſcribed in the Lectures on Elocution) is made by us two ways; either by dwelling longer upon one ſyllable than the reſt, or by giving it a ſmarter percuſſion of the voice in utterance. Of the firſt of theſe we have inſtances in the words *glōry*, *fāther*, *hōly;* of the laſt in *bat'tle*, *hab'it*, *bor'row.* So that accent with us is not referred to tune, but to time; to quantity, not quality; to the more equable or precipitate motion of the voice, not to the variation of the notes or inflections."

In *theatric declamation*, in order to give it more pomp and ſolemnity, it is uſual to dwell longer than common upon the unaccented ſyllables; and the author now quoted has endeavoured to prove (p. 51. 54.) the practice faulty, and to ſhow (p. 55.) that " though it (i. e. true ſolemnity) may demand a ſlower utterance than uſual, yet (it) requires that the ſame proportion in point of quantity be obſerved in the ſyllables, as there is in muſical notes when the ſame tune is played in quicker or ſlower time." But that this deviation from ordinary ſpeech is not a fault, as our author aſſerts; nay, that on the contrary it is a real beauty when kept under proper regulation, the following obſervations it is hoped will ſufficiently prove.

(I.) It is a truth of the moſt obvious nature, that thoſe things which on their application to their proper ſenſes have a power of raiſing in us certain ideas and emotions, are ever *differently* modified in their conſtituent parts when different effects are produced in the mind: and alſo (II.) that, within proper bounds, were we to ſuppoſe theſe conſtituent parts to be proportionally increaſed or diminiſhed as to *quantity*, this effect would ſtill be the ſame as to *quality*.—For inſtance: The different ideas of ſtrength, ſwiftneſs, &c. which are raiſed in us by the ſame ſpecies of animals, is owing to the different form of their correſponding parts; the different effects of muſic on the paſſions, to the different airs and movements of the melody; and the different expreſſions of human ſpeech, to a difference in tone, ſpeed, &c. of the voice. And theſe peculiar effects would ſtill remain the ſame, were we to ſuppoſe the animals above alluded to, to be *greater* or *leſſer*, within their proper bounds; the movement of the muſic *quicker* or *ſlower*, provided it did not palpably interfere with that of ſome other ſpecies; and the pitch of the voice *higher* or *lower*, if not carried out of the limits in which it is obſerved on ſimilar occaſions naturally to move. Further (III.) ſince, reſpecting the emotions more eſpecially, there are no rules to determine *à priori* what effect any particular attribute or modification of an object will have upon a percipient, our knowledge of this kind muſt evidently be gained from experience. Laſtly, (IV.) In every art imitating nature we are pleaſed to ſee the characteriſtic members of the pattern *heightened* a little further than perhaps it ever was carried in any real example, provided it be not bordering upon ſome ludicrous and diſagreeable provinces of exceſs.

Now for the application of theſe premiſſes.—To keep pace and be conſiſtent with the *dignity* of the tragic muſe, the delivery of her language ſhould neceſſarily be dignified; and this it is plain from obſervation (I.) cannot be accompliſhed otherwiſe than by ſomething different in the manner of it from that of ordinary ſpeech; ſince *dignity* is eſſentially different from *familiarity*. But how muſt we diſcover this different manner? By attending to nature: and in this caſe ſhe tells us that, beſides uſing a *ſlower* delivery, and greater *diſtinctneſs* of the words (which every thing merely *grave* requires, and gravity is a *concomitant* of dignity, though not its *eſſence*), we muſt dwell a little *longer* upon the *unaccented* ſyllables than we do in common. As to what our author obſerves in the above quotation, of *dignity's* only requiring a *ſlower* utterance than ordinary, while the proportion of the ſyllables as to quantity continues the ſame; it is apprehended the remark (II.) reſpecting *quickneſs* and *ſlowneſs* of movement, will ſhow it to be not altogether true. For ſince the delivery is not altered in *form*, its expreſſion muſt be ſtill of the ſame kind, and perhaps what may be rightly ſuggeſted by the term *gravely familiar.*

But ſomething further may be yet ſaid in defence of this *artificial* delivery, as our author calls it. Is not the movement of any thing, of whatever ſpecies, when dignified or ſolemn, in general of an *equable* and *deliberate* nature (as in the minuet, the military ſtep, &c.)? And in theatrical declamation, is not the propenſity to introduce this *equableneſs* ſo ſtrong, that it is almoſt *impoſſible* to avoid it wholly, were we ever ſo determined to do it? If theſe two queries be anſwered in the affirmative (as we are perſuaded they will), while the firſt ſupports our argument for the *propriety* of the manner of delivery in queſtion, the ſecond diſcovers a kind of *neceſſity* for it. And that this manner may be carried a little *further* in quantity on the *ſtage* than is uſual in *real life*, the principle (IV.) of heightening nature will juſtify, provided faſhion (which has ever ſomething to do in theſe articles) give it a ſanction; for the *preciſe* quantity of ſeveral heightenings may be varied by this great legiſlator almoſt at will.

II. *Emphaſis.* As *emphaſis* is not a thing annexed to particular words, as *accent* is to ſyllables, but owes its riſe chiefly to the *meaning* of a paſſage, and muſt therefore vary its ſeat according as that meaning varies, it will be neceſſary to explain a little further the general idea given of it above.

> Of man's firſt diſobedience, and the fruit
> Of that forbidden tree, whoſe mortal taſte
> Brought death into the world, and all our woe, &c.
> Sing heav'nly muſe, &c.

Suppoſing, in reference to the above well-known lines, that originally other beings, beſides men, had diſobeyed the commands of the Almighty, and that the circumſtance were well known to us, there would fall an *emphaſis* upon the word *man's* in the firſt line, and hence it would be read thus;

Of *man's* firſt diſobedience, and the fruit, &c.

But if it were a notorious truth, that mankind had tranſgreſſed in a peculiar manner more than once, the *emphaſis* would fall on *firſt*, and the line be read,

Of man's *firſt* diſobedience, &c.

Again, admittting death (as was really the caſe) to have been an unheard-of and dreadful puniſhment brought upon man in conſequence of his tranſgreſſion; on that ſuppoſition the third line would be read,

Brought *death* into the world, &c.

But if we were to ſuppoſe mankind knew there was ſuch an evil as death in other regions, though the place they inhabited had been free from it till their tranſgreſſion; the line would run thus,

Brought death into the *world*, &c.

Now from a proper delivery of the above lines, with regard to any one of the ſuppoſitions we have choſen, out of ſeveral others that might in the ſame manner have been imagined, it will appear that the *emphaſis* they illuſtrate is effected by a manifeſt *delay* in the pronunciation, and a tone ſomething *fuller* and *louder* than is uſed in ordinary; and that its office is ſolely to determine the meaning of a ſentence with reference to ſomething ſaid before, preſuppoſed by the author as general knowledge, or in order to remove an ambiguity where a paſſage is capable of having more ſenſes given it than one.

But, ſuppoſing in the above example, that none of the ſenſes there pointed out were preciſely the true one, and that the meaning of the lines were no other than what is obviouſly ſuggeſted by their ſimple conſtruction; in that caſe it may be aſked, if in reading them there ſhould be no word dignified with the emphatical accompanyments above deſcribed?—The anſwer is, Not one with an emphaſis of the *ſame* kind as that we have juſt been illuſtrating; yet it is nevertheleſs true, that on hearing theſe lines well read, we ſhall find ſome words diſtinguiſhed from the reſt by a manner of delivery bordering a little upon it (*). And theſe words will in general be ſuch as ſeem the moſt important in the ſentence, or on other accounts to merit this diſtinction. But as at beſt it only *enforces*, *graces*, or *enlivens*, and not *fixes* the meaning of any paſſage, and even caprice and faſhion (†) have often a hand in determining its place and magnitude, it cannot properly be reckoned as *eſſential* of delivery. However, it is of too much moment to be neglected by thoſe who would wiſh to be good readers: and, for the ſake of diſtinction, we may not unaptly denominate both the kinds of energies in queſtion, by the terms *emphaſis of ſenſe*, and *emphaſis of force* (‡).

Now from the above account of theſe two ſpecies of emphaſis it will appear, "that in reading, as in ſpeaking, the firſt of them muſt be determined entirely by the ſenſe of the paſſage, and always made *alike*: But as to the other, *taſte* alone ſeems to have a right of fixing its ſituation and quantity."—Further: Since the more eſſential of theſe two energies is ſolely the work of *nature* (as appears by its being *conſtantly* found in the common converſation of people of all kinds of capacities and degrees of knowledge), and the moſt ignorant perſon never fails of uſing it *rightly* in the effuſions of his own heart, it happens very luckily, and ought always to be remembered, that provided we underſtand what we read, and give way to the dictates of our own feeling, the *emphaſis of ſenſe* can ſcarce ever avoid falling ſpontaneouſly upon its proper place.

Here it will be neceſſary to ſay ſomething by way of reply to a queſtion which will naturally occur to the mind of every one. As the rule for the *emphaſis* of *ſenſe* requires we ſhould underſtand what we read before it can be properly uſed, it is incumbent upon us never to attempt to read what we have not previouſly ſtudied for that purpoſe? In anſwer to this, it muſt be obſerved, that though ſuch a ſtep will not be without its advantages; yet, as, from the fairneſs of printed types, the well known pauſes of punctuation, and a long acquaintance with the phraſeology and conſtruction of our language, &c. experience tells us it is *poſſible* to comprehend the ſenſe at the firſt reading, a previous peruſal of what is to be read does not ſeem *neceſſary* to *all*, though, if they would wiſh to appear to advantage, it may be *expedient* to *many*; and it is this circumſtance which makes us venture upon extemporary reading, and give it a place among our amuſements.—Similar remarks might be made with regard to *modulation*, *expreſſion*, &c. did not what is here obſerved naturally anticipate them.

III. *Modulation* (§). Every perſon muſt have obſerved,

(*) The following lines will illuſtrate both theſe kinds of ſtreſſes: For, to convey their right meaning, the word ANY is evidently to be pronounced louder and fuller than thoſe with the accents over them.

Get wéalth and pláce, if poſſible with gráce:
If not, by ANY means get wéalth and pláce. POPE.

This couplet is accented in the manner we find it in the *Eſſay on Elocution* by *Maſon*. And if, according to the judgment of this author, the words thus diſtinguiſhed are to have an emphatical ſtreſs, it muſt be of the inferior kind above-mentioned, and which a little further on we call *emphaſis of force*; while the word ANY in a different type alone poſſeſſes the other ſort of energy, and which is there contradiſtinguiſhed by the term *emphaſis of ſenſe*.

(†) Among a number of people who have had proper opportunities of learning to read in the beſt manner it is now taught, it would be difficult to find two, who in a given inſtance, would uſe the *emphaſis of force* alike, either as to place or quantity. Nay ſome ſcarce uſe any at all: and others will not ſcruple to carry it *much* beyond any thing we have a precedent for in common diſcourſe; and even now and then throw it upon words ſo very trifling in themſelves, that it is evident they do it with no other view, than for the ſake of the *variety* it gives to the modulation.—This practice, like the introduction of diſcords into muſic, may without doubt be indulged now and then; but were it too frequent, the capital intent of theſe energies would manifeſtly either be deſtroyed or rendered dubious.

(‡) The firſt of theſe terms anſwers to the *ſimple emphaſis* deſcribed in the *Lectures on Elocution*, and the ſecond *nearly* to what is there called *complex*. The difference lies in this. Under *complex emphaſis* the author ſeems (for he is far from being clear in this article) to include the *tones* ſimply conſidered of all the emotions of the mind: as well the *tender* and *languid*, as the *forcible* and *exulting*. Our term is intended to be confined to ſuch modes of expreſſion alone as are marked with an apparent *ſtreſs* or *increaſe* of the voice.

(§) The author of the *Introduction to the Art of Reading*, not allowing that there is any variation of tone, as to *high* and *low*, in the delivery of a complete period or ſentence, places modulation ſolely in the diverſification of the key-note and the variety of ſyllables, as to *long* or *ſhort*, *ſwift* or *ſlow*, *ſtrong* or *weak*, and *loud* or *ſoft*. As we are of a different opinion;

that, in ſpeaking, the voice is ſubject to an alteration of ſound, which in ſome meaſure reſembles the movement of a tune. Theſe ſounds, however, are evidently nothing like ſo much varied as thoſe that are ſtrictly muſical; and we have attempted to ſhow in the preceding chapter, that, beſides this, they have an eſſential difference in themſelves. Nevertheleſs, from the general ſimilitude of theſe two articles, they poſſeſs ſeveral terms in common: and the particular we have now to examine is in both of them called *modulation*. This affection of the voice, being totally *arbitrary*, is differently characterized in different parts of the world: and, through the power of cuſtom, every place is inclined to think their own the only one natural and agreeable. and the reſt affected with ſome barbarous twang or ungainly variation (*). It may be obſerved, however, that though there is a general uniform caſt or faſhion of modulation peculiar to every country, yet it by no means follows, that there is or can be any thing fixed in its application to particular paſſages; and therefore we find different people will, in any given inſtance, uſe modulations ſomething different, and nevertheleſs be each of them equally agreeable.

But, quitting theſe general remarks, we ſhall (as our purpoſe requires it) conſider the properties of modulation a little more minutely.

Firſt, then, we may obſerve, that, in ſpeaking, there is a particular ſound (or *key-note*, as it is often called) in which the modulation for the moſt part runs, and to which its occaſional inflexions, either above or below, may in ſome reſpects be conceived to have a reference, like that which common muſic has to its key-note. Yet there is this difference between the two kinds of modulation, that whereas the firſt always concludes in the key-note, the other frequently concludes a little below it (†). This key-note, in ſpeaking, is generally the ſound given at the outſet of every complete ſentence or period; and it may be obſerved on ſome occaſions to vary its pitch through the limits of a muſical interval of a conſiderable magnitude. The tones, that fall a little lower than the key at the cloſe of a ſentence or period, are called *cadences*. Theſe cadences, if we are accurate in our diſtinctions, will, with reſpect to their offices, be found of two kinds; though they meet ſo frequently together, that it may be beſt to conceive them only as anſwering a double purpoſe. One of theſe offices is to aſſiſt the ſenſe, and the other to decorate the modulation. An account of the firſt may be ſeen in the ſection on *Pauſes;* and the latter will be found to ſhow itſelf pretty frequently in every thing grave and plaintive, or in poetic deſcription and other highly ornamented language, where the mind is by its influence brought to feel a placid kind of dignity and ſatisfaction. Theſe two cadences, therefore, may be conveniently diſtinguiſhed by applying to them reſpectively the epithets *ſignificant* and *ornamental*.

We have already obſerved that reading ſhould in ſome things differ from ſpeaking; and the particular under conſideration ſeems to be one which ought to vary a little in theſe arts. For,

Modulation in reading ſerves a twofold purpoſe. At the ſame time that it gives pleaſure to the ear on the principles of harmony, it contributes through that medium to preſerve the attention. And ſince written language (when not purely dramatical) is in general more elegant in its conſtruction, and muſical in its periods, than the oral one; and ſince many intereſting particulars are wanting in reading which are preſent in ſpeaking, that contribute greatly to fix the regard of the hearer; it ſeems reaſonable, in order to do juſtice to the language, and in part to ſupply the incitements of attention juſt alluded to, that in the former of theſe two articles a modulation ſhould be uſed ſomething more harmonious and artificial than in the latter. Agreeably to this reaſoning, it is believed, we ſhall find every reader, on a narrow examination, adopt more or leſs a modulation thus ornamented: though, after all, it muſt be acknowledged there are better grounds to believe, that the practice has been hitherto directed intuitively by nature, than that it was diſcovered by the inductions of reaſon. We ſhall conclude this head with a rule for modulation in reading. "In every thing dramatic, colloquial, or of ſimple narrative, let your modulation be the ſame as in ſpeaking; but when the ſubject is flowery, ſolemn, or dignified, add ſomething to its harmony, diverſify the key-note, and increaſe the frequency of cadences in proportion to the merit of the compoſition."

It will readily be ſeen, that the precepts here drawn from a compariſon between ſpeaking and reading, would be very inadequate, were they left deſtitute of the aſſiſtance of *taſte*, and the opportunity of *frequently hearing and imitating maſterly readers*. And, indeed, to theſe two great auxiliaries we might very properly have referred the whole matter at once, as capable of giving ſufficient directions, had we not remembered that our plan required us to found ſeveral of our rules as much on the principles of a philoſophical analyſis, as on thoſe more familiar ones which will be found of greater efficacy in real practice.

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our idea of modulation is confined purely to *harmonious inflexions of voice*. Theſe qualities of words, it is true, add greatly both to the force and beauty of delivery; yet, ſince ſome of them are fixed and not arbitrary (as *long* and *ſhort*), and the others (of *ſwift* and *ſlow*, *ſtrong* and *weak*, *loud* and *ſoft*), may be conſidered as modes of expreſſion which do not affect the modulation as to *tone*, it will agree beſt with our plan to eſteem theſe properties as reſpectively belonging to the eſtabliſhed laws of *pronunciation* and the *imitative* branch of expreſſion mentioned in the end of the enſuing head.

(*) From what accounts we have remaining of the modulation of the ancients, it appears to have been highly ornamented, and apparently ſomething not unlike our modern *recitative;* particularly that of their theatric declamation was muſic in its ſtricteſt ſenſe, and accompanied with inſtruments. In the courſe of time and the progreſs of refinement, this modulation became gradually more and more ſimple, till it has now loſt the genius of muſic, and is entirely regulated by taſte. At home here, every one has heard the *ſing ſong* cant, as it is called, of

Ti ti dum dum, ti ti dum ti dum de,
Ti dum ti dum, ti dum ti dum dum de;

which, though diſguſtful now to all but mere ruſtics on account of its being out of faſhion, was very probably the favourite modulation in which heroic verſes were recited by our anceſtors. So fluctuating are the taſte and practices of mankind! But whether the power of language over the paſſions has received any advantage from the change juſt mentioned, will appear at leaſt very doubtful, when we recollect the ſtories of its former triumphs, and the inherent charms of muſical ſounds.

(†) As muſical ſounds have always a harmonical reference to a key or fundamental note, and to which the mind is ſtill ſecretly attending, no piece of muſic would appear perfect that did not cloſe in it, and ſo naturally put an end to expectation. But as the tones uſed in ſpeech are not muſical, and therefore cannot refer harmonically to any other ſound, there can be no neceſſity that this terminating ſound (and which we immediately below term the *cadence)* ſhould either be uſed at all, or follow any particular law as to form, &c. further than what is impoſed by taſte and cuſtom.

IV. *Expreſſion.* 1. There is no compoſition in muſic, however perfect as to key and melody, but, in order to do juſtice to the ſubject and ideas of the author, will require, in the performing, ſomething more than an exact adherence to *tune* and *time.* This ſomething is of a nature, too, which perhaps can never be adequately pointed out by any thing graphic, and reſults entirely from the taſte and feeling of the performer. It is that which chiefly gives muſic its power over the paſſions, and characteriſes its notes with what we mean by the words *ſweet*, *harſh*, *dull*, *lively*, *plaintive*, *joyous*, &c. for it is evident every ſound, conſidered abſtractedly without any regard to the movement, or high and low, may be thus modified. In practical muſic, this commanding particular is called *Expreſſion;* and as we find certain tones analogous to it frequently coaleſcing with the modulation of the voice, which indicate our paſſions and affections (thereby more particularly pointing out the meaning of what we ſay), the term is uſually applied in the ſame ſenſe to ſpeaking and reading.

Theſe tones are not altogether peculiar to man.—Every animal, that is not dumb, has a power of making ſeveral of them. And from their being able, unaſſiſted by words, to manifeſt and raiſe their kindred emotions, they conſtitute a kind of language of themſelves. In this language of the heart man is eminently converſant; for we not only underſtand it in one another, but alſo in many of the inferior creatures ſubjected by Providence to our ſervice.

The expreſſion here illuſtrated is one of the moſt eſſential articles in good reading, ſince it not only gives a finiſhing to the ſenſe, but, on the principles of ſympathy and antipathy, has alſo a peculiar efficacy in intereſting the heart. It is likewiſe an article of moſt difficult attainment; as it appears from what follows, that a maſterly reader ought not only to be able to incorporate it with the modulation properly as to *quality*, but in any degree as to *quantity*.

Every thing written being a proper imitation of ſpeech, expreſſive reading muſt occaſionally partake of all its tones. But from what was ſaid above, of the difference between reading and ſpeaking, it follows, that theſe ſigns of the emotions ſhould be leſs ſtrongly characteriſed in the former article than in the latter. Again, as ſeveral of theſe tones of expreſſion are in themſelves agreeable to the mind, and raiſe in us agreeable emotions (as thoſe of *pity*, *benevolence*, or whatever indicates *happineſs* and *goodneſs* of heart), and others diſagreeable (as thoſe of a *boiſterous*, *malevolent* and *depraved* nature, &c.) it further appears, ſince reading is an art *improving* and not *imitating* nature, that, in whatever degree we abate the expreſſions of the tones above alluded to in the firſt caſe, it would be eligible to make a greater abatement in the latter. But as to the quantities and proportional magnitudes of theſe abatements, they, like many other particulars of the ſame nature, muſt be left ſolely to the taſte and judgment of the reader.

To add one more remark, which may be of ſervice on more accounts than in ſuggeſting another reaſon for the doctrine above. Let it be remembered, that though in order to acquit himſelf agreeably in this article of expreſſion, it will be neceſſary every reader ſhould *feel* his ſubject as well as *underſtand* it; yet, that he may preſerve a proper eaſe and maſterlineſs of delivery, it is alſo neceſſary he ſhould guard againſt diſcovering too much emotion and perturbation.

From this reaſoning we deduce the following rule, for the tones which indicate the paſſions and emotions.

"In reading, let all your tones of expreſſion be borrowed from thoſe of common ſpeech, but ſomething more faintly characteriſed. Let thoſe tones which ſignify any diſagreeable paſſion of the mind, be ſtill more faint than thoſe which indicate their contrary; and preſerve yourſelf ſo far from being affected with the ſubject, as to be able to proceed through it with that peculiar kind of eaſe and maſterlineſs, which has its charms in this as well as every other art."

We ſhall conclude this ſection with the following obſervation, which relates to ſpeaking as well as reading. When words fall in our way, whoſe "ſounds ſeem an echo to the ſenſe," as *ſquirr*, *buzz*, *humm*, *rattle*, *hiſs*, *jar*, &c. we ought not to pronounce them in ſuch a manner as to heighten the imitation, except in light and ludicrous ſubjects. For inſtance, they ſhould not in any other caſe be ſounded *ſquir.r.r—buzz.z.z—hum.m.m—r.r.rattle*, &c. On the contrary, when the imitation lies in the *movement*, or *flow and ſtructure of a whole paſſage* (which frequently happens in poetry), the delivery may always be allowed to give a heightening to it with the greateſt propriety; as in the following inſtances, out of a number more which every experienced reader will quickly recollect.

In theſe deep ſolitudes and awful cells,
Where heav'nly-penſive Contemplation dwells,
And ever-muſing Melancholy reigns—
Pope's Eloiſa to Abelard.

With eaſy courſe
The veſſels glide, unleſs their ſpeed be ſtopp'd
By dead calms, that oft lie on theſe ſmooth ſeas.
Dyer's Fleece.

Softly ſweet in Lydian meaſure,
Soon he ſooth'd her ſoul to pleaſure.
Dryden's Ode on St. Cecilia's day.

Still gathering force it ſmokes, and, urg'd amain,
Whirls, leaps, and *thunders down impetuous to the plain.*
Pope's Iliad, B. 13.

For who to dumb forgetfulneſs a prey,
This pleaſing anxious being ere reſign'd,
Left the warm precincts of the cheerful day,
Nor caſt *one longing ling'ring look behind?*
Gray's Elegy.

2. Beſides the particular tones and modifications of voice above deſcribed, which always accompany and expreſs our inward agitations, nature has in theſe caſes endowed us with another language, which, inſtead of the ear, addreſſes itſelf to the eye, thereby giving the communications of the heart a double advantage over thoſe of the underſtanding, and us a double chance to preſerve ſo ineſtimable a bleſſing. This language is what ariſes from the different, almoſt involuntary movements and configurations of the face and body in our emotions and paſſions, and which, like that of tones, every one is formed to underſtand by a kind of intuition.

When men are in any violent agitation of mind, this co-operating *expreſſion* (as it is called) of face and geſture is very ſtrongly marked, and totally free from the mixture of any thing which has a regard to gracefulneſs, or what appearance they may make in the eyes of others. But in ordinary converſation, and where the emotions are not ſo warm, faſhionable people are perpetually inſinuating into their countenance and action, whatever they imagine will add to the eaſe and elegance of their deportment, or impreſs on the ſpectator an idea of their amiableneſs and breeding. Now, though the above-mentioned natural organical ſigns of the emotions ſhould accompany every thing ſpoken, yet from what was obſerved in the introductory part of this article (like the tones we have juſt treated upon), they ſhould in reading be much leſs ſtrongly expreſſed, and thoſe ſuffer the greateſt diminution that are in themſelves the moſt ungainly. And, as it was in the laſt ſection recommended to the reader to preſerve himſelf as far from being affected in all paſſionate ſubjects as to be able to keep a temperate command over the various affections of the voice, &c. ſo under the ſanction of this ſubordinate feeling he may accompany his delivery more frequently with any eaſy action or change of face, which will contribute to ſet off his manner, and make it agreeable on the principles of art.

As theſe calm decorations of action (as we may call them) are not altogether natural, but have their riſe from a kind of inſtitution, they muſt be modelled by the practices of the polite. And though mankind differ from one another ſcarce more in any particular than in that of talents for adopting the graceful actions of the body, and hence nothing determinate can be ſaid of their nature and frequency, yet even thoſe, moſt happily calculated to acquit themſelves well in their uſe, might profit by conſidering that it is better greatly to abridge the diſplay, than to over do it ever ſo little. For the peculiar modeſty of deportment with which the inhabitants of this kingdom are endowed, makes us in common endeavour to ſuppreſs many ſigns of an agitated mind; and in ſuch caſes the bodily ones in particular are very ſparingly uſed. We have have alſo a natural and rooted diſlike to any kind of affectation; and to no ſpecies, that we can recollect, a greater, than to that which is ſeen in a perſon who pretends to mimicry and courtly geſture, without poſſeſſing the advantages and talents they require; and of which not many people, comparatively ſpeaking, have any remarkable ſhare.

The inference of this is too obvious to need drawing out, and we would particularly recommend it to the conſideration of thoſe readers who think the common occurrences of a newſpaper, &c. cannot be properly delivered without a good deal of elbow-room.

Although it is impoſſible to come to particulars in any directions of this kind, yet there is one article of our preſent ſubject on which a ſerviceable remark may be made. In ordinary diſcourſe, when we are particularly preſſing and earneſt in what we ſay, the eye is naturally thrown upon thoſe to whom we addreſs ourſelves: And in reading, a turn of this organ now and then upon the hearers, when any thing very remarkable or intereſting falls in the way, has a good effect in gaining it a proper attention, &c. But this ſhould not be too frequently uſed; for if ſo, beſides its having a tendency to confound the natural importance of different paſſages, it may not be altogether agreeable to ſome to have their own reflections broken in upon by a ſignal, which might be interpreted to hint at their wanting regulation.

One obſervation more, and then we ſhall attempt to recapitulate the ſubſtance of this ſection in the form of a precept. Though it is, when ſtrictly examined, inconſiſtent, both in ſpeaking and reading, to imitate with action what we are deſcribing, yet as in any thing *comic* ſuch a practice may ſuggeſt ideas that will *accord* with thoſe of the ſubject, it may there be now and then indulged in either of theſe articles.

“ In a manner ſimilar to that directed with regard to tones, moderate your bodily expreſſions of the ſigns of the emotions. And in order to ſupply, as it were, this deficiency, introduce into your carriage ſuch an eaſy gracefulneſs, as may be conſiſtent with your acquirements in theſe particulars, and the neceſſary dread which ſhould ever be preſent of falling into any kind of affectation or grimace.”

V. *Pauſes.* Speech conſiſting of a ſucceſſion of diſtinct words, muſt naturally be liable (both from a kind of accident, and a difficulty there may be in beginning certain ſounds or portions of phraſes immediately on the ending of certain others) to ſeveral ſmall intermiſſions of voice; of which, as they can have no meaning, nothing further need here be ſaid. There are, however, ſome pauſes, which the ſenſe neceſſarily demands; and to theſe the ſubſtance of this ſection is directed.

The pauſes are in part to diſtinguiſh the members of ſentences from one another, the terminations of complete periods, and to afford an opportunity for taking breath. Beſides this, they have a very graceful effect in the modulation, on the ſame account they are ſo eſſential in muſic.—In both articles, like blank ſpaces in pictures, they ſet off and render more conſpicuous whatſoever they disjoin or terminate.

Were language made up of nothing but ſhort colloquial ſentences, theſe pauſes, though they might do no harm, and would generally be graceful, would however be ſuperſeded as to uſe by the completeneſs and *narrowneſs*, as we may ſay, of the meaning. But in more diffuſe language, compoſed of ſeveral detached ſentences, and which require ſome degree of attention in order to take in the ſenſe, the intermiſſions of voice under conſideration are of the greateſt ſervice, by ſignifying to the mind the progreſs and completion of the whole paſſage. Now, though in extenſive and differently formed periods there may be members whoſe completeneſs of ſenſe might be conceived of various degrees, and hence might ſeem to require a ſet of pauſes equally numerous; yet, ſince the ſenſe does not altogether depend upon theſe intermiſſions, and their ratios to one another, if capable of being properly defined, could not be accurately obſerved, grammarians have ventured to conceive the whole claſs of pauſes as reducible to the four or five kinds now in uſe, and whoſe marks and ratios are well known *; preſuming that under the eye of taſte, and with the aſſiſtance of a particular to be next mentioned, they would not fail in all caſes to ſuggeſt intermiſſions of voice ſuitable to the ſenſe. But in many of theſe extenſive and complex periods, rounded with a kind of redundancy of matter, where the full ſenſe is long ſuſpended, and the final words are not very important, there would be ſome hazard of a miſapprehenſion of the termination, had we not more evident and infallible notice of it than that which is given by the pauſe. This notice is the *cadence*, referred to in the ſection on *Modulation*; which, as is there obſerved, beſides the ornamental variety it affords, appears from theſe remarks to be a very neceſſary and ſerviceable article in perſpicuous delivery.

As this cadence naturally accompanies the end of every entire ſenſe, circumſtanced as above-mentioned, it may ſometimes fall before the *ſemicolon*, but more generally before the *colon*, as well as the period: For theſe marks are often found to terminate a complete ſenſe; and, in theſe caſes, the relation what follows has to what went before is ſignified to the mind by the relative ſhortneſs of the ſtop, and the form of introducing the additional matter. Nor can any bad conſequence ariſe from thus founding diſtinctions on ratios of time, which it may be ſaid are too nice to be often rightly hit upon: for if a confuſion ſhould happen between that of the *colon* and *period*, there is perhaps ſo trifling a difference between the nature of the paſſages they ſucceed, as to make a ſmall inaccuracy of no conſequence. And as to the reſts of the ſemicolon and period, it will not be eaſy to miſtake about them, as their ratio is that of two to one. Add to this the power which the matter and introduction of the ſubſequent paſſages have to rectify any ſlight error here made, and we ſhall be fully ſatisfied, that the pauſes as uſually explained, with the cadence above deſcribed, and a proper knowledge of the language, will convey ſufficient information to the underſtanding of the conſtructive nature of the paſſages after which they are found.

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* Suppoſe the *comma* (,) one *time*, the *ſemicolon* (;) will be two; the *colon* (:) three, and the *period* (.) as alſo the marks of *interrogation* (?) and *admiration* (!) four of theſe times. The blank line (— or ---), and the breaks between *paragraphs*, intimate ſtill greater times: and by the ſame analogy may be reckoned a double and quadruple period reſpectively. Now and then theſe blank lines are placed immediately *after* the ordinary points, and then they are conceived only as ſeparating for the *eye* the different natures of the matter;—as a queſtion from an anſwer,—precept from example,—premiſes from inferences, &c. in which caſe their import is evident. But of late ſome authors have not ſcrupled to confound theſe diſtinctions; and to make a blank ſerve for all the pauſes univerſally, or the mark of an indefinite reſt, the quantity of which is left to the determination of the reader's taſte. A practice, it is imagined, too deſtructive of the intended preciſion of theſe typical notices to be much longer adopted.

It may be obſerved that in natural ſpeech, according to the warmth and agitation of the ſpeaker, the reſts are often ſhort and injudiciouſly proportioned, and hence that every thing thus delivered cannot be ſo graceful as it might have been from a proper attention to their magnitude and effects.

Pauſes then, though chiefly ſubjected to the ſenſe, are, as was remarked at the outſet, ſerviceable in beautifying the modulation, &c.—And ſince books are often inaccurately printed as to points, and people's taſtes differ ſome little about their place and value, it appears, that "although in reading great attention ſhould be paid to the ſtops, yet a greater ſhould be given to the ſenſe, and their correſpondent times occaſionally lengthened beyond what is uſual in common ſpeech;" which obſervation contains all that we ſhall pretend to lay down by way of rule for the management of pauſes in the delivery of written language.

☞ As there are two or three ſpecies of writing which have ſomething ſingular in them, and, with regard to the manner in which they ſhould be read, a few *particular* remarks ſeem neceſſarily required, we ſhall conclude this article with laying them before the reader:

1. Of Plays, and ſuch like conversation-pieces. Writings of this kind may be conſidered as intended for two different purpoſes; one to unfold ſubject matter for the exerciſe of theatric powers; and the other to convey amuſement, merely as fable replete with pleaſing incidents and characteriſtic manners. Hence there appears to be great latitude for the diſplay of a *conſiſtent* delivery of theſe performances: for while, on one hand, a good reader of very inferior talents for mimicry may be heard with a tolerable degree of pleaſure; on the other, if any perſon be qualified to give a higher degree of life and force to the dialogue and characters by delivering them as an actor, he muſt be fully at liberty to ſtart from the confinement of a chair to a poſture and area more ſuited to his abilities; and, if he be not deceived in himſelf, his hearers will be conſiderable gainers by the change.—The next article is,

2. Sermons or other orations, which in like manner may be conceived intended for a double purpoſe. Firſt, as matter for the diſplay of oratorical powers; and ſecondly, as perſuaſive diſcourſes, &c. which may be read like any other book. Therefore it appears (for reaſons ſimilar to thoſe above) that according as clergymen are poſſeſſed of the talents of elocution, they may conſiſtently either rehearſe their ſermons, in the manner of an extemporary harangue, or deliver them in the more humble capacity of one who is content to entertain and inſtruct his hearers with reading to them his own or ſome other perſon's written diſcourſe.

That either of theſe manners of delivery (or a mixture of them), in either of the caſes above mentioned, is agreeable, we find on a careful examination. For this will ſhow us how frequently they run into one another; and that we are ſo far from thinking ſuch tranſitions wrong, that, without a particular attention that way, we ſcarce ever perceive them at all.

3. Poetry is the next and laſt object of our preſent remarks. This is a very peculiar kind of writing, and as much different from the language of ordinary diſcourſe as the movements of the dance are from common walking. To ornament and improve whatever is ſubſervient to the pleaſures and amuſements of life, is the delight of human nature. We are alſo pleaſed with a kind of *exceſs* in any thing which has a power to amuſe the fancy, inſpire us with enthuſiaſm, or awaken the ſoul to a conſciouſneſs of its own importance and dignity. Hence one pleaſure, at leaſt, takes its riſe, that we feel in contemplating the performances of every art; and hence the language of poetry, conſiſting of a meaſured rythmus, harmonious cadences, and an elevated picture ſque diction, has been ſtudied by the ingenious, and found to have a powerful influence over the human breaſt in every age and region. There is ſuch an affinity between this language and muſic, that they were in the earlier ages never ſeparated; and though modern refinement has in a great meaſure deſtroyed this union, yet it is with ſome degree of difficulty in rehearſing theſe divine compoſitions that we can forget the ſinging of the muſe.

From theſe conſiderations (and ſome kindred ones mentioned in ſect. iii.), in repeating verſes, they are generally accompanied with a modulation rather more ornamented and muſical than is uſed in any other kind of writing. And, accordingly, as there ſeems to be the greateſt propriety in the practice, the rule for this particular, in the ſection juſt referred to, will allow any latitude in it that can gain the ſanction of taſte and pleaſure.

Rhymes in the lighter and more ſoothing provinces of poetry are found to have a good effect; and hence (for reaſons like thoſe juſt ſuggeſted) it is certainly abſurd to endeavour to ſmother them by a feeble pronunciation, and running one line precipitately into another, as is often affected to be done by many of our modern readers and ſpeakers. By this method they not only deſtroy one ſource of pleaſure intended by the compoſer (which though not great is nevertheleſs genuine), but even often ſupply its place with what is really diſagreeable, by making the rhymes, as they are interruptedly perceived, appear accidental blemiſhes of a different ſtyle, ariſing from an unmeaning recurrence of ſimilar ſounds. With regard then to reading verſes terminated with rhyme, the common rule, which directs to pronounce the final words *full*, and to diſtinguiſh them by a ſlight pauſe even where there is none required by the ſenſe, ſeems the moſt rational, and conſequently moſt worthy of being followed. See Declamation, Narration, and Oratory.

Reading, a town of Berkſhire in England, pleaſantly ſeated on the river Kenneth, near the conſluence with the Thames. It had once a fine rich monaſtery, of which there are large ruins remaining. It had alſo a caſtle built by king Henry I. but it was afterwards levelled with the ground. It is a corporation, enjoys ſeveral privileges, and ſends two members to parliament. The two navigable rivers render it a fit place for trade. W. lon. 1. 0. N. lat. 51. 25.

READINGS, or *Various* Readings, in criticiſm, are the different manner of reading the texts of authors in ancient manuſcripts, where a diverſity has ariſen from the corruption of time, or the ignorance of copyiſts. A great part of the buſineſs of critics lies in ſettling the readings by confronting the various readings of the ſeveral manuſcripts, and conſidering the agreement of the words and ſenſe. *Readings* are alſo uſed for a ſort of commentary or gloſs on a law, text, paſſage, or the like, to ſhow the ſenſe an author takes it in, and the application he conceives to be made of it.

RE-AGGRAVATION, in the Romiſh eccleſiaſtical law, the laſt monitory, publiſhed after three admonitions, and before the laſt excommunication. Before they proceed to fulminate the laſt excommunication, they publiſh an aggravation, and a re-aggravation. Fevret obſerves, that in France the miniſter is not allowed to come to re-aggravation, without the permiſſion of the biſhop or official, as well as that of the lay judge. See Excommunication.

REAL (Cæsar Vichard de St.), a polite French writer, ſon of a counſellor to the ſenate of Chamberry in Savoy. He came young to France, diſtinguiſhed himſelf at Paris by ſeveral ingenious productions, and reſided there a long time without title or dignity, intent upon literary purſuits. He died at Chamberry in 1692, advanced in years, though not in circumſtances. He was a man of great parts and penetration, a lover of the ſciences, and particularly fond of hiſtory. A complete edition of his works was printed at Paris, in 3 vols. 4to, 1745, and another in 6 vols. 12mo.

Real *Preſence*. See Transubstantiation.

REALISTS, a ſect of ſchool-philoſophers formed in oppoſition to the nominaliſts. Under the Realiſts are included the Scotiſts, Thomiſts, and all excepting the followers of Ocham. Their diſtinguiſhing tenet is, that univerſals are realities, and have an actual exiſtence out of an idea or imagination; or, as they expreſs it in the ſchools, a *parte rei*; whereas the nominaliſts contend, that they exiſt only in the mind, and are only ideas, or manners of conceiving things.—Dr. Odo, or Oudard, a native of Orleans, afterwards abbot of St. Martin de Tournay, was the chief of the ſect of the realiſts. He wrote three books of dialectics, where, on the principles of Boethius and the ancients, he maintained that the object of that art is things, not words; whence the ſect took its riſe and name.

REALITY, in the ſchools, a diminutive of *res*, "thing," firſt uſed by the Scotiſts, to denote a thing which may exiſt of itſelf; or which has a full and abſolute being of itſelf, and is not conſidered as a part of any other.

REALM, a country which gives its head or governor the denomination of a *king*.

RE-ANIMATION means the reviving or reſtoring to life thoſe who are apparently dead. Sudden death is dreaded by every human being, and it is one of thoſe evils againſt which the Church of England prays in her Litany. Accidents, however, cannot always be prevented; but, after they have happened, it is often poſſible to prevent their effects. This, by the eſtabliſhment of what with great propriety has been called the *Humane Society*, has been abundantly proved: for in the courſe of 12 years immediately after their inſtitution, they were the means of ſaving the lives of 850 perſons, who otherwiſe would in all human probability have been loſt to the community. Since that period, they have ſaved many more; and various perſons, even in the moſt diſtant parts of the kingdom, by following their directions have done the ſame. To preſerve one human being from premature death, we muſt conſider as of the utmoſt conſequence both as citizens and chriſtians; how much more the preſervation of thouſands. It appears from the writings of Doctors Mead, Winſlow, Bruhier, Fothergill, Haller, Lecat, Tiſſot, Van Engelen, Gummer, and others, that they had prepared the way for inſtitutions ſimilar to the Humane Society: for in their works they have elucidated the principles on which they go, and furniſhed directions for the practice they favour. See Death, *Premature* Interment, and Drowning.

REAR, a term frequently uſed in compoſition, to denote ſomething behind, or backwards, in reſpect of another, in oppoſition to *van*.

Rear *of an* Army, ſignifies, in general, the hindermoſt part of an army, battalion, regiment, or ſquadron; alſo the ground behind either.

Rear-*Guard*, is that body of an army which marches after the main-body; for the march of an army is always compoſed of an advance guard, a main-body, and a rear-guard; the firſt and laſt commanded by a general. The old grand-guards of the camp always form the rear guard of the army, and are to ſee that every thing come ſafe to the new camp.

Rear *Half-Files*, are the three hindmoſt ranks of the battalion, when it is drawn up ſix deep.

Rear-*Line*, of an army encamped, is always 1200 feet at leaſt from the centre line; both of which run parallel to the front line, as alſo to the reſerve.

Rear-*Rank*, is the laſt rank of a battalion, when drawn up, and generally 16 or 18 feet from the centre line when drawn in open order.

REASON, a faculty or power of the mind, whereby it diſtinguiſhes good from evil, truth from falſehood. See Metaphysics.

REASONING, ratiocination, the exerciſe of that faculty of the mind called *reaſon*; or it is an act or operation of the mind, deducing ſome unknown propoſition from other previous ones that are evident and known. See Logic.

REAUMUR (Rene Antoine Ferchault, Sieur de), a perſon diſtinguiſhed for his laborious reſearches into natural knowledge, was born at Rochelle in 1683, of a family belonging to the law. After having finiſhed his early ſtudies in the place of his birth, he began a courſe of philoſophy at Poitiers, and of civil law at Bourges; but ſoon relinquiſhed the latter, to apply himſelf, according to his taſte, to mathematics, phyſics, and natural hiſtory. Being come to Paris, he was received into the Academy of Sciences in 1708. From that hour he was wholly employed in natural hiſtory, to which his inclination particularly led him, and his inquiries were not confined to any one part of it. His memoirs, his obſervations, his diſcoveries on the formation of ſhells, ſpiders, muſcles, the marine flea, the berry which affords the purple colour, and on the cauſe of the numbneſs of the torpedo, excited the curioſity of the public, and early procured our author the character of an able, curious and entertaining naturaliſt. Filled with zeal for the welfare and advantage of ſociety, and the progreſs and perfection of arts, he endeavoured in all his reſearches to promote the public good. We were indebted to him for the diſcovery of the Turquois mines in Languedoc. He alſo found out a ſubſtance which is uſed to give falſe ſtones a colour, which is obtained from a certain fiſh called in the French *Able* or *Ablete* on account of its whiteneſs, and which is the *Bleak* or *Blay* of our writers. His experiments on the art of turning iron into ſteel obtained him a penſion of 12,000 livres; and this reward was to be continued to the Academy to ſupport the expenſe which might accrue in this art.

He continued his inquiries on the art of making tin and porcelain, and endeavoured to render our thermometers more uſeful than thoſe of former times: he compoſed a curious hiſtory of rivers where gold duſt is found in France; and gave ſo ſimple and eaſy a detail of the art of gathering this duſt, that perſons have been employed for that purpoſe.

He alſo made curious and important obſervations on the nature of flints, on the banks of foſſil ſhells from whence is obtained in Touraine an excellent manure for land; as likewiſe on birds and their preſervation, on their method of building neſts; on inſects; and a great number of other ſubjects, not leſs curious than uſeful.

He imagined at firſt, that a certain varniſh would keep eggs freſh; but the waſte of time and money, &c. ſhowed him the inconveniencies of ſuch a proceſs. He afterwards adopted the method practiſed for time immemorial in Greece and the iſlands of the Archipelago which is to ſteep or immerſe eggs in oil, or melted fat; by this means, not being expoſed to the air or to froſt, they are well preſerved, and contract no bad ſmell. Another experiment ſtill more important, made by our author, was to introduce into France the art of hatching fowl and birds, as practiſed in Egypt, without covering the eggs. Active, ſedulous, and attentive, he was early in his ſtudy, often at ſix in the morning. Exact in his experiments and obſervations, he let no circumſtance eſcape him. His writings muſt be of great uſe to future philoſophers. In ſociety, he was diſtinguiſhed through life for his modeſt and agreeable behaviour. His probity, benevolence, goodneſs of heart, and other amiable qualities, as well natural as acquired, endeared him to his countrymen. He died in the 76th year of his age, on the 18th of October, 1757, and left this world filled with ſentiments of piety. His death was the conſequence of a fall, which happened at the caſtle of Barnardiere on the Maine, where he went to paſs his vacation. He bequeathed to the Academy of Sciences his manuſcripts and all his natural productions. His works are, 1. A very great number of memoirs and obſervations on different parts of natural hiſtory; they are printed in the collections of the Academy of Sciences. 2. A large work printed ſeparately in 6 vols. in 4to, intitled, A Natural Hiſtory of Inſects. This important work contains a deſcription of vaſt numbers of caterpillars, moths, gall inſects, flies with two and four wings, lady-birds, and thoſe ephemeron flies which live only a few hours in that form: and laſtly, of thoſe ſingular and wonderful inſects which are called *polypes*, which being cut into ſeveral pieces, each piece lives, grows, and becomes an inſect, and affords to our eyes a great number of prodigies. See Polypus. The works of M. de Reaumur are exact, curious, intereſting, and very ingenious. They are written with much candour, clearneſs, and elegance; it muſt, however, be acknowledged his manner is ſomewhat too diffuſe. But we muſt not deceive the reader; he often raiſes our expectations, and does not give us all the ſatisfaction we promiſe ourſelves from his writings. His method of raiſing poultry, in particular, rather diſappoints us. He ſpared neither care, time, nor expenſe, to render it practicable: he flattered himſelf and his countrymen with the greateſt hopes; but, notwithſtanding his aſſiduous induſtry, and vaſt expenſes, it proved abortive. The late M. l'Advocat recommended him to obtain better information from Egypt on the ſubject; and if poſſible to procure a perſon verſed in the art to inſtruct him in it; but his death prevented the completion of the ſcheme. If the native of Egypt had arrived, ſhowed M. de Reaumur a better method than his own, and practiſed it with ſucceſs, as in his country, the community would have been benefited; on the other hand he would have ſeen, had it failed, that the climate of France was not proper for ſuch experiments. M. Maillet, conſul at Cairo, to whom Monſieur the regent had written to obtain the art, offered to ſend over a native of Egypt, if the government would pay the expenſe of his voyage, and allow him a penſion of 1500 livres. M. Maillet rightly judged, when he preferred this method of proceeding. M. de Reaumur was not ignorant of the deſign; but he flattered himſelf, that his efforts would be ſucceſsful without further aid, and thought he ſhould acquire ſome honour. He certainly had great talents, induſtry, ſagacity, and every other qualification which is neceſſary in ſuch attempts; but it is morally impoſſible that a ſingle man in a different climate, can attain ſuch knowledge in an art as thoſe who live in a more favourable country, and have had the experience of many ages to profit by: however unſucceſsful M. de Reaumur may have been, poſterity is indebted to him for his repeated trials. He has removed ſome difficulties in the road, and thoſe that travel it may diſcover what he only ſaw at a diſtance.

REAUMURIA, in botany: A genus of the pentagynia order, belonging to the pentandria claſs of plants; and in the natural method ranking under the 13th order, *Succulentæ*. The calyx is hexaphyllous, and there are five petals; the capſule is unilocular, quinquevalved, and polyſpermous.

REBATE, or Rebatement, in commerce, a term much uſed at Amſterdam for an abatement in the price of ſeveral commodities, when the buyer, inſtead of taking time, advances ready money.

Rebatement, in heraldry, a diminution or abatement, of the bearings in a coat of arms. See Abatement.

REBELLION, *Rebellio*, among the Romans, was where thoſe who had been formerly overcome in battle, and yielded to their ſubjection, made a ſecond reſiſtance: but with us it is generally uſed for the taking up of arms traiterouſly againſt the king, whether by natural ſubjects, or others when once ſubdued; and the word *rebel* is ſometimes applied to him who wilfully breaks a law; alſo to a villein diſobeying his lord. There is a difference between enemies and rebels. Enemies are thoſe who are out of the king's allegiance: therefore ſubjects of the king, either in open war, or rebellion, are not the king's enemies but traitors. And David Prince of Wales, who levied war againſt Edw. I. becauſe he was within the allegiance of the king, had ſentence pronounced againſt him as a traitor and rebel. Private perſons may arm themſelves to ſuppreſs rebels, enemies, &c.

REBELLIOUS assembly, is a gathering together of twelve perſons or more, intending or going about to practiſe or put in uſe unlawfully, of their own authority, any thing to change the law or ſtatutes of the realm; or to deſtroy the incloſures of any ground, or banks of any fiſh-pond, pool, or conduit, to the intent the ſame ſhall lie waſte and void: or to deſtroy the deer in any park, or any warren of conies, dove-houſes, or fiſh in ponds, or any houſe, barns, mills, or bays; or to burn ſtacks of corn; or abate rents, or prices of victuals, &c.

REBUS, an enigmatical repreſentation of ſome name, &c. by uſing figures or pictures inſtead of words, or parts of words. Camden mentions an inſtance of this abſurd kind of wit in a gallant who expreſſed his love to a woman named *Roſe Hill*, by painting in the border of his gown a roſe, a hill, an eye, a loaf, and a well; which, in the ſtile of the rebus, reads, "*Roſe Hill I love well.*" This kind of wit was long practiſed by the great, who took the pains to find devices for their names. It was, however, happily ridiculed by Ben Jonſon, in the humorous deſcription of Abel Drugger's device in the Alchemiſt; by the Spectator, in the device of Jack of Newberry; at which time the rebus, being raiſed to ſign-poſts, was grown out of faſhion at court.

Rebus is alſo uſed by the old chemical writers ſometimes to ſignify ſour milk, and ſometimes for what they call the ultimate matter of which all bodies are compoſed.

Rebus, in heraldry, a coat of arms which bears an alluſion to the name of the perſon; as three caſtles, for Caſtleton; three cups, for Butler; three conies, for Coniſby; a kind of bearings which are of great antiquity.

REBUTTER (from the Fr. *bouter*, i. e. *repellere*, to put back or bar), is the anſwer of defendant to plaintiff's *ſurrejoinder*; and plaintiff's anſwer to the rebutter is called a *ſurrebutter*: but it is very rare the parties go ſo far in pleading. *Rebutter* is alſo where a man by deed or fine grants to warranty any land or hereditament to another; and the perſon making the warranty, or his heir, ſues him to whom the warranty is made, or his heir or aſſignee, for the ſame thing; if he who is ſo ſued plead the deed or fine with warranty, and pray judgment, if the plaintiff ſhall be received to demand the thing which he ought to warrant to the party againſt the warranty in the deed, &c. this is called a *rebutter*. And if I grant to a tenant to hold without impeachment of waſte, and afterwards implead him for waſte done, he may debar me of this action by ſhowing my grant, which is a rebutter.

RECAPITULATION, is a ſummary, or a conciſe and tranſient enumeration of the principal things inſiſted on in the preceding diſcourſe, whereby the force of the whole is collected into one view. See Oratory.

RECEIPT, or Receit, in commerce, an acquittance, or diſcharge, in writing, intimating that the party has received a certain ſum of money, either in full for the whole debt, or in part, or on account.

RECEIVER, in pneumatics, a glaſs veſſel for containing the thing on which an experiment in the air-pump is to be made.

Receiver, *receptor* or *receptator*, in law, is commonly underſtood in a bad ſenſe, and uſed for ſuch as knowingly receive ſtolen goods from thieves, and conceal them. This crime is felony, and the puniſhment is tranſportation for 14 years.

RECENSIO was an account taken by the cenſors, every luſtrum, of all the Roman people. It was a general ſurvey at which the equites, as well as the reſt of the people, were to appear. New names were now put upon the cenſor's liſt, and old ones cancelled. The *recenſio*, in ſhort, was a more ſolemn and accurate ſort of *probatio*, and anſwered the purpoſe of a review, by ſhowing who were fit for military ſervice.

RECEPTACULUM, in botany, one of the ſeven parts of fructification, defined by Linnæus to be the baſe which connects or ſupports the other parts.

Receptaculum *Chyli*, or *Pecquet's Reſervatory*, the reſervoir or receptacle for the chyle, ſituated in the left ſide of the upper vertebra of the loins, under the aorta and the veſſels of the left kidney. See Anatomy.

RECHABITES, a kind of religious order among the ancient Jews, inſtituted by Jonadab the ſon of Rechab, comprehending only his own family and poſterity. Their founder preſcribed them three things: firſt, not to drink any wine; ſecondly, not to build any houſes, but to dwell in tents; and thirdly, not to ſow any corn, or plant vines. The Rechabites obſerved theſe rules with great ſtrictneſs, as appears from Jer. xxxv. 6. &c. Whence St. Jerome, in his 13th epiſtle to Paulinus, calls them *monachi, monks*. Jonadab, their founder, lived under Jehoaſh king of Judah, contemporary with Jehu king of Iſrael: his father Rechab, from whom his poſterity were denominated, deſcended from Raguel or Jethro, father-in-law to Moſes, who was a Kenite, or of the race of Ken: whence Kenite and Rechabite are uſed as ſynonymous in Scripture.

RECHEAT, in hunting, a leſſon which the huntſman plays on the horn, when the hounds have loſt their game, to call them back from purſuing a counter ſcent.

RECIPE, in medicine, a preſcription or remedy, to be taken by a patient; ſo called becauſe always beginning with the word *recipe*, i. e. *take*; which is generally denoted by the abbreviature ℞.

RECIPROCAL, in general, ſomething that is mutual, or which is returned equally on both ſides, or that affects both parties alike.

Reciprocal *Terms*, among logicians, are thoſe which have the ſame ſignification; and conſequently are convertible, or may be uſed for each other.

Reciprocal, in mathematics, is applied to quantities which multiplied together produce unity. Thus $\frac{1}{x}$ and x, y and $\frac{1}{y}$, are reciprocal quantities. Likewiſe $\frac{1}{x}$ is ſaid to be the reciprocal of x, which is again the reciprocal of $\frac{1}{x}$.

Reciprocal *Figures*, in geometry, thoſe which have the antecedents and conſequents of the ſame ratio in both figures.

Reciprocal *Proportion*, is when in four numbers the fourth is leſs than the ſecond by ſo much as the third is greater than the firſt, and *vice verſa*. See Proportion and Arithmetic. Great uſe is made of this reciprocal proportion by Sir Iſaac Newton and others, in demonſtrating the laws of motion.

RECITAL, in law, means the rehearſal or making mention in a deed or writing of ſomething which has been done before.

RECITATIVO, or Recitative, in muſic, a kind of ſinging, that differs but little from orderly pronunciation; ſuch as that in which ſeveral parts of the liturgy are rehearſed in cathedrals; or that wherein the actors commonly deliver themſelves on the theatre at the opera, when they are to expreſs ſome action or paſſion; to relate ſome event; or reveal ſome deſign.

RECKENHAUSEN, a ſtrong town of Cologne, in Germany, in the middle territory of that name. The abbeſs of its nunnery has power of puniſhing offenders with death, and ſhe alone is obliged to the vow of chaſtity.

RECKONING, or a *Ship's* Reckoning, in navigation, is that account whereby at any time it may be known where the ſhip is, and on what courſe or courſes ſhe is to ſteer in order to gain her port; and that account taken from the log-board is called the *dead reckoning*. See Navigation.

RECLAIMING, or Reclaming, in our ancient cuſtoms, a lord's purſuing, proſecuting, and recalling his vaſſal, who had gone to live in another place without his permiſſion. *Reclaiming* is alſo uſed for the demanding of a perſon, or thing, to be delivered up to the prince or ſtate to which it properly belongs; when, by any irregular means, it is come into another's poſſeſſion.

Reclaiming, in falconry, is taming a hawk, &c. and making her gentle and familiar. A partridge is ſaid to *reclaim* when ſhe calls her young ones together, upon their ſcattering too much from her.

RECLINATION of a plane in dialling. See Dialling.

RECLUSE, among the Papiſts, a perſon ſhut up in a ſmall cell of an hermitage, or monaſtery, and cut off, not only from all converſation with the world, but even with the houſe. This is a kind of voluntary impriſonment, from a motive either of devotion or penance. The word is alſo applied to incontinent wives, whom their huſbands procure to be thus kept in perpetual impriſonment in ſome religious houſe. Recluſes were anciently very numerous. They took an oath never to ſtir out of their retreat: and having entered it the biſhop ſet his ſeal upon the door; and the recluſe was to have every thing neceſſary for the ſupport of life conveyed to him through a window. If he was a prieſt, he was allowed a ſmall oratory, with a window which looked into the church, through which he might make his offerings at the maſs, hear the ſinging, and anſwer thoſe who ſpoke to him; but this window had curtains before it, ſo that he could not be ſeen. He was allowed a little garden, adjoining to his cell, in which he might plant a few herbs, and breathe a little freſh air. If he had diſciples, their cells were contiguous to his, with only a window of communication, through which they conveyed neceſſaries to him, and received his inſtructions. If a recluſe fell ſick, his door might be opened for perſons to come in and aſſiſt him, but he himſelf was not to ſtir out.

RECOGNITION, in law, an acknowledgment; a word particularly uſed in our law-books for the firſt chapter of the ſtatute 1 Jac. I. by which the parliament acknowledged that, after the death of queen Elizabeth, the crown had rightfully deſcended to king James.

RECOGNIZANCE, in law, is an obligation of record, which a man enters into before ſome court of record or magiſtrate duly authoriſed, with condition to do ſome particular act;

as to appear at the aſſizes, to keep the peace, to pay a debt, or the like. It is in moſt reſpects like another bond: the difference is chiefly this, that the bond is the creation of a freſh debt or obligation *de novo*, the recognizance is an acknowledgement of a former debt upon record; the form whereof is, "that A. B. doth acknowledge to owe to our lord the king, to the plaintiff, to C. D. or the like, the ſum of ten pounds," with condition to be void on performance of the thing ſtipulated: in which caſe the king, the plaintiff, C. D. &c. is called the cognizee, *is cui cognoſcitur*; as he that enters into the cognizance is called the cognizor, *is qui cognoſcit*. This being certified to, or taken by the officer of ſome court, is witneſſed only by the record of that court, and not by the parties ſeal: ſo that it is not in ſtrict propriety a deed, though the effects of it are greater than a common obligation; being allowed a priority in point of payment, and binding the lands of the cognizor from the time of enrolment on record.

RECOIL, or **Rebound**, the ſtarting backward of a firearm after an exploſion. Merſennus tells us, that a cannon 12 feet in length weighing 6400lb. gives a ball of 24lb. an uniform velocity of 640 feet *per* ſecond. Putting, therefore, $W=6400$, $w=14$, $V=40$, and $v=$ the velocity with which the cannon recoils; we ſhall have (becauſe the momentums of the cannon and ball are equal) $Wv=wV$; and ſo $v=\frac{wV}{W}=\frac{24\times 64}{6400}=2,4$; that is, it would recoil at the rate of $\frac{4}{10}$ foot *per* ſecond, if free to move.

RECOLLECTION, a mode of thinking, by which ideas ſought after by the mind are found and brought to view.

RECONNOITRE, in military affairs, implies to view and examine the ſtate of things, in order to make a report thereof. Parties ordered to reconnoitre are to obſerve the country and the enemy; to remark the routes, conveniences, and inconveniences of the firſt; the poſition, march, or forces of the ſecond. In either caſe, they ſhould have an expert geographer, capable of taking plans readily: he ſhould be the beſt mounted of the whole, in caſe the enemy happen to ſcatter the eſcorte, that he may ſave his works and ideas. See **War**.

RECORD, an authentic teſtimony in writing, contained in rolls of parchment, and preſerved in a court of record. See **Court**.

Trial by **Record**, a ſpecies of trial which is uſed only in one particular inſtance: and that is where a matter of record is pleaded in any action, as a fine, a judgment, or the like; and the oppoſite party pleads, *nul tiel record*, that there is no ſuch matter of record exiſting. Upon this, iſſue is tendered and joined in the following form, "and this he prays may be inquired of by the record, and the other doth the like;" and hereupon the party pleading the record has a day given him to bring it in, and proclamation is made in court for him to "bring forth the record by him in pleading alleged, or elſe he ſhall be condemned;" and, on his failure, his antagoniſt ſhall have judgment to recover. The trial, therefore, of this iſſue, is merely by the record: for, as Sir Edward Coke obſerves, a record or enrolment is a monument of ſo high a nature, and importeth in itſelf ſuch abſolute verity, that if it be pleaded that there is no ſuch record, it ſhall not receive any trial by witneſs, jury, or otherwiſe, but only by itſelf. Thus titles of nobility, as whether earl or not earl, baron or not baron, ſhall be tried by the king's writ or patent only, which is matter of record. Alſo in caſe of an alien, whether alien friend or enemy, ſhall be tried by the league or treaty between his ſovereign and ours; for every league or treaty is of record. And alſo, whether a manor be held in ancient demeſne or not, ſhall be tried by the record of domeſday in the king's exchequer.

RECORDER, a perſon whom the mayor and other magiſtrates of a city or corporation aſſociate to them for their better direction in matters of juſtice and proceedings in law; on which account this perſon is generally a counſellor, or other perſon well ſkilled in the law. The recorder of London is choſen by the lord mayor and aldermen; and as he is held to be the mouth of the city, delivers the judgment of the courts therein, and records and certifies the city-cuſtoms. See **London**.

RECOVERY, or *Common* **Recovery**, in Engliſh law, a ſpecies of aſſurance by matter of record; concerning the original of which it muſt be remarked, that common recoveries were invented by the eccleſiaſtics to elude the ſtatutes of mortmain (ſee **Tail**); and afterwards encouraged by the fineſſe of the courts of law in 12 Edward IV. in order to put an end to all fettered inheritances, and bar not only eſtates-tail, but alſo all remainders and reverſions expectant thereon. We have here, therefore, only to conſider, firſt, the *nature* of a common recovery; and ſecondly, its *force* and *effect*.

1. A common recovery is a ſuit or action, either actual or fictitious: and in it the lands are recovered againſt the tenant of the freehold; which recovery, being a ſuppoſed abjudication of the right, binds all perſons, and veſts a free and abſolute fee-ſimple in the recoverer. To explain this as clearly and conciſely as poſſible, let us, in the firſt place, ſuppoſe David Edwards to be tenant of the freehold, and deſirous to ſuffer a common recovery, in order to bar all entails, remainders, and reverſions, and to convey the ſame in fee-ſimple, to Francis Golding. To effect this, Golding is to bring an action againſt him for the lands; and he accordingly ſues out a writ, called a *præcipe quod reddat*, becauſe theſe were its initial or moſt operative words when the law-proceedings were in Latin. In this writ the demandant Golding alleges, that the defendant Edwards (here called the tenant) has no legal title to the land; but that he came into poſſeſſion of it after one Hugh Hunt had turned the demandant out of it. The ſubſequent proceedings are made up into a record or recovery roll, in which the writ and complaint of the demandant are firſt recited: whereupon the tenant appears, and calls upon one Jacob Morland, who is ſuppoſed, at the original purchaſe, to have warranted the title to the tenant; and thereupon he prays, that the ſaid Jacob Morland may be called in to defend the title which he ſo warranted. This is called the *voucher*, "vocatio," or calling of Jacob Morland to warranty; and Morland is called the *vouchee*. Upon this Jacob Morland, the vouchee, appears, is impleaded, and defends the title. Whereupon Golding the demandant deſires leave of the court to imparl, or confer with the vouchee in private; which is (as uſual) allowed him. And ſoon afterwards the demandant Golding returns to court; but Morland the vouchee diſappears, or makes default. Whereupon judgment is given for the demandant Golding, now called the *recoverer*, to recover the lands in queſtion againſt the tenant Edwards, who is now the recoveree: and Edwards has judgment to recover of Jacob Morland lands of equal value in recompenſe for the lands ſo warranted by him, and now loſt by his default; which is agreeable to the doctrine of warranty mentioned in the preceding chapter. This is called the *recompenſe*, or *recovery in value*. But Jacob Morland having no lands of his own, being uſually the cryer of the court, who, from being frequently thus vouched, is called the *common vouchee*, it is plain that Edwards has only a nominal recompenſe for the lands ſo recovered againſt him by Golding; which lands are now abſolutely veſted in the ſaid recoverer by judgment of law, and ſeiſin thereof is delivered by the ſheriff of the county. So that this colluſive recovery operates merely in the nature of a conveyance in fee-ſimple, from Edwards the tenant in tail to Golding the purchaſer.

The recovery here deſcribed, is with a ſingle voucher only; but ſometimes it is with a double, treble, or further voucher, as the exigency of the caſe may require. And indeed it is now uſual always to have a recovery with double voucher at the leaſt: by firſt conveying an eſtate of freehold to any indifferent perſon, againſt whom the *præcipe* is brought; and then he vouches the tenant in tail, who vouches over the common vouchee. For, if a recovery be had immediately againſt tenant in tail, it bars only ſuch eſtate in the premiſes of which he is then actually ſeized; whereas if the recovery be had againſt another perſon, and the tenant in tail be vouched, it bars every latent right and intereſt which he may have in the lands recovered. If Edwards therefore be tenant of the freehold in poſſeſſion, and John Barker be tenant in tail in remainder, here Edwards doth firſt vouch Barker, and then Barker vouches Jacob Morland the common vouchee; who is always the laſt perſon vouched, and always makes default; whereby the demandant Golding recovers the land againſt the tenant Edwards, and Edwards recovers a recompenſe of equal value againſt Barker the firſt vouchee, who recovers the like againſt Morland the common vouchee, againſt whom ſuch ideal recovery in value is always ultimately awarded.

This ſuppoſed recompenſe in value is the reaſon why the iſſue in tail is held to be barred by a common recovery. For, if the recoveree ſhould obtain a recompenſe in lands from the common vouchee (which there is a poſſibility in contemplation of law, though a very improbable one, of his doing), theſe lands would ſupply the place of thoſe ſo recovered from him by colluſion, and would deſcend to the iſſue in tail. The reaſon will alſo hold with equal force as to moſt remainder-men and reverſioners, to whom the poſſibility will remain and revert, as a full recompenſe for the reality which they were otherwiſe entitled to: but it will not always hold; and therefore, as Pigott ſays, the judges have been even *aſtuti*, in inventing other reaſons to maintain the authority of recoveries. And in particular, it hath been ſaid, that though the eſtate tail is gone from the recoveree; yet it is not deſtroyed, but only transferred, and ſtill ſubſiſts; and will ever continue to ſubſiſt (by conſtruction of law) in the recoveror, his heirs and aſſigns: and as the eſtate-tail ſo continues to ſubſiſt for ever, the remainders or reverſions expectant on the determination of ſuch eſtate-tail can never take place.

To ſuch aukward ſhifts, ſuch ſubtile refinements, and ſuch ſtrange reaſoning, were our anceſtors obliged to have recourſe, in order to get the better of that ſtubborn ſtatute *de donis*. The deſign for which theſe contrivances were ſet on foot was certainly laudable; the unrivetting the fetters of eſtates-tail, which were attended with a legion of miſchiefs to the commonwealth: but, while we applaud the end, we cannot but admire the means. Our modern courts of juſtice have indeed adopted a more manly way of treating the ſubject; by conſidering common recoveries in no other light than as the formal mode of conveyance by which tenant in tail is enabled to aliene his lands. But, ſince the ill conſequences of fettered inheritances are now generally ſeen and allowed, and of courſe the utility and expedience of ſetting them at liberty are apparent, it hath often been wiſhed that the proceſs of this conveyance was ſhortened, and rendered leſs ſubject to niceties, by either totally repealing the ſtatute *de donis*; which, perhaps, by reviving the old doctrine of conditional fees, might give birth to many litigations: or by veſting in every tenant in tail, of full age, the ſame abſolute fee-ſimple at once, which now he may obtain whenever he pleaſes, by the colluſive fiction of a common recovery; though this might poſſibly bear hard upon thoſe in remainder or reverſion, by abridging the chances they would otherwiſe frequently have, as no recovery can be ſuffered in the intervals between term and term, which ſometimes continue for near five months together: or, laſtly, by empowering the tenant in tail to bar the eſtate-tail by a ſolemn deed, to be made in term-time, and enrolled in ſome court of record; which is liable to neither of the other objections, and is warranted not only by the uſage of our American colonies, but by the precedent of the ſtatute 21 Jac. I. c. 19. which, in the caſe of a bankrupt tenant in tail, empowers his commiſſioners to ſell the eſtate at any time, by deed indented and enrolled. And if, in ſo national a concern, the emoluments of the officers concerned in paſſing recoveries are thought to be worthy attention, thoſe might be provided for in the fees to be paid upon each enrollment.

2. The force and effect of common recoveries may appear, from what has been ſaid, to be an abſolute bar not only of all eſtates tail, but of remainders and reverſions expectant on the determination of ſuch eſtates. So that a tenant in tail may, by this method of aſſurance, convey the lands held in tail to the recoverer, his heirs and aſſigns, abſolutely free and diſcharged of all conditions and limitations in tail, and of all remainders and reverſions. But, by ſtatute 34 and 35 H. VIII. c. 20. no recovery had againſt tenant in tail of the king's gift, whereof the remainder or reverſion is in the king, ſhall bar ſuch eſtate-tail, or the remainder or reverſion of the crown. And by the ſtatute 11 H. VII. c. 20. no woman, after her huſband's death, ſhall ſuffer a recovery of lands ſettled on her by her huſband, or ſettled on her huſband and her by any of his anceſtors. And by ſtatute 14 Eliz. c. 8. no tenant for life, of any ſort, can ſuffer a recovery ſo as to bind them in remainder or reverſion. For which reaſon, if there be tenant for life, with remainder in tail, and other remainders over, and the tenant for life be deſirous to ſuffer a valid recovery, either he, or the tenant to the *præcipe* by him made, muſt vouch the remainder-man in tail, otherwiſe the recovery is void: but if he does vouch ſuch remainder-man, and he appears and vouches the common vouchee, it is then good; for if a man be vouched and appears, and ſuffers the recovery to be had, it is as effectual to bar the eſtate-tail as if he himſelf were the recoveree.

In all recoveries, it is neceſſary that the recoveree, or tenant to the *præcipe*, as he is uſually called, be actually ſeized of the freehold, elſe the recovery is void. For all actions to recover the ſeiſin of lands muſt be brought againſt the actual tenant of the freehold, elſe the ſuit will loſe its effect; ſince the freehold cannot be recovered of him who has it not. And, though theſe recoveries are in themſelves fabulous and fictitious, yet it is neceſſary that there be *actores fabulæ*, properly qualified. But the nicety thought by ſome modern practitioners to be requiſite in conveying the legal freehold, in order to make a good tenant to the *præcipe*, is removed by the proviſions of the ſtatute 14 Geo. II. c. 20. which enacts, with a retroſpect and conformity to the ancient rule of law, that, though the legal freehold be veſted in leſſees, yet thoſe who are entitled to the next freehold eſtate in remainder, or reverſion, may make a good tenant to the *præcipe*; and that, though the deed or fine which creates ſuch tenant be ſubſequent to the judgment of recovery, yet if it be in the ſame term, the recovery ſhall be valid in law: and that though the recovery itſelf do not appear to be entered, or be not regularly entered on record, yet the deed to make a tenant to the *præcipe* and declare the uſes of the recovery, ſhall after a poſſeſſion of 20 years be ſufficient evidence on behalf of a purchaſer for valuable conſideration, that ſuch recovery was duly ſuffered.

Recovery of perſons drowned, or apparently dead. See Drowning.

RECREANT, Cowardly, *Faint-hearted*; formerly a word very reproachful. See Battel.

RECREMENT, in chemiſtry, ſome ſuperfluous matter ſeparated from ſome other that is uſeful; in which ſenſe it is the ſame with *ſcoriæ*, *fæces*, and *excrements*.

RECRIMINATION, in law, an accuſation brought by the accuſed againſt the accuſer upon the ſame fact.

RECRUITS, in military affairs, new-raiſed ſoldiers deſigned to ſupply the place of thoſe who have loſt their lives in the ſervice, or who are diſabled by age or wounds.

RECTANGLE, in geometry, the ſame with a right-angled parallelogram. See GEOMETRY.

RECTIFICATION, in chemiſtry, is nothing but the repetition of a diſtillation or ſublimation ſeveral times, in order to render the ſubſtance purer, finer, and freer from aqueous and earthy parts.

RECTIFICATION *of Spirits*. See DISTILLATION.

RECTIFIER, in navigation, an inſtrument conſiſting of two parts, which are two circles, either laid one upon, or let into the other, and ſo faſtened together in their centres, that they repreſent two compaſſes, one fixed, the other moveable; each of them divided into the 32 points of the compaſs, and 360°, and numbered both ways, from the north and the ſouth, ending at the eaſt and weſt, in 90°. The fixed compaſs repreſents the horizon, in which the north and all the other points of the compaſs are fixed and immoveable. The moveable compaſs repreſents the mariner's compaſs; in which the north and all other points are liable to variation. In the centre of the moveable compaſs is faſtened a ſilk thread, long enough to reach the outſide of the fixed compaſs. But if the inſtrument be made of wood, there is an index inſtead of the thread. Its uſe is to find the variation of the compaſs, to rectify the courſe at ſea; having the amplitude or azimuth given.

RECTIFYING the GLOBE. See GEOGRAPHY.

RECTILINEAR, in geometry, right-lined; thus figures whoſe perimeter conſiſts of right lines are ſaid to be rectilinear.

RECTITUDE, in philoſophy, refers either to the act of judging or of willing; and therefore whatever comes under the denomination of rectitude, is either what is true or what is good, theſe being the only objects about which the mind exerciſes its two faculties of judging and willing. *Moral* rectitude, or uprightneſs, is the chooſing and purſuing thoſe things which the mind, upon due inquiry and attention, clearly perceives to be good; and avoiding thoſe that are evil. See MORAL *Philoſophy*.

RECTOR, a term applied to ſeveral perſons whoſe offices are very different: as, 1. The rector of a pariſh is a clergyman that has the charge and cure of a pariſh, and poſſeſſes all the tithes, &c. 2. The ſame name is alſo given to the chief elective officer in ſeveral foreign univerſities, particularly in that of Paris, and alſo in thoſe of Scotland. It is alſo applied to the head maſter of large ſchools in Scotland, as in the high ſchool of Edinburgh. 3. Rector is alſo uſed in ſeveral convents for the ſuperior officer who governs the houſe: and the Jeſuits give this name to the ſuperiors of ſuch of their houſes as are either ſeminaries or colleges.

RECTORY, a pariſh church, parſonage, or ſpiritual living, with all its rights, tithes, and glebes. Rectory is alſo ſometimes uſed for the rector's manſion or parſonage-houſe.

RECTUM, in anatomy, the third and laſt of the large inteſtines or guts. See ANATOMY.

RECTUS, in anatomy, a name common to ſeveral pairs of muſcles, ſo called on account of the ſtraightneſs of their fibres.

RECUPERATORES, among the Romans, were commiſſioners appointed to take cognizance of private matters in diſpute, between the ſubjects of the ſtate and foreigners, and to take care that the former had juſtice done them. It came at laſt to be uſed for commiſſioners, to whom the prætor referred the determination of any affair between one ſubject and another.

RECURRENTS, in anatomy, a name given to ſeveral large branches of nerves ſent out by the par vagum from the upper part of the thorax to the larynx.

RECURVIROSTRA, in ornithology; a genus belonging to the order of grallæ of Linnæus, and that of palmipedes of Pennant and Latham. The bill is long, ſubulated, bent back, ſharp and flexible at the point. The feet are webbed, and furniſhed with three toes forwards, and a ſhort one behind. Mr. Latham notes of this genus three ſpecies, viz. the Avoſetta, or the one commonly known, the Americana, and the Alba. This laſt, it is probable, has ſome affinity to the Americana. The recurviroſtra avoſetta is about the ſize of a lapwing in body, but has very long legs. The ſubſtance of the bill is ſoft, and almoſt membranous at its tip; it is thin, weak, ſlender compreſſed horizontally, and incapable of defence or effort. Theſe birds are variegated with black and white, and during the winter are frequent on the eaſtern ſhores of Great Britain. They viſit alſo the Severn, and ſometimes the pools of Shropſhire. They feed on worms and inſects, which they ſcoop out of the ſand with their bills. They lay two eggs, white, with a greeniſh hue, and large ſpots of black; theſe eggs are about the ſize of a pigeon's. They are found alſo in various parts of the continent of Europe, in Ruſſia, Denmark, and Sweden, but they are not numerous. They are alſo found in Siberia, but oftener about the ſalt lakes of the Tartarian deſart, and about the Caſpian ſea. They are found likewiſe on the coaſts of Picardy in France in April and November, and at Orleans, but rarely. In breeding-time they are very plentiful on the coaſts of Bas Poictou. They do not appear to wander further ſouth in Europe than Italy. Whether from timidity or addreſs, the avoſet ſhuns ſnares, and is not eaſily taken. The American avoſet is rather larger and longer than the laſt. The bill is ſimilar, and its colour black: the forehead is duſky white: the head, neck, and upper part of the breaſt, are of a deep cream-colour: the lower parts of the neck behind white: the back is black, and the under parts from the breaſt pure white: the wings are partly black, partly white, and partly aſh-coloured. Theſe birds inhabit North America, and were found by Dampier in Shark's Bay, on the coaſt of New Holland. See plate 41.

The recurviroſtra, or ſcolopax alba, is about 14 inches and a quarter long, its colour white, the inferior coverts of its wings duſkiſh, its bill orange, its legs brown. Edwards remarks that the bill of this bird is bent upwards, as in the avoſet; its bill black at the tip, and orange the reſt of its length; all the plumage is white, except a tint of yellowiſh on the great quills of the wing and of the tail. Edwards ſuppoſes that the whiteneſs is produced by the cold climate of Hudſon's Bay, from which he received it, and that they reſume their brown feathers during the ſummer. It appears that ſeveral ſpecies of this bird have ſpread further into America, and have even reached the ſouthern provinces: for Sloane found our third ſpecies in Jamaica; and Fernandez ſeems to indicate two of them in New Spain, by the names *chiquatotl* and *clototell*; the former being like our woodcock, and the latter lodging under the ſtalks of maize.

A bird of this kind, Mr. Latham ſays, was ſent from Hudſon's Bay, and from the figure, has every appearance of an avoſet: however, in Edwards's plate the toes appear cloven to the bottom; a circumſtance ſeeming to overturn the ſuppoſition, and only to be authenticated when other ſpecimens ſhall have come under the eye of the well-informed naturaliſt.

RECUSANTS, ſuch perſons as acknowledge the pope to be the ſupreme head of the church, and refuſe to acknowledge the king's ſupremacy; who are hence called *Popiſh recuſants*. The penal laws againſt papiſts are now aboliſhed in Britain and in Ireland; and in all probability they will quickly be allowed the ampleſt privileges.

Red, one of the colours called *ſimple* or *primary*: being one of the ſhades into which the light naturally divides itſelf when refracted through a priſm. See Chromatics.

Red, in dyeing, ſee that article.—Some reckon ſix kinds or caſts of red, viz. ſcarlet-red, crimſon-red, madder-red, half-grain red, lively orange-red, and ſcarlet of cochineal: but it is eaſy to ſee that there can be but one proper ſpecies of red; namely, the reflection of the light exactly in ſuch a manner as it is refracted by the priſm; all other ſhades being adulterations of that pure colour, with yellow, brown, &c.

Red, in heraldry. See Gules.

Red-*Bird*. See Muscicapa.

Red-*Breaſt*, in ornithology, See Motacilla.

Red-*Book* of the exchequer, an ancient record or manuſcript volume, in the keeping of the king's remembrancer, containing divers miſcellany treatiſes relating to the times before the Conqueſt.

Red-*Lead*. See Chemistry.

Red-*Ruſſia*, or *Little Ruſſia*, a province of Poland, bounded on the weſt by Upper Poland, on the north by Lithuania, on the eaſt by the country of the Little Tartars, and on the ſouth by Moldavia, Tranſylvania, and a part of Hungary. It comprehends Ruſſia properly ſo called, Volhinia, and Podolia. It is about 650 miles in length, and from 150 to 250 in breadth. It conſiſts chiefly of large fields, but little cultivated on account of the frequent inroads of the Tartars, and becauſe there is no water-carriage. It had the name of *Red Ruſſia* from the colour of the hair of its inhabitants. Ruſſia, properly ſo called, comprehends the three palatinates of Leopol or Lemburg, Belſko, and Chelm.

Red-*Sea*, or *Arabic Gulph*, ſo much celebrated in ſacred hiſtory, ſeparates Arabia from Upper Ethiopia and part of Egypt. This ſea is 350 leagues in length and 40 in breadth. As no river falls into it of ſufficient force to counteract the influence of the tide, it is more affected by the motions of the great ocean than any of the inland ſeas nearly in the ſame latitude. It is not much expoſed to tempeſts: the winds uſually blow from north to ſouth, and being periodical, like the monſoons of India, invariably determine the ſeaſon of ſailing into or out of this ſea. It is divided into two gulphs; that to the eaſt was called the *Ælanitic gulph*, from the city Ælana at the north end of it; and that to the weſt the *Heroopolitic*, from the city of Heroopolis; the former of which belongs to Arabia, and the latter to Egypt.

Mr. Bruce has made many obſervations on this ſea, which are worthy of notice.—With regard to the name, he ſays it was certainly derived from Edom or Eſau the ſon of Jacob; though in another place he ſays, he wonders that writers have not rather ſuppoſed it to have got the epithet of *Red*, from the colour of the ſand on its coaſts, than for other reaſons they have alleged With regard to any redneſs in the water itſelf, or in the bottom, which ſome have aſſerted, our traveller aſſures us that there is no ſuch thing. It is more difficult to aſſign a reaſon for the Hebrew name of it, which ſignifies the *Sea of Weeds*; as he never ſaw a weed throughout the whole extent of it. "Indeed, (ſays he) upon the ſlighteſt conſideration, it will occur to any one, that a narrow gulph under the immedite influence of the monſoons, blowing from contrary points ſix months each year, would have too much agitation to produce ſuch vegetables, ſeldom found but in ſtagnant waters, and ſeldom, if ever, found in ſalt ones. My opinion then is, that it is from the large trees or plants of white coral, ſpread everywhere over the bottom of the Red Sea, perfectly in imitation of plants on land, that the ſea has obtained this name.—I ſaw one of theſe, which, from a root nearly central, threw out ramifications of an almoſt circular form meaſuring 26 feet every way."

Our author has alſo made many uſeful obſervations on the navigation of this ſea. "All the weſtern ſhore (he ſays) is bold, and has more depth of water than the eaſt; but on this ſide there is neither anchoring ground nor ſhoals. It is rocky, with a conſiderable depth of water everywhere; and there are a number of ſunken rocks, which, though not viſible, are ſufficiently near the ſurface to deſtroy a large ſhip." The cauſe of this, in Mr. Bruce's opinion, is, that the mountains on the ſide of Abyſſinia and Egypt are all of hard ſtone, porphyry, many different kinds of marble, granite, alabaſter, and baſaltes. Theſe being all compoſed of ſolid materials; therefore, can part with very little duſt or ſand, which might otherwiſe be blown from them into the ſea. On the oppoſite coaſt, viz. that of Hejaz and Tahamah, on the Arabian ſide, the whole conſiſts of moving ſands; a large quantity of which is blown from the ſouth-eaſt by the dry winter monſoons; which being lodged among the rocks on that ſide, and confined there by the north-eaſt or ſummer monſoon, which is in a contrary direction, hinders them from coming over to the Egyptian ſide. Hence the weſtern coaſt is full of ſunk rocks for want of ſand to cover them, with which they would otherwiſe become iſlands. They are naked and bare all round, with ſharp points like ſpears; while, on the eaſt-ſide, every rock becomes an iſland, and every two or three iſlands become a harbour. On the ends of the principal of theſe harbours the people have piled up great heaps of ſtones to ſerve as ſignals: "and it is theſe (ſays Mr. Bruce) that the large veſſels from Cairo to Jidda, equal in ſize to our large 74-gun ſhips (but, from the ciſterns of maſon-work built within for holding water, I ſuppoſe double their weight), after navigating their portion of the channel in the day-time, come ſafely and quietly to at four o'clock in the afternoon; and in theſe little harbours paſs the night, to ſail into the channel again next morning."

The weſtern channel of the Red Sea was choſen, in the days of the Ptolemies, for the track of the Indian and African. Theſe monarchs erected a great number of cities all along the weſtern coaſt; and, notwithſtanding the dangers of the navigation, we do not hear that it was ever abandoned on account of them.

From the obſervations made by our author on the navigation of the Red Sea, he undertakes to point out a ſafe paſſage for large ſhips to the gulph of Suez, ſo that they may be able to judge of the propriety of their own courſe themſelves, without truſting implicitly to the pilots they met with, who are often very ignorant of their profeſſion. This ſea, according to Mr. Bruce, may be divided into four parts, of which the channel occupies two, till near the latitude of 26°, or that of Coſſair. On the weſt it is deep water, with many rocks; and on the eaſt it is full of iſlands, as has been already mentioned. Between theſe iſlands there are channels and harbours of deep water, where ſhips may be protected in any wind; but a pilot is neceſſary in ſailing among theſe from Mocha to Suez, and the voyage beſides can be only continued during part of the day. Ships bound to Suez without the conſent of the ſheriffe of Mecca, that is, without any intention of ſelling their cargo at Jidda, or paying cuſtom there, ought to take in their freſh water at Mocha; or if there be any reaſon againſt this, a few hours will carry them to Azab or Saba on the Abyſſinian coaſt, where they may be plentifully ſupplied: but it muſt be remembered, "that the people here are *Galla*, the moſt treacherous and villanous wretches on earth." Here not only water may be procured, but plenty of ſheep, goats, with ſome myrrh, and incenſe in the proper ſeaſon.—Great caution, however, muſt be uſed in dealing with the people, as even thoſe of Mocha, who are abſolutely neceſſary to them in their commercial dealings, cannot truſt them without ſurety or hoſtages. Not many years ago, the ſurgeon and mate of the Elgin Eaſt Indiaman, with ſeveral other ſailors, were murdered by theſe ſavages as they went aſhore to purchaſe myrrh, though they had a letter of ſafe conduct from the ſhekh.

To ſuch as do not want to be known, our author recommends a low black iſland on the coaſt of Arabia named *Camaran*, in latitude 15° 30′. It is diſtinguiſhed by a white houſe or fortreſs on the weſt end of it; where water is to be had in ſtill greater plenty than at Azab; but no proviſions, or ſuch only as are very bad, can be procured. If it is neceſſary not to be ſeen at all on the coaſt, the iſland of Fooſht is recommended by our author as having excellent water, with a ſaint or monk, whoſe office is to keep the wells clean. This is one of the chain of iſlands which ſtretches almoſt acroſs the gulph from Loheia to Maſuah, and from actual obſervation by Mr. Bruce, is found to be ſituated in N. lat. 15° 59′ 43″. E. lon. 42° 47′. From this to Yambo there is a ſafe watering-place; and there is an abſolute neceſſity for having a pilot before you come to Ras Mahomet; becauſe, over the Ælanitic gulph, the mountains of Aucha, and the Cape itſelf, there is often a thick haze which laſts for many days together, and a number of ſhips are loſt by miſtaking the eaſtern bay or Ælanitic gulph for the entrance of the gulph of Suez; the former has a ridge of rocks nearly acroſs it. After reaching Sheduan, a large iſland, about three leagues further in a north by weſt direction, there is a bare rock diſtinguiſhed by no particular name; but ſo ſituated that ſhips ought not to come within three leagues of it. This rock is to be left to the weſtward at the diſtance juſt mentioned; after paſſing which you meet with ſhoals forming a pretty broad channel, with ſoundings from 15 to 30 fathoms; and again, on ſtanding directly for Tor, there are two other oval ſands with ſunk rocks in the channel, between which you are to ſteer. Tor may be known at a diſtance by two hills that ſtand near the water ſide; which, in clear weather, may be ſeen ſix leagues off. Juſt to the ſouth-eaſt of theſe is the town and harbour, where there are ſome palm-trees about the houſes, the more remarkable, as being the firſt that are ſeen on the coaſt. The ſoundings in the way to Tor harbour are clean and regular; "and, by giving the beacon a ſmall birth on the larboard hand, you may haul in a little to the northward, and anchor in five or ſix fathom." In ſpring-tides it is high water at Tor nearly about 12 o'clock: in the middle of the gulph there is no perceptible tide, but at the ſides it runs at the rate of more than two knots in the hour. Tor itſelf is but a ſmall village, with a convent of monks belonging to thoſe of Mount Sinai. It was taken by Don John de Caſtro, and fortified ſoon after its diſcovery by the Portugueſe; but has never ſince been a place of any conſideration; ſerving now only for a watering place to the ſhips trading to or from Suez.—From this place there is a diſtinct view of mounts Horeb and Sinai, which appear above and behind the others, with their tops frequently covered with ſnow in the winter.

Mr. Bruce next proceeds to conſider ſome queſtions which may be reckoned matters of curioſity rather than any thing elſe. One of theſe is concerning the level of the water of this ſea itſelf, which has been ſuppoſed ſeveral feet above that of the Mediterranean. "To this (ſays our author) I anſwer that the fact has been ſuppoſed to be ſo by antiquity, and alleged as a reaſon why Ptolemy's canal was made from the bottom of the Heroopolitic gulph rather than brought due north acroſs the iſthmus of Suez; in which laſt caſe it was feared it would ſubmerge a great part of Aſia Minor. But who has ever attempted to verify this by experiment? or who is capable of ſettling the difference of levels, amounting, as ſuppoſed, to ſome feet and inches, between two points 120 miles diſtant from each other, over a deſert that has no ſettled ſurface, but is changing its height every day? Beſides, ſince all ſeas are in fact but one, what is it that hinders the Indian ocean to flow to its level? What is it that keeps the Indian ocean up? Till this laſt branch of the queſtion is reſolved, I ſhall take it for granted that no ſuch difference of level exiſts, whatever Ptolemy's engineers might have pretended to him; becauſe to ſuppoſe it fact is to ſuppoſe the violation of one very material law of nature."

The next thing conſidered by our author is the paſſage of the Iſraelites through the Red Sea. At the place where he ſuppoſes the paſſage to have been, the ſea is not quite four leagues broad, ſo that it might eaſily have been croſſed in one night without any miracle. There is about 14 fathom water in the channel, and 9 at the ſides, with good anchorage everywhere; the furtheſt ſide is a low ſandy coaſt, and a very eaſy landing place. "The draught of the bottom of the gulph (ſays he) given by Dr. Pococke, is very erroneous in every part of it. It was propoſed to Mr. Niebuhr, when in Egypt, to inquire upon the ſpot, whether there were not ſome ridges of rocks where the water was ſhallow, ſo that an army at particular times might paſs over? Secondly, whether the Eteſian winds, which blow ſtrongly all ſummer from the north-weſt, could not blow ſo violently againſt the ſea, as to keep it back on a heap, ſo that the Iſraelites might have paſſed without a miracle? And a copy of theſe queries was left for me to join my inquiries likewiſe. But I muſt confeſs, however learned the gentlemen were who propoſed theſe doubts, I did not think they merited any attention to ſolve them. If the Eteſian winds, blowing from the north-weſt in ſummer, could heap up the ſea as a wall on the right or to the ſouth, of 50 feet high, ſtill the difficulty would remain of building the wall on the left hand or to the north. Beſides, water ſtanding in that poſition for a day, muſt have loſt the nature of a fluid. Whence came that coheſion of particles that hindered that wall to eſcape at the ſides? This is as great a miracle as that of Moſes. If the Eteſian winds had done this once, they muſt have repeated it many a time before and ſince, from the ſame cauſes. Yet Diodorus Siculus ſays, the Troglodytes, the indigenous inhabitants of that very ſpot, had a tradition from father to ſon, from their very earlieſt and remoteſt ages, that once this diviſion of the ſea did happen there; and that, after leaving the bottom ſome time dry, the ſea again came back and covered it with great fury. The words of this author are of the moſt remarkable kind. We cannot think this heathen is writing in favour of revelation. He knew not Moſes, nor ſays a word about Pharaoh and his hoſt; but records the miracle of the diviſion of the ſea in words nearly as ſtrong as thoſe of Moſes, from the mouths of unbiaſſed undeſigning pagans."

Red-*Shank*, in ornithology. See Scolopax.

Red-*Start*, a ſpecies of Motacilla.

Red-*Wing*. See Turdus.

REDANS, in field fortification. See the article Redens.

REDDENDUM, in law, is uſed ſubſtantively for the clauſe in a leaſe wherein the rent is reſerved to the leſſor. The proper place for it is next after the limitation of eſtate.

REDDITIO, was the third part of the ſacrifice of the heathens, and conſiſted of the ſolemn act of putting in again the entrails of the victims, after they had been religiouſly inſpected. See Sacrifice.

REDDLE, a ſoft, heavy, red marle, of great uſe in colouring; and being waſhed and freed from ſand, is often ſold by our druggiſts under the name of *bole armenic*.

REDEMPTION, in law, a faculty or right of re-entering upon lands, &c. that have been ſold and aſſigned, upon reimburſing the purchaſe-money with legal coſts.

Redemption, in theology, denotes the recovery of mankind from ſin and death, by the obedience and ſacrifice of Chriſt, who on this account is called the *Redeemer of the world*. See Theology.

REDENS, Redans, or *Redant*, in fortification, a kind of work indented in form of the teeth of a ſaw, with ſaliant and re-entering angles; to the end that one part may flank or defend another. It is likewiſe called *ſaw-work* and *indented work*. The lines or faces in this flank one another. Redens are uſed in fortifying walls, where it is not neceſſary to be at the expenſe of building baſtions; as when they ſtand on the ſide of a river running through a garriſon town, a marſh, the ſea, &c. But the fault of ſuch fortification is, that the beſiegers from one battery may ruin both the ſides of the tenaille or front of a place, and make an aſſault without fear of being enfiladed, ſince the defences are mined. The parapet of the corridor is likewiſe often redented or carried on by the way of redens. The redens was uſed before baſtions were invented, and ſome people think them preferable.

REDI (Francis), an Italian phyſician and polite ſcholar, was born at Arezzo in Tuſcany in 1626. His ingenuity and learning recommended him to the office of firſt phyſician to Ferdinand II. duke of Tuſcany; and he contributed not a little toward the compiling of the Dictionary of La Cruſca. He wrote upon vipers, upon the generation of inſects, and compoſed a good deal of poetry. All his writings are in Italian; and his language is ſo fine and pure, that the authors of the Dictionary of La Cruſca have often cited them as ſtandards of perfection. He died in 1697.

REDOUBT, in fortification, a ſmall ſquare fort, without any defence but in front; uſed in trenches, lines of circumvallation, contravallation, and approach; as alſo for the lodgings of the corps-de-gard, and to defend paſſages.

REDUCTION, in the ſchools, a manner of bringing a term or propoſition, which was before oppoſite to ſome other, to be equivalent to it.

Reduction, in arithmetic, that rule whereby numbers of different denominations are brought into one denomination. See Arithmetic.

Reduction *of Equations*, in algebra, is the clearing them from all ſuperfluous quantities, bringing them to their loweſt terms, and ſeparating the known from the unknown, till at length only the unknown quantity is found on one ſide, and known ones on the other. The reduction of an equation is the laſt part of the reſolution of the problem. See Algebra.

Reduction of a figure, deſign, or draught, is the making a copy thereof, either larger or ſmaller than the original; ſtill preſerving the form and proportion. The great uſe of the proportional compaſſes is the reduction of figures, &c. whence they are called *compaſſes of reduction*. See the article Compass. There are various methods of reducing figures, &c. the moſt eaſy is by means of the pentagraph, or parallelogram; but this has its defects. See the article Pentagraph.

The beſt and moſt uſual methods of reduction are as follow: 1. To reduce a figure, as ABCDE (pl. 39, No. 1.), into a leſs compaſs. About the middle of the figure, as *z*, pitch on a point, and from this point draw lines to its ſeveral angles A, B, C, &c. then drawing the line *ab* parallel to AB, *bc* parallel to BC, &c. you will have the figure *abcde* ſimilar to ABCDE. If the figure *abcde* had been required to be *enlarged*, there needed nothing but to produce the lines from the point beyond the angles, as *z*D, *z*C, and to draw lines, viz. DC, CB, &c. parallel to the ſides *dc*, *cb*, &c. 2. To reduce a figure by the *angle of proportion*, ſuppoſe the figure ABCDE (No. 2.) required to be diminiſhed in the proportion of the line AB to *ab* (No. 3.), draw the indefinite line GH (No. 4.), and from G to H ſet off the line AB. On G deſcribe the arch HI. Set off the line *ab* as a chord on HI, and draw GI. Then with the angle IGH, you have all the meaſures of the figure to be drawn. Thus to lay down the point *c*, take the interval BC, and upon the point G deſcribe the arch KL. Alſo on the point G deſcribe MN; and upon A, with the diſtance of MN, deſcribe an arch cutting the preceding one in *c*, which will determine the ſide *bc*. And after the ſame manner are the other ſides and angles to be deſcribed. The ſame proceſs will alſo ſerve to enlarge the figure. 3. To reduce a figure by a *ſcale*. Meaſure all the ſides of the figure, as ABCDE (No. 2.) by a ſcale, and lay down the ſame meaſures reſpectively from a ſmaller ſcale in the proportion required. 4. To reduce a map, deſign, or figure, *by ſquares*. Divide the original into little ſquares, and divide a freſh paper of the dimenſions required into the ſame number of ſquares, which are to be larger or leſs than the former, as the map is to be enlarged or diminiſhed. This done in every ſquare of the ſecond figure, draw what you find in its correſpondent one in the firſt.

Reduction, in metallurgy, is the bringing back metalline ſubſtances which have been changed into ſcoriæ or aſhes, or otherwiſe diveſted of their metallic form, into their natural and original ſtate of metals again. See Metallurgy, *paſſim*; and Chemistry.

Reduction, in ſurgery, denotes an operation whereby a diſlocated, luxated, or fractured bone, is reſtored to its former ſtate or place.

REDUNDANCY, a fault in diſcourſe, conſiſting in the uſe of a ſuperfluity of words. Words perfectly ſynonymous are redundant, and ought to be retrenched.

REDUNDANT, in muſic. What the French call *une accord ſuperflue*, which we have tranſlated *a redundant chord* in the article Music (from d'Alembert), has by others been rendered *a chord extremely ſharp*, as in the tranſlation of Rameau's Principles of Compoſition. Their nature will be beſt underſtood by a few examples, and an account of the number of tones, ſemitones, or leſſer intervals, contained in each. The *ſecond redundant* is compoſed of a major tone, and a minor ſemitone; as from *fa* to *ſol* ſharp. Its proportion is as 64 to 75. The *third redundant* conſiſts of two tones and a ſemitone, as *fa*, *la*, ſharp. Its proportion is as 96 to 125. The *fourth redundant* is the ſame with the tritone. From theſe examples compared with the ſame intervals in their natural ſtate, the reader may form a general idea of what is meant by *redundant*.

REE, Reis, or *Res*, a little Portugueſe coin. See Money-*Table*.

REED, in botany. See Arundo and Bamboo. There are two ſorts of reeds, ſays Haſſelquiſt, growing near the Nile. One of them has ſcarce any branches; but is furniſhed with numerous leaves, which are narrow, ſmooth, channelled on the upper ſurface; and the plant is about 11 feet high. The Egyptians make ropes of the leaves. They lay them in water like hemp, and then make them into good ſtrong cables. Theſe, with the bark of the date-tree, form almoſt the only cable uſed in the Nile. The other ſort is of great conſequence. It is a ſmall reed, about two or three feet high, full branched, with ſhort, ſharp, lancet-ſhaped leaves. The roots, which are as thick as the ſtem, creep and mat themſelves together to a conſiderable diſtance. This plant ſeems uſeleſs in common life: but to it, continues the learned author, is the very ſoil of Egypt owing: for the matted roots have ſtopped the earth which floated in the waters, and thus formed, out of the ſea, a country that is habitable.

Fire-Reeds. See Fire-*Ship*.

Reed, a term in the weſt of England for the ſtraw uſed by thatchers, which is wheat ſtraw finely combed, conſiſting of ſtiff, unbruiſed, and unbroken ſtalks of great length, carefully ſeparated from the ſtraw uſed for fodder by the threſher, and bound in ſheaves or nitches, each of which weighs 28 lb. and are ſold from 21 s. to 31 s. per hundred nitches, according to the ſeaſon. This is a great improvement in the art of thatching, as it gives a finiſh to the work which cannot be attained by ſtraw, rough and tumbled together, without any ſeparation of the long and ſhort: it alſo is a readier mode of working.

REEF, a term in navigation. When there is a great gale of wind, they commonly roll up part of the ſail below, that by this means it may become the narrower, and not draw ſo much wind; which contracting or taking up the ſail they call a *reef*, or *reefing the ſail:* ſo alſo when a *top-maſt is ſprung*, as they call it, that is, when it is cracked, or almoſt broken in the cap, they cut off the lower piece that was near broken off, and ſetting the other part, now much ſhorter, in the ſtep again, they call it a *reefed top-maſt*.

REEL, in the manufactories, a machine ſerving for the office of reeling. There are various kinds of reels; ſome very ſimple, others very complex.

REELING, in the manufactories, the winding of ſilk, cotton or the like, into a ſkain, or upon a button, to prevent its entangling. It is alſo uſed for the charging or diſcharging of bobbins, or quills, to uſe them in the manufacture of different ſtuffs, as thread, ſilk, cotton, &c. Reeling is performed in different ways, and on different engines.

REEVING, in the ſea language, the putting a rope through a block: hence to pull a rope out of a block is called *unreeving*.

RE-EXCHANGE, in commerce, a ſecond payment of the price of exchange, or rather the price of a new exchange due upon a bill of exchange that comes to be proteſted, and to be refunded the bearer by the drawer or indorſer.

REFECTION, among eccleſiaſtics, a ſpare meal or repaſt juſt ſufficing for the ſupport of life: hence the hall in convents, and other communities, where the monks, nuns, &c. take their refections or meals in common, is called the *refectory*.

REFERENCE, in writing, &c. a mark relative to another ſimilar one in the margin, or at the bottom of the page, where ſomething omitted in the text is added, and which is to be inſerted either in reading or copying.

REFINING, in general, is the art of purifying a thing; including not only the eſſaying or refining of metals, but likewiſe the depuration or clarification of liquors. See METALLURGY, Part II. CLARIFICATION, and PHARMACY. Gold and ſilver may be refined by ſeveral methods, which are all founded on the eſſential properties of theſe metals, and acquire different names according to their kinds. Thus, for inſtance, gold having the property which no other metal, not even ſilver, has, of reſiſting the action of ſulphur, of antimony, of nitrous acid, of marine acid, may be purified by theſe agents from all other metallic ſubſtances, and conſequently may be refined. Theſe operations are diſtinguiſhed by proper names, as *purification of gold by antimony*, *parting*, *concentrated parting*, *dry parting*. See PARTING. In a ſimilar manner, as ſilver has the property, which the imperfect metals have not, of reſiſting the action of nitre, it may be refined by this ſalt: but the term *refining* is chiefly applied to the purification of gold and ſilver by lead in the cupel. This is performed by the deſtruction, vitrification, and ſcorification, of all the extraneous and deſtructible metallic ſubſtances with which they are all allayed.

As none but the perfect metals can reſiſt the combined action of air and fire, without loſing their inflammable principle and being changed into earthy or vitreous matters, incapable of remaining any longer united with ſubſtances in a metallic ſtate, there is then a poſſibility of purifying gold and ſilver from all allay of imperfect metals merely by the action of fire and air; only by keeping them fuſed till all the allay be deſtroyed: but this purification would be very expenſive, from the great conſumption of fuel, and would be exceedingly tedious. Silver allayed with copper has been expoſed longer than 60 hours to a glaſs-houſe fire without being perfectly refined: the reaſon of which is, that when a ſmall quantity only of imperfect metal remains united with gold or ſilver, it is covered and protected from the action of the air, which is neceſſary for the combuſtion of the imperfect metals, as of all combuſtible matters.

This refining of gold and ſilver merely by the action of fire, which was the only method anciently known, was very long, difficult, expenſive, and imperfect; but a much ſhorter and more advantageous method has been diſcovered. This method conſiſts in adding to the allayed gold and ſilver a certain quantity of lead, and in expoſing afterwards this mixture to the action of the fire. Lead is one of the metals which loſes moſt quickly and eaſily a ſufficient quantity of its inflammable principle to ceaſe to be in a metallic ſtate; but, at the ſame time, this metal has the remarkable property of retaining, notwithſtanding the action of the fire, enough of this ſame inflammable principle to be very eaſily melted into a vitrified and powerfully vitrifying matter, called *litharge*.

The lead then which is to be added to the gold and ſilver to be refined, or which happens naturally to be mixed with theſe metals, produces in their refining the following advantages: 1. By increaſing the proportion of imperfect metals, it prevents them from being ſo well covered and protected by the perfect metals. 2. By uniting with theſe imperfect metals, it communicates to them a property it has of loſing very eaſily a great part of its inflammable principle. 3. By its vitrifying and fuſing property which it exerciſes with all its force upon the calcined and naturally refractory parts of the other metals, it facilitates and accelerates the fuſion, the ſcorification, and the ſeparation of theſe metals. Theſe are the advantages procured by lead in the refining of gold and ſilver.

The lead, which in this operation is ſcorified, and ſcorifies along with it the imperfect metals, ſeparates from the metallic maſs, with which it is then incapable of remaining united. It floats upon the ſurface of the melted maſs; becauſe, by loſing part of its phlogiſton, it loſes alſo part of its ſpecific gravity, and laſtly it vitrifies.

Theſe vitrified and melted matters accumulating more and more upon the ſurface of the metal while the operation advances, would protect this ſurface from the contact of air which is ſo abſolutely neceſſary for the ſcorification of the reſt, and would thus ſtop the progreſs of the operation, which could never be finiſhed if a method had not been contrived for their removal. This removal of the vitrified matter is procured either by the nature of the veſſel in which the melted matter is contained, and which being porous, abſorbs and imbibes the ſcorified matter as faſt as it is formed, or by a channel cut in the edge of the veſſel through which the matter flows out.

The veſſel in which the refining is performed is flat and ſhallow, that the matter which it contains may preſent to the air the greateſt ſurface poſſible. This form reſembles that of a cup, and hence it has been called *cupel*. The furnace ought to be vaulted, that the heat may be applied upon the ſurface of the metal during the whole time of the operation. Upon this ſurface a cruſt of dark-coloured pellicle is continually forming. In the inſtant when all the imperfect metal is deſtroyed, and conſequently the ſcorification ceaſes, the ſurface of the perfect metals is ſeen, and appears clean and brilliant. This forms a kind of fulguration or coruſcation. By this mark the metal is known to be refined. If the operation be ſo conducted that the metal ſuſtains only the preciſe degree of heat neceſſary to keep it fuſed before it be perfectly refined, we may obſerve that it fixes or becomes ſolid all at once in the very inſtant of the coruſcation; becauſe a greater heat is required to keep ſilver or gold in fuſion when they are pure than when allayed with lead.

The operation of refining may be performed in ſmall or in large quantities, upon the ſame principles, but only with ſome differences in the management. As the refining of ſmall quantities of perfect metals is performed in the ſame manner as theſe metals are eſſayed, the eſſay being only a very accurate refining, we refer to the article ESSAY *of the Value of Silver*.

Large quantities of ſilver are thus purified, after the operations by which that metal is obtained from its ores. This ſilver, being always much allayed, is to be mixed with a ſufficient quantity of lead to complete its purification, unleſs lead has been added in its firſt fuſion from the ore, or unleſs it has been extracted from an ore which alſo contains lead; in which latter caſe, it is allayed naturally with a ſufficient quantity, or more than ſufficient, for the refining of it.

REFLECTION, the return or progreſſive motion of a moving body, occaſioned by ſome obſtacle which hindered it from purſuing its former direction.

Circular Inſtrument of REFLECTION, an inſtrument for meaſuring angles to a very great degree of accuracy. It was invented by the celebrated aſtronomer Mr. Tobias Mayer of Göttingen, principally with a view to do away the errors of the diviſions of the limb; and has ſince been much improved by the Chevalier de Borda, and M. J. H. de Magellan. This inſtrument is particularly applicable to the meaſuring of the diſtances of the heavenly bodies, and was uſed by the French in their part of the operation for determining the difference of meridians of Paris and Greenwich. For the deſcription, rectification, and uſe of this inſtrument, ſee the article NAVIGATION, and *Mackay on the Longitude*, vol. i. p. 44.

REFLECTION *of the Rays of Light*, in catoptrics, is their return, after approaching ſo near the ſurface of bodies as to be thereby repelled or driven backwards. For the cauſes of reflection, ſee OPTICS, *Index* at *Rays of Light*, and *Reflection of Light*, &c. For the application of the doctrine of reflection to mirrors, ſee OPTICS. See alſo MIRROR, BURNING-*Glaſs*, and *Glaſs*-GRINDING; and for the *coating* or *foliating* of mirrors, ſee the article FOLIATING *of Looking-glaſſes*, &c. See alſo TELESCOPE.

REFLECTION is alſo uſed, figuratively, for an operation of the mind, whereby it turns its view backwards as it were upon itſelf, and makes itſelf and its own operations the object of its diſquiſition; and by contemplating the manner, order, and laws, which it obſerves in perceiving ideas, comparing them together, reaſoning, &c. it frames new ideas of the relations diſcovered therein. See METAPHYSICS.

REFLEX, in painting, means thoſe places in a picture which are ſuppoſed to be illuminated by light reflected from ſome other body in the ſame piece. See PAINTING, Part I. ſect. 2. and 5.

REFLUX, the backward courſe of water, has the ſame meaning as the ebbing of the ſea, and is oppoſed to flood, flux, or the flowing of the ſea. See TIDES.

REFORM means a change from worſe to better, a re-eſtabliſhment or revival of former neglected diſcipline, or a correction of abuſes therein. The term is much uſed in a monaſtic ſenſe for the reducing an order or congregation of religious to the ancient ſeverity of the rule from which it had gradually ſwerved, or even for improving on the ancient rule and inſtitution itſelf, and voluntarily making it more ſevere. In this ſenſe the order of St. Bernard is ſaid to be only a reform of that of St. Benedict. In this country it is applied both to politics and religion, and may innocently be applied to any endeavours to change an eſtabliſhment from worſe to better. But it appears at preſent to have been chiefly made a pretence for deſigns which could not fairly or ſafely be avowed.

A reform in religion and in parliament (ſee PARLIAMENT) has, we know, been moſt loudly called for by men whoſe religious notions are immenſely different from what has been generally reckoned Chriſtianity, and whoſe deſigns, as has been legally proved, went to the overthrow of all civil order. For inſidious purpoſes like theſe, the word reform is a good cloak, eſpecially if any thing can be fixed upon, either in the religion or government of the ſtate, which, with the help of exaggeration and diſtortion, can be repreſented to the weak and unthinking as extremely defective and erroneous.

The general error of theſe men, ſeems to be, that having picked up a ſet of ſpeculative notions which flatter their own pride and the pride of thoſe who liſten to them, they will allow nothing to the arguments of their opponents or the experience of mankind. They think ſo often and ſo much upon their ideal reforms, that while they imagine their notions are liberal and extenſive, they become contracted beyond imagination; while their judgments, of courſe are warped with the moſt inveterate prejudices (ſee PREJUDICE). They ſee, or think they ſee, the propriety of their ſchemes; but they ſeldom, perhaps never, reflect, that that may be true in ſpeculation or in theory which cannot poſſibly be reduced to practice. They will not take the world as it is, and allow it to profit by the wiſdom and experience of ages; but they will reform it according to thoſe ideas of right which they have learned from their own ſpeculations and airy theories; ſeldom conſidering what may be done, they are determined to do what they think ought to be done. Liberty of conſcience, and liberty of action, have been claimed by them as the unalienable rights of man; and ſo we ourſelves are diſpoſed to think them: nor have we heard that in this country they have been denied to any man, or ſet of men, ſo far as has been thought conſiſtent with the ſafety of the ſtate, and that of the other individuals who compoſe it. At the ſame time, the very ſame men heſitate not to blame, with acrimony the moſt violent, and to the utmoſt of their power to reſtrain, the actions and opinions of thoſe who with equal conviction, often on better grounds, and generally with more modeſty, differ from them.

Amidſt that exceſſive ardour, too, with which they propagate their opinions, they forget the extreme danger of withdrawing the attention of that part of the community, who muſt earn their bread by the ſweat of their brow, from their proper occupations, to the tempeſtuous ſea of political debate, for which their education and mode of life cannot poſſibly have qualified them. It requires but very little penetration, however, to be able to ſee, that it can be of no real ſervice either to the individuals themſelves, or to the community at large, in whatever light we look upon it. Indeed, to make thoſe the judges of the law, and the reformers of the legiſlature, who have all their lives been employed in manual labour, is the extreme of folly; and yet it is what ſome men of conſiderable abilities, and from whom we had reaſon to expect better things, have more than once attempted. The effect of ſuch a mode of ſeduction (and it deſerves no better name), when it ſhall become general, inſtead of ſerving the purpoſes of a real reform, muſt be to annihilate all civil order. Diſſatisfaction is the moſt powerful check to honeſt induſtry; and diſſatisfaction and idleneſs muſt be the effect of the wanderings of ſuch men in the labyrinths of politics; which, for uncultivated minds eſpecially, paves the way for every ſpecies of vice, and gradually ripens them for any wickedneſs, however atrocious. For the truth of theſe remarks, we appeal to the hiſtory of mankind from the creation to the preſent time: and we would ſeriouſly requeſt the *ſober friends of reform*, and many ſuch, we doubt not, there are, to reflect, that in the preſent day we have more to fear from licentiouſneſs than from deſpotiſm; from reform carried to an extreme than from the pretended attempts either of kings or miniſters to annihilate our real liberty.

It may alſo be worth their while to conſider that times of public danger are not generally the beſt adapted to attempt changes of government; becauſe what might ſatisfy one party would probably be thought too little by another, and diviſions at ſuch a period are moſt dangerous. When, therefore, attempts are made for reform which appear to be inconſiſtent with the ſafety of the ſtate, reſtrictions muſt be uſed, which may by ſpeculative men be thought ſevere and unneceſſary, but of which they themſelves are the cauſes. Theſe reſtrictions too will be patiently ſubmitted to by the wiſer part of the community, when in more peaceable times they would neither have been thought of nor allowed.

Speculative reaſoners may ſpeak as much as they will of enlightening the minds of men, and of reforming government by the dictates of a refined and diſpaſſionate philoſophy; but when they come to apply their notions to practice, they will either find their repreſentations little better than empty ſounds, and therefore ineffectual; or, as is more generally found to be the caſe, thoſe ſchemes which in theory appeared to be perfect, will in practice, when combined with the malignant and ambitious paſſions of men, lead to ruin and diſorder. The firſt inſtitution of government, except among the Jews, was unqueſtionably the effect of paſſion and intereſt combined; and this paſſion and this intereſt, reſtrained within due bounds, is productive of much happineſs. That government, we believe, too, will be beſt ſupported, and moſt productive of happineſs, in which the mutual paſſions and intereſts of the individuals who compoſe it are ſo equally poiſed as to ſupport one another, and to promote each the ends and ſucceſs of the other: and this by the ableſt reaſoners and the beſt men has been thought to be the caſe with the Britiſh conſtitution. If the modern favourers of reform ſhould think this an unſtable ſupport, if they will conſider the world as it ever has been, and as it is, they will find it the only one we have, except religion; and they will thence be inclined to make the beſt of it. If, after all, however, they ſhould be diſpoſed to doubt the poſition, we have only further to requeſt them, with the ſincerity of men and of Chriſtians, to conſult their own breaſts, and ſeriouſly to conſider the probable motives of thoſe who act with them. They will then perhaps ſee, and they ſurely ought to acknowledge, that few men have acted more according to the impulſe of paſſion, intereſt, and ambition, than thoſe who have for ſome time paſt ſounded the tocſin of reform.

REFORMATION, in general, an act of reforming or correcting an error or abuſe in religion, diſcipline, or the like. By way of eminence the word is uſed for that great alteration and reformation in the corrupted ſyſtem of Chriſtianity, begun by Luther in the year 1517.

In hiſtory, the various corruptions in religion, the oppreſſions and uſurpations of the clergy, and the extreme inſolence of the popes, have been fully treated of. It is ſufficient to obſerve, that, before the period of the Reformation, the pope had in the moſt audacious manner declared himſelf the ſovereign of the whole world. All the parts of it which were inhabited by thoſe who were not Chriſtians, he accounted to be inhabited by *no-body*; and if Chriſtians took it into their heads to poſſeſs any of thoſe countries, he gave them full liberty to make war upon the inhabitants without any provocation, and to treat them with no more humanity than they would have treated wild beaſts. The countries, if conquered, were to be parcelled out according to the pope's pleaſure; and dreadful was the ſituation of that prince who refuſed to obey the will of the holy pontiff, of which many inſtances will occur to the reader in the various hiſtorical articles of this work. In conſequence of this extraordinary authority which the pope had aſſumed, he at laſt granted to the king of Portugal all the countries to the eaſtward of Cape Non in Africa, and to the king of Spain all the countries to the weſtward of it. In this, according to the opinions of ſome, was completed in his perſon the character of *Antichriſt, ſitting in the temple of God, and ſhowing himſelf as God.* He had long before, ſay they, aſſumed the ſupremacy belonging to the Deity himſelf, in ſpiritual matters; and now he aſſumed the ſame ſupremacy in worldly matters alſo, giving the extreme regions of the earth to whom he pleaſed. The Reformation, therefore, they conſider as the immediate effect of divine power taking vengeance on this and all other deviations from the ſyſtem of truth; while others conſider it merely as an effect of natural cauſes, and which might have been foreſeen and prevented, without abridging the papal power in any conſiderable degree.

Be this as it will, however, the above-mentioned partition was the laſt piece of inſolence which the pope ever had, or in all probability ever will have, in his power to exerciſe, in the way of parcelling out the globe to his adherents. Every thing was quiet, every heretic exterminated, and the whole Chriſtian world ſupinely acquieſced in the enormous abſurdities which were inculcated upon them; when, in 1517, the empire of ſuperſtition began to decline, and has continued to do ſo ever ſince. The perſon who made the firſt attack on the extravagant ſuperſtitions then prevailing was Martin Luther. See the article LUTHER. By ſome it is pretended, that the only motive which Luther had in beginning the Reformation was his enmity to the Dominican friars, who had excluded his order (the Auguſtins) from all ſhare in the gainful traffic of indulgences. But this does not ſeem at all probable, if we conſider that ſuch a motive would not naturally have led him to deny the virtue of indulgences, as ſuch conduct could not but exclude him for ever from any chance of a ſhare in the traffic, which otherwiſe perhaps he might have obtained. Beſides, the extreme contrariety of this traffic to the common principles of reaſon and honeſty was ſo great, that we cannot wonder at finding *one* man in the world who had ſenſe enough to diſcern it, and virtue enough to oppoſe ſuch an infamous practice. In all probability, however, the inſignificancy of the firſt reformer was the reaſon why he was not perſecuted and exterminated at his firſt beginning, as others had been before him. Another reaſon might probably be, that he did not at once attack the whole errors of popery, but brought about his reformation gradually, probably as it occurred to himſelf, and as we have related in the account of his life.

The Reformation began in the city of Wittemberg in Saxony, but was not long confined either to that city or province. In 1520 the Franciſcan friars, who had the care of promulgating indulgences in Switzerland, were oppoſed by Zuinglius, a man not inferior in underſtanding and knowledge to Luther himſelf. He proceeded with the greateſt vigour, even at the very beginning, to overturn the whole fabric of popery; but his opinions were declared erroneous by the univerſities of Cologne and Louvain. Notwithſtanding this, the magiſtrates of Zurich approved of his proceedings; and that whole canton, together with thoſe of Bern, Baſil, and Chaffauſen, embraced his opinions.

In Germany, Luther continued to make great advances, without being in the leaſt intimidated by the eccleſiaſtical cenſures which were thundered againſt him from all quarters, he being continually protected by the German princes either from religious or political motives, ſo that his adverſaries could not accompliſh his deſtruction as they had done that of others. The princes, who were upon bad terms with the court of Rome, took advantage of the ſucceſs of the new doctrines; and in their own dominions eaſily overturned a church which had loſt all the reſpect and veneration of the inferior ranks. The court of Rome had diſobliged ſome of the ſmaller princes in the north of Germany, whom the pope probably thought too inſignificant to be worth the managing, and they univerſally eſtabliſhed the Reformation in their own dominions. Melancthon, Carloſtadius, and other men of eminence, alſo greatly forwarded the work of Luther; and in all probability the popiſh hierarchy would have ſoon come to an end, in the northern parts of Europe at leaſt, had not the emperor

Charles V. given a ſevere check to the progreſs of reformation in Germany. In order to follow out the ſchemes dictated by his ambition, he thought it neceſſary to ingratiate himſelf with the pope; and the moſt effectual way of doing this was by deſtroying Luther. The Pope's legates inſiſted that Luther ought to be condemned by the diet of Worms without either trial or hearing; as being a moſt notorious, avowed, and incorrigible heretic. However, this appeared unjuſt to the members of the diet, and he was ſummoned to appear; which he accordingly did without heſitation (See Luther). There is not the leaſt doubt that his appearance there had been his laſt in this world, had not the aſtoniſhing reſpect that was paid him, and the crowds who came daily to ſee him, deterred his judges from delivering the church from the author of ſuch a peſtilent hereſy; which they were ſtrongly ſolicited by the pope's party to do. He was therefore permitted to depart with a ſafe conduct for á certain time; after which he was in the ſtate of a proſcribed criminal, to whom it was unlawful to perform any of the offices of humanity.

During the confinement of Luther in a caſtle near Warburg, the Reformation advanced rapidly; almoſt every city in Saxony embracing the Lutheran opinions. At this time an alteration in the eſtabliſhed forms of worſhip was firſt ventured upon at Wittemberg, by aboliſhing the celebration of private maſſes, and by giving the cup as well as the bread to the laity in the Lord's ſupper. In a ſhort time, however, the new opinions were condemned by the univerſity of Paris, and a refutation of them was attempted by Henry VIII. of England. But Luther was not to be thus intimidated. He publiſhed his animadverſions on both with as much acrimony as if he had been refuting the meaneſt adverſary; and a controverſy managed by ſuch illuſtrious antagoniſts drew a general attention, and the Reformers daily gained new converts both in France and England.

But, while the efforts of Luther were thus every where crowned with ſucceſs, the diviſions began to prevail which have ſince ſo much agitated the reformed churches. The firſt diſpute was between Luther and Zuinglius concerning the manner in which the body and blood of Chriſt were preſent in the euchariſt. Luther and his followers, though they had rejected the notion of tranſubſtantiation, were nevertheleſs of opinion that the body and blood of Chriſt were really preſent in the Lord's ſupper, in a way which they could not pretend to explain. Carloſtadius, who was Luther's colleague, firſt ſuggeſted another view of the ſubject, which was afterwards confirmed and illuſtrated by Zuinglius, namely, that the body and blood of Chriſt were not really preſent in the euchariſt; and that the bread and wine were no more than external ſymbols to excite the remembrance of Chriſt's ſufferings in the minds of thoſe who received it. Both parties maintained their tenets with the utmoſt obſtinacy; and, by their diviſions, firſt gave their adverſaries an argument againſt them, which to this day the Catholics urge with great force; namely, that the Proteſtants are ſo divided, that it is impoſſible to know who is right or wrong; and that there cannot be a ſtronger proof than theſe diviſions, that the whole doctrine is falſe.

To theſe inteſtine diviſions were added the horrors of a civil war, occaſioned by oppreſſion on the one hand, and enthuſiaſm on the other. In 1525, a great number of ſeditious fanatics aroſe on a ſudden in different parts of Germany, took arms, united their forces, and made war againſt the empire, laying waſte the country with fire and ſword, and committing every where the greateſt cruelties. The greateſt part of this furious mob was compoſed of peaſants and vaſſals, who groaned under heavy burdens, and declared that they were no longer able to bear the deſpotic government of their chiefs; and hence this ſedition had the name of *the ruſtic war*, or the *war of the peaſants*. At firſt this rabble declared, that they had no other motives than the redreſs of their grievances; but no ſooner had the enthuſiaſt Munzer, or Munſter, the anabaptiſt, put himſelf at their head, than the face of things was entirely changed, and the civil commotions in Saxony and Thuringia exceedingly increaſed. See the article Anabaptists.

In the mean time Frederic, ſurnamed the *Wiſe*, elector of Saxony, and Luther's great patron, departed this life, and was ſucceeded by his brother John. Frederic, though he had protected and encouraged Luther, yet was at no pains to introduce the reformed religion into his dominions. But with his ſucceſſor it was otherwiſe: for he, convinced that Luther's doctrine muſt ſoon be totally deſtroyed and ſuppreſſed unleſs it received a ſpeedy and effectual ſupport, ordered Luther and Melancthon to draw up a body of laws relating to the form of eccleſiaſtical government, the method of public worſhip, &c. which was to be proclaimed by heralds throughout his dominions. This example was followed by all the princes and ſtates of Germany who renounced the papal ſupremacy; and a like form of worſhip, diſcipline, and government, was thus introduced into all the churches which diſſented from that of Rome. This open renunciation of the Romiſh juriſdiction ſoon changed the face of affairs; and the patrons of popery ſoon intimated, in a manner not at all ambiguous, that they intended to make war on the Lutheran party; which would certainly have been put in execution had not the troubles that took place in Europe diſconcerted their meaſures. On the other hand, the Lutherans, apprized of theſe hoſtile intentions, began alſo to deliberate on a proper plan of defence againſt that ſuperſtitious violence with which they were in danger of being aſſailed. The diet of the empire aſſembled at Spire in the year 1526; where the emperor's ambaſſadors were deſired to uſe their utmoſt endeavours to ſuppreſs all diſputes about religion, and to inſiſt upon the rigorous execution of the ſentence which had been pronounced againſt Luther and his followers at Worms. The greateſt part of the German princes oppoſed this motion with the utmoſt reſolution, declaring that they could not execute that ſentence, nor come to any determination with regard to the doctrines by which it had been occaſioned, before the whole matter was ſubmitted to the deciſion of a council lawfully aſſembled; alleging further, that the deciſion of controverſies of this nature belonged properly to it, and to it alone. This opinion after long and very warm debates, was adopted by a great majority, and at length conſented to by the whole aſſembly: for it was unanimouſly agreed to preſent a ſolemn addreſs to the emperor, intreating him to aſſemble, without delay, a free and general council; while in the mean time it was alſo agreed that the princes of the empire ſhould, in their reſpective dominions, be at liberty to manage eccleſiaſtical affairs in the manner they ſhould think moſt proper; yet ſo as to be able to give to God and the emperor a proper account of their adminiſtration when it ſhould be required of them.

Theſe reſolutions proved extremely favourable to the cauſe of reformation; neither had the emperor any leiſure for ſome time to give diſturbance to the reformed. The war, which at this time enſued between him and the pope, gave the greateſt advantage to the friends of the reformed, and conſiderably augmented their number. Several princes, whom the fear of perſecution and puniſhment had hitherto prevented from lending their aſſiſtance, publicly renounced the Romiſh ſuperſtition, and introduced among their ſubjects the ſame forms of religious worſhip, and the ſame ſyſtem of doctrine, that had been received in Saxony. Others, though placed in ſuch circumſtances as diſcouraged them from acting in an open manner againſt the intereſts of the Roman pontiff, were, however, far from diſcovering the ſmalleſt oppoſition to thoſe who withdrew the people from his deſpotic yoke; nor did they moleſt the private aſſemblies of thoſe who had ſeparated themſelves from the church of Rome. And in general, all the Germans who, before theſe reſolutions of the diet of Spire, had rejected the papal diſcipline and doctrine, were now, in conſequence of the liberty they enjoyed, wholly employed in bringing their ſchemes and plans to a certain degree of conſiſtence, and in adding vigour and firmneſs to the cauſe in which they were engaged. But this tranquillity and liberty was of no long duration. In 1529, a new diet was aſſembled at the ſame place by the emperor, after he had quieted the troubles in various parts of his dominions, and concluded a peace with the pope. The power which had been granted to princes of managing eccleſiaſtical affairs till the meeting of a general council, was now revoked by a majority of votes; and every change declared unlawful that ſhould be introduced into the doctrine, diſcipline, or worſhip of the eſtabliſhed religion, before the determination of the approaching council was known. This decree was conſidered as iniquitous and intolerable by the elector of Saxony, the landgrave of Heſſe, and other members of the diet, who were perſuaded of the neceſſity of a reformation. The promiſe of ſpeedily aſſembling a general council they looked upon to be an artifice of the church of Rome; well knowing that a free and lawful council would be the laſt thing to which the pope would conſent. When, therefore, they found that all their arguments and remonſtrances made no impreſſion upon Ferdinand the emperor's brother, who preſided in the diet, Charles himſelf being then at Barcelona, they entered a ſolemn proteſt againſt this decree on the 19th of April, and appealed to the emperor and a future council. Hence aroſe the denomination of *Proteſtants*, which from this period has been given to thoſe who ſeparate from the communion of the church of Rome. The princes of the empire who entered this proteſt were, John elector of Saxony; George elector of Brandenburgh; Erneſt and Francis dukes of Lunenburgh; the landgrave of Heſſe; and the prince of Anhalt. Theſe were ſeconded by 13 imperial towns, viz. Straſburg, Ulm, Nuremberg, Conſtance, Rotlingen, Windſeim, Memmingen, Nortlingen, Lindaw, Kempton, Heilbron, Wiſſemburg, and St. Gall.

The diſſenting princes, who were the protectors and heads of the reformed churches, had no ſooner entered their proteſt, than they ſent proper perſons to the emperor, who was then upon his paſſage from Spain to Italy, to acquaint him with their proceedings in this matter. The miniſters employed in this commiſſion executed it with the greateſt intrepidity and preſence of mind; but the emperor, exaſperated at the audacity of thoſe who preſumed to differ from him, cauſed the ambaſſadors to be arreſted. The news of this violent ſtep made the proteſtant princes conclude, that their perſonal ſafety, and the ſucceſs of their cauſe, depended entirely upon their own courage and union. They determined, therefore, to enter into a ſolemn confederacy: for which purpoſe they held ſeveral meetings at Rot, Nuremberg, Smalcald, and other places: but ſo different were their opinions and views, that they could determine upon nothing.

One great obſtacle to the intended confederacy was the diſpute which had ariſen between Luther and Zuinglius concerning the real preſence of Chriſt in the Lord's Supper. To terminate this diſpute, if poſſible, Philip, landgrave of Heſſe, invited, in the year 1529, to a conference at Marpurg, Luther and Zuinglius, together with ſeveral other of the more eminent doctors who adhered to the reſpective parties of theſe contending chiefs: but this meaſure was not attended with the ſalutary effects which were expected from it. The divines diſputed for four days in preſence of the landgrave. Luther attacked Oecolampadius, and Zuinglius was attacked by Melancthon. Zuinglius was accuſed of hereſy, not only on account of his explanation of the nature and deſign of the Lord's Supper, but alſo in conſequence of the falſe notions he was ſuppoſed to have adopted concerning the divinity of Chriſt, the efficacy of the divine word, original ſin, and ſome other parts of the Chriſtian doctrine. This illuſtrious reformer, however, cleared himſelf from the greateſt part of theſe charges with the moſt triumphant evidence, and in ſuch a manner as appeared ſatisfactory even to Luther himſelf: but their diſſenſion concerning the manner of Chriſt's preſence in the euchariſt ſtill remained; nor could either of the contending parties be perſuaded to abandon, or even to modify, their opinions on that matter. The only advantage, therefore, which reſulted from the meeting was, that the jarring doctors formed a kind of truce, by agreeing to a mutual toleration of their ſentiments, and leaving to the diſpoſal of Providence the cure of their diviſions.

In the mean time news were received that the emperor deſigned to come into Germany, with a view to terminate all religious differences at the approaching diet of Augſburg. Having foreſeen ſome of the conſequences of thoſe diſputes, and, beſides, taken the advice of men of wiſdom, ſagacity, and experience, he became at certain times more cool in his proceedings, and more impartial in his opinions both of the contending parties and the merits of the cauſe. He, therefore, in an interview with the pope at Bologna, inſiſted, in the moſt ſerious and urgent manner, on the neceſſity of a general council. His remonſtrances and expoſtulations, however, could not move the pontiff; who maintained with zeal the papal prerogatives, reproached the emperor with an ill-judged clemency, and alleged that it was the duty of that prince to ſupport the church, and to execute ſpeedy vengeance upon that obſtinate heretical faction who dared to call in queſtion the authority of Rome and its pontiff. To this diſcourſe the emperor paid no regard; looking upon it as a moſt iniquitous thing, and a meaſure directly oppoſite to the laws of the empire, to condemn unheard a ſet of men who had always approved themſelves good citizens, and deſerved well of their country in ſeveral reſpects. Hitherto indeed it was not eaſy for the emperor to form a clear idea of the matters in debate, ſince there was no regular ſyſtem as yet compoſed, by which it might be known with certainty what were the true cauſes of Luther's oppoſition to the pope. The elector of Saxony, therefore, ordered Luther, and other eminent divines, to commit to writing the chief articles of their religious ſyſtem, and the principal points in which they differed from the church of Rome. Luther, in compliance with this order, delivered to the elector at Torgaw 17 articles which had been agreed upon in a conference at Sultzbach in 1529; from whence theſe received the name of *the articles of Torgaw*. But though theſe were deemed by Luther a ſufficient declaration of the ſentiments of the reformers, yet it was judged proper to enlarge them, in order to give perſpicuity to their arguments, and ſtrength to their cauſe. In this work Melancthon was employed; in which he ſhowed a proper deference to the counſels of Luther, and expreſſed his ſentiments and doctrine with the greateſt elegance and perſpicuity; and thus came forth to view the famous *Confeſſion of Augſburg*.

On the 15th of June 1530, Charles arrived at Augſburg, and the diet was opened five days after. The Proteſtants received a formal permiſſion to preſent an account of their tenets to the diet on the 25th of the ſame month; in conſequence of which, at the time appointed, Chriſtian Bayer, chancellor of Saxony, read, in the German language, before the emperor and the princes aſſembled, the confeſſion of Augſburg abovementioned. It contained 28 chapters, of which 21 were employed in repreſenting the religious opinions of the Proteſtants, and the other ſeven in pointing out the errors and ſuperſtitions of the church of Rome. The princes heard it with the deepeſt attention and recollection of mind: it confirmed ſome in the principles they had embraced; ſurpriſed others; and many, who before this time had little or no idea of the religious ſentiments of Luther, were now not only convinced of their innocence, but delighted with their purity and ſimplicity. The copies of this Confeſſion which after being read were delivered to the emperor, were ſigned by John elector of Saxony, George marquis of Brandenburg, Erneſt duke of Lunenburg, Philip landgrave of Heſſe, Wolfgang prince of Anhalt, and by the imperial cities of Nuremberg and Reutlingen.

The creatures of the church of Rome who were preſent at this diet employed John Faber, afterwards biſhop of Vienna, together with Eckius, and another doctor named *Cochlæus*, to draw up a refutation of the Proteſtant confeſſion: which refutation having been publicly read, the emperor required the Proteſtant members to acquieſce in it, and put an end to the religious diſputes by an unlimited ſubmiſſion to the opinions and doctrines contained in this anſwer. But this demand was far from being complied with. The Proteſtants declared on the contrary, that they were by no means ſatisfied with the reply of their adverſaries; and earneſtly deſired a copy of it, that they might more fully demonſtrate its extreme inſufficiency and weakneſs. But this reaſonable requeſt was refuſed by the emperor; who interpoſed his ſupreme authority to prevent any further proceedings in this matter, and ſolemnly prohibited the publication of any new writings or declarations that might contribute to lengthen out theſe religious debates. This, however, did not reduce the Proteſtants to ſilence. The divines of that communion, who had been preſent at the diet, endeavoured to recollect the arguments and objections employed by Faber, and had again recourſe to the pen of Melancthon, who refuted them in an ample and ſatisfactory manner in a piece which was preſented to the emperor on the 22d of September, but which Charles refuſed to receive. This anſwer was afterwards enlarged by Melancthon, when he had obtained a copy of Faber's reply; and was publiſhed in the year 1531, with the other pieces that related to the doctrine and diſcipline of the Lutheran church, under the title of *A Defence of the Confeſſion of Augsburg*.

Matters now began to draw towards a criſis. There were only three ways of bringing to a concluſion theſe religious differences. 1. To grant the Proteſtants a toleration and privilege of ſerving God as they thought proper: 2. To compel them to return to the church of Rome by the violent methods of perſecution; or, 3. That a reconciliation ſhould be made, upon fair, candid, and equitable terms, by engaging each of the parties to temper their zeal with moderation, to abate reciprocally the rigour of their pretenſions, and remit ſomething of their reſpective claims. The third expedient was moſt generally approved of, being peculiarly agreeable to all who had at heart the welfare of the empire; nor did the pope ſeem to look upon it either with averſion or contempt. Various conferences therefore were held between perſons eminent for piety and learning on both ſides; and nothing was omitted that might have the leaſt tendency to calm the animoſities and heal the diviſions which reigned between the contending parties. But the differences were too great to admit of a reconciliation; and therefore the votaries of Rome had recourſe to the powerful arguments of imperial edicts, and the force of the ſecular arm. On the 19th of November, a ſevere decree was iſſued out by the expreſs order of the emperor (during the abſence of the Heſſian and Saxon princes, who were the chief ſupporters of the Proteſtant cauſe), in which every thing was manifeſtly adapted to deject the friends of religious liberty, excepting only a faint and dubious promiſe of engaging the pope to aſſemble a general council about ſix months after the ſeparation of the diet. In this decree the dignity and excellence of the Popiſh religion were extolled beyond meaſure, a new degree of ſeverity and force was added to that which had been publiſhed at Worms againſt Luther and his adherents, the changes which had been introduced into the doctrine and diſcipline of the Proteſtant churches were ſeverely cenſured, and a ſolemn order was addreſſed to the princes, cities, and ſtates, who had thrown off the papal yoke, to return to their allegiance to Rome, on pain of incurring the indignation and vengeance of the emperor as the patron and protector of the church. Of this formidable decree the elector of Saxony and confederated princes were no ſooner informed, than they aſſembled in order to deliberate on the meaſures proper to be taken in ſuch a criſis. In the years 1530 and 1531 they met, firſt at Smalcald, and afterwards at Francfort, where they formed a ſolemn alliance and confederacy, with the intention of defending vigorouſly their religion and liberties againſt the dangers and encroachments with which they were threatened by the edict of Augſburg, without attempting, however, any thing offenſive againſt the votaries of Rome; and into this confederacy they invited the kings of England, France, Denmark, &c. leaving no means unemployed that might corroborate and cement this important alliance.

This confederacy was at firſt oppoſed by Luther, from an apprehenſion of the calamities and troubles which it might produce; but at laſt, perceiving the neceſſity of it, he conſented; though he uncharitably, as well as imprudently, refuſed to comprehend in it the followers of Zuinglius among the Swiſs, together with the German ſtates and cities who had adopted the ſentiments and confeſſion of Bucer. In the invitation addreſſed to Henry VIII. of England, whom the confederate princes were willing to declare the head and protector of their league, the following things, among others, were expreſsly ſtipulated: That the king ſhould encourage, promote and maintain, the true doctrine of Chriſt as it was contained in the confeſſion of Augſburg, and defend the ſame at the next general council: that he ſhould not agree to any council ſummoned by the biſhop of Rome, but proteſt againſt it; and neither ſubmit to its decrees, nor ſuffer them to be reſpected in his dominions: that he ſhould never allow the Roman pontiff to have any pre-eminence or juriſdiction in his dominions; that he ſhould advance 100,000 crowns for the uſe of the confederacy, and double that ſum if it became neceſſary: all which articles the confederate princes were equally obliged to obſerve on their part. To theſe demands the king replied, that he would maintain and promote the true doctrine of Chriſt; but, at the ſame time, as the true ground of that doctrine lay only in the Holy Scriptures, he would not accept at any one's hand what ſhould be his own faith, or that of his kingdom; and therefore deſired that they would ſend over two learned men to confer with him, in order to promote a religious union between him and the confederates. However, he declared himſelf of their opinion with regard to the meeting of a free general council, and promiſed to join with them in all ſuch councils for the defence of the true doctrine; but thought the regulation of the ceremonial part of religion, being a matter of indifference, ought to be left to the choice of each ſovereign for his own dominions. After this the king gave them a ſecond anſwer more full and ſatisfactory; but after the execution of queen Anne, this negotiation came to nothing. On the one hand, the king grew cold when he perceived that the confederates were no longer of uſe to him in ſupporting the validity of his marriage; and, on the other hand, the German princes became ſenſible that they could never ſucceed with Henry unleſs they allowed him an abſolute dictatorſhip in matters of religion.

While every thing thus tended to an open war between the two oppoſite parties, the elector Palatine and the elector of Mentz offered their mediation, and endeavoured to procure a reconciliation. The emperor himſelf, for various reaſons, was at this time inclined to peace: for, on the one hand, he ſtood in need of ſuccours againſt the Turks, which the Proteſtant princes refuſed to grant as long as the edicts of Worms and Augſburg remained in force; and, on the other, the election of his brother Ferdinand to the dignity of king of the Romans, which had been carried by a majority of votes at the diet of Cologne in 1531, was by the ſame princes conteſted, as being contrary to the fundamental laws of the empire. In conſequence of all this, after many negotiations and projects of reconciliation, a treaty of peace was concluded at Nuremberg, in 1532, between the emperor and the Proteſtant princes, on the following conditions, viz. That the latter ſhould furniſh a ſubſidy for carrying on the war againſt the Turks, and acknowledge Ferdinand lawful king of the Romans; and that the emperor on his part ſhould abrogate and annul the edicts of Worms and Augſburg, and allow the Lutherans the free and undiſturbed exerciſe of their religious doctrine and diſcipline, until a rule of faith was fixed either in the free general council that was to be aſſembled in the ſpace of ſix months, or in a diet of the empire.

Soon after the concluſion of the peace at Nuremberg died John elector of Saxony, who was ſucceeded by his ſon John Frederic, a prince of invincible fortitude and magnanimity, but whoſe reign was little better than one continued train of diſappointments and calamities. The religious truce, however, gave new vigour to the Reformation. Thoſe who had hitherto been only ſecret enemies to the Roman pontiff, now publicly threw off his yoke; and various cities and provinces of Germany enliſted themſelves under the religious ſtandards of Luther. On the other hand, as the emperor had now no other hope of terminating the religious diſputes but by the meeting of a general council, he repeated his requeſts to the pope for that purpoſe. The pontiff (Clement VII.), whom the hiſtory of paſt councils filled with the greateſt uneaſineſs, endeavoured to retard what he could not with decency refuſe. At laſt, in 1533, he made a propoſal by his legate to aſſemble a council at Mantua, Placentia, or Bologna; but the Proteſtants refuſed their conſent to the nomination of an Italian council, and inſiſted that a controverſy which had its riſe in the heart of Germany ſhould be determined within the limits of the empire. The pope, by his uſual artifices, eluded the performance of his own promiſe; and in 1534 was cut off by death, in the midſt of his ſtratagems. His ſucceſſor Paul III. ſeemed to ſhow leſs reluctance to the aſſembling a general council, and in the year 1535 expreſſed his inclination to convoke one at Mantua; and, the year following, actually ſent circular letters for that purpoſe through all the ſtates and kingdoms under his juriſdiction. This council was ſummoned by a bull iſſued out on the 2d of June 1536, to meet at Mantua the following year: but ſeveral obſtacles prevented its meeting; one of the moſt material of which was, that Frederic duke of Mantua had no inclination to receive at once ſo many gueſts, ſome of them very turbulent, into the place of his reſidence. On the other hand, the Proteſtants were firmly perſuaded that, as the council was aſſembled in Italy, and by the authority of the pope alone, the latter muſt have had an undue influence in that aſſembly; of conſequence, that all things muſt have been carried by the votaries of Rome. For this reaſon they aſſembled at Smalcald in the year 1537, where they ſolemnly proteſted againſt this partial and corrupt council, and, at the ſame time, had a new ſummary of their doctrine drawn up by Luther, in order to preſent it to the aſſembled biſhops if it ſhould be required of them. This ſummary, which had the title of *The Articles of Smalcald*, is commonly joined with the creeds and confeſſions of the Lutheran church.

After the meeting of the general council in Mantua was thus prevented, many ſchemes of accommodation were propoſed both by the emperor and the Proteſtants; but, by the artifices of the church of Rome, all of them came to nothing. In 1541, the emperor appointed a conference at Worms on the ſubject of religion, between perſons of piety and learning choſen from the contending parties. This conference, however, was, for certain reaſons, removed to the diet which was to be held at Ratiſbon that ſame year. and in which the principal ſubject of deliberation was a memorial preſented by a perſon unknown, containing a project of peace. But the conference produced no other effect than a mutual agreement of the contending parties to refer their matters to a general council, or, if the meeting of ſuch a council ſhould be prevented, to the next German diet.

This reſolution was rendered ineffectual by a variety of incidents, which widened the breach. and put off to a further day the deliberations which were deſigned to heal it. The pope ordered his legate to declare to the diet of Spire, aſſembled in 1542, that he would, according to the promiſe he had already made, aſſemble a general council, and that Trent ſhould be the place of its meeting, if the diet had no objection to that city. Ferdinand, and the princes who adhered to the cauſe of the pope, gave their conſent to this propoſal; but it was vehemently objected to by the Proteſtants, both becauſe the council was ſummoned by the authority of the pope only, and alſo becauſe the place was within the juriſdiction of the pope; whereas they deſired a free council, which ſhould not be biaſſed by the dictates, nor awed by the proximity, of the pontiff. But this proteſtation produced no effect. Paul III. perſiſted in his purpoſe, and iſſued out his circular letters for the convocation of the council, with the approbation of the emperor. In juſtice to this pontiff, however, it muſt be obſerved, that he ſhowed himſelf not to be averſe to every reformation. He appointed four cardinals, and three other perſons eminent for their learning, to draw up a plan, for the reformation of the church in general, and of the church of Rome in particular. The reformation propoſed in this plan was indeed extremely ſuperficial and partial, yet it contained ſome particulars which could ſcarcely have been expected from thoſe who compoſed it. They complained of the pride and ignorance of the biſhops, and propoſed that none ſhould receive orders but learned and pious men; and that therefore care ſhould be taken to have proper maſters for the inſtruction of youth. They condemned tranſlations from one benefice to another, grants of reſervation, non-reſidence, and pluralities. They propoſed that ſome convents ſhould be aboliſhed; that the liberty of the preſs ſhould be reſtrained and limited; that the colloquies of Eraſmus ſhould be ſuppreſſed; that no eccleſiaſtic ſhould enjoy a benefice out of his own country; that no cardinal ſhould have a biſhopric; that the queſtors of St. Anthony and ſeveral other ſaints ſhould be aboliſhed; and, which was the beſt of all their propoſals, that the effects and perſonal eſtates of eccleſiaſtics ſhould be given to the poor. They concluded with complaining of the prodigious number of indigent and ragged prieſts who frequented St. Peter's church; and declared, that it was a great ſcandal to ſee the whores lodged ſo magnificently at Rome, and riding through the ſtreets on fine mules, while the cardinals and other eccleſiaſtics accompanied them in the moſt courteous manner.—This plan of reformation was turned into ridicule by Luther and Sturmius; and indeed it left unredreſſed the moſt intolerable grievances of which the Proteſtants complained.

All this time the emperor had been labouring to perſuade the Proteſtants to conſent to the meeting of the council at Trent; but when he found them fixed in their oppoſition to this meaſure, he began to liſten to the ſanguinary meaſures of the pope, and reſolved to terminate the diſputes by force of arms. The elector of Saxony and landgrave of Heſſe, who were the chief ſupporters of the Proteſtant cauſe, upon this took proper meaſures to prevent their being ſurpriſed and overwhelmed by a ſuperior force; but, before the horrors of war commenced, the great reformer Luther died in peace at Ayſelben, the place of his nativity, in 1546.

The emperor and the pope had mutually reſolved on the deſtruction of all who ſhould dare to oppoſe the council of Trent. The meeting of it was to ſerve as a ſignal for taking up arms; and accordingly its deliberations were ſcarcely begun in 1546, when the Proteſtants perceived undoubted ſigns of the approaching ſtorm, and a formidable union betwixt the emperor and pope, which threatened to cruſh and overwhelm them at once. This year indeed there had been a new conference at Ratiſbon upon the old ſubject of accommodating differences in religion; but from the manner in which the debates were carried on, it plainly appeared that theſe differences could only be decided in the field of battle. The council of Trent, in the mean time, promulgated their decrees; while the reformed princes, in the diet of Ratiſbon, proteſted againſt their authority, and were on that account proſcribed by the emperor, who raiſed an army to reduce them to obedience. See *Father Paul's Hiſtory of the Council of Trent,* and our articles Paul (Father), and Trent.

The elector of Saxony and the landgrave of Heſſe led their forces into Bavaria againſt the emperor, and cannonaded his camp at Ingoldſtadt. It was ſuppoſed that this would bring on an engagement, which would probably have been advantageous to the cauſe of the reformed; but this was prevented, chiefly by the perfidy of Maurice duke of Saxony, who invaded the dominions of his uncle. Diviſions were alſo fomented among the confederate princes, by the diſſimulation of the emperor; and France failed in paying the ſubſidy which had been promiſed by its monarch: all which ſo diſcouraged the heads of the Proteſtant party, that their army ſoon diſperſed, and the elector of Saxony was obliged to direct his march homewards. But he was purſued by the emperor, who made ſeveral forced marches, with a view to deſtroy his enemy before he ſhould have time to recover his vigour. The two armies met near Muhlberg, on the Elbe, on the 24th of April 1547; and, after a bloody action, the elector was entirely defeated, and himſelf taken priſoner.—Maurice, who had ſo baſely betrayed him, was now declared elector of Saxony; and by his entreaties Philip landgrave of Heſſe, the other chief of the Proteſtants, was perſuaded to throw himſelf on the mercy of the emperor, and to implore his pardon. To this he conſented, relying on the promiſe of Charles for obtaining forgiveneſs, and being reſtored to liberty; but, notwithſtanding theſe expectations, he was unjuſtly detained priſoner, by a ſcandalous violation of the moſt ſolemn convention. It is ſaid that the emperor retracted his promiſe, and deluded this unhappy prince by the ambiguity of two German words. Hiſtory indeed can ſcarce afford a parallel to the perfidious, mean-ſpirited, and deſpotic behaviour of the emperor in the preſent caſe. After having received in public the humble ſubmiſſion of the prince on his knees, and after having ſet him at liberty by a ſolemn treaty, he had him arreſted anew without any reaſon, nay, without any pretence, and kept him cloſe priſoner for ſeveral years. When Maurice remonſtrated againſt this new confinement, the emperor anſwered, that he had never promiſed that the landgrave ſhould not be impriſoned anew, but only that he ſhould be exempted from perpetual impriſonment; and, to ſupport this aſſertion, he produced the treaty, in which his miniſters had perfidiouſly foiſted *ewiger gefangnis,* which ſignifies a "perpetual priſon," inſtead of *einiger gefangnis,* which ſignifies "any priſon." This, however, is conteſted by ſome hiſtorians.

The affairs of the Proteſtants now ſeemed to be deſperate. In the diet of Augſburg, which was ſoon after called, the emperor required the Proteſtants to leave the deciſion of theſe religious diſputes to the wiſdom of the council which was to meet at Trent. The greateſt part of the members conſented to this propoſal, being convinced by the powerful argument of an imperial army, which was at hand to diſpel the darkneſs from the eyes of ſuch as might otherwiſe have been blind to the force of Charles's reaſoning. However, this general ſubmiſſion did not produce the effect which was expected from it. A plague which broke out, or was ſaid to do ſo, in the city, cauſed the greateſt part of the biſhops to retire to Bologna; by which means the council was in effect diſſolved, nor could all the entreaties and remonſtrances of the emperor prevail upon the pope to re-aſſemble it without delay. During this interval, therefore, the emperor judged it neceſſary to fall upon ſome method of accommodating the religious differences, and maintaining peace until the council ſo long expected ſhould be finally obtained. With this view he ordered Julius Pelugius biſhop of Naumberg, Michael Sidonius, a creature of the pope, and John Agricola, a native of Ayſelben, to draw up a formulary which might ſerve as a rule of faith and worſhip, till the council ſhould be aſſembled: but as this was only a temporary expedient, and had not the force of a permanent or perpetual inſtitution, it thence obtained the name of the *Interim.*

This project of Charles was formed partly with a deſign to vent his reſentment againſt the pope, and partly to anſwer other political purpoſes. It contained all the eſſential doctrines of the church of Rome, though conſiderably ſoftened by the artful terms which were employed, and which were quite different from thoſe employed before and after this period by the council of Trent. There was even an affected ambiguity in many of the expreſſions, which made them ſuſceptible of different ſenſes, and applicable to the ſentiments of both communions. The conſequence of all this was, that the imperial creed was reprobated by both parties. However, it was promulgated with great ſolemnity by the emperor at Augſburg. The elector of Mentz, without even aſking the opinion of the princes preſent, gave a ſanction to this formula, as if he had been commiſſioned to repreſent the whole diet. Many kept ſilence through fear, and that ſilence was interpreted as a tacit conſent. Some had the courage to oppoſe it, and theſe were reduced by force of arms; and the moſt deplorable ſcenes of bloodſhed and violence were acted throughout the whole empire. Maurice, elector of Saxony, who had hitherto kept neutral, now aſſembled the whole of his nobility and clergy, in order to deliberate on this critical affair. At the head of the latter was Melancthon, whoſe word was reſpected as a law among the Proteſtants. But this man had not the courage of Luther; and was therefore on all occaſions ready to make conceſſions, and to propoſe ſchemes of accommodation. In the preſent caſe, therefore, he gave it as his opinion, that the whole of the book called *Interim* could not by any means be adopted by the Proteſtants; but at the ſame time he declared, that he ſaw no reaſon why this book might not be approved, adopted, and received, as an authoritative rule in things that did not relate to the eſſential parts of religion, and which he accounted indifferent. But this ſcheme, inſtead of cementing the differences, made them much worſe than ever; and produced a diviſion among the Proteſtants themſelves, which might have overthrown the Reformation entirely, if the emperor and pope had ſeized the opportunity.

In the year 1459, the pope (Paul III.) died; and was ſucceeded by Julius III. who, at the repeated ſolicitations of the emperor, conſented to the re-aſſembling of a council at Trent. A diet was again held at Augſburg under the cannon of an imperial army, and Charles laid the matter before the princes of the empire. Moſt of thoſe preſent gave their conſent to it, and amongſt the reſt Maurice elector of Saxony; who conſented on the following conditions: 1. That the points of doctrine which had already been decided there, ſhould be re-examined. 2. That this examination ſhould be made in preſence of the Proteſtant divines. 3. That the Saxon Proteſtants ſhould have a liberty of voting as well as of deliberating in the council. 4. That the pope ſhould not pretend to preſide in that aſſembly, either in perſon or by his legates. This declaration of Maurice was read in the diet, and his deputies inſiſted upon its being entered into the regiſters; which the archbiſhop of Mentz obſtinately refuſed. The diet was concluded in the year 1551; and, at its breaking up, the emperor deſired the aſſembled princes and ſtates to prepare all things for the approaching council, and promiſed to uſe his utmoſt endeavours to procure moderation and harmony, impartiality and charity, in the tranſactions of that aſſembly.

On the breaking up of the diet, the Proteſtants took ſuch ſteps as they thought moſt proper for their own ſafety. The Saxons employed Melancthon, and the Wirtemburgers Brengius, to draw up Confeſſions of Faith to be laid before the new Council. The Saxon divines, however, proceeded no further than Nuremberg, having received ſecret orders from Maurice to ſtop there: For the elector, perceiving that Charles had formed deſigns againſt the liberties of the German princes, reſolved to take the moſt effectual meaſures for cruſhing his ambition at once. He therefore entered with the utmoſt ſecrecy and expedition into an alliance with the king of France, and ſeveral of the German princes, for the ſecurity of the rights and liberties of the empire; after which, aſſembling a powerful army, in 1552 he marched againſt the emperor, who lay with a handful of troops at Inſpruck, and expected no ſuch thing. By this ſudden and unforeſeen accident Charles was ſo much diſpirited, that he was willing to make peace almoſt on any terms. The conſequence of this was, that he concluded a treaty at Paſſau, which by the Proteſtants is conſidered as the baſis of their religious liberty. By the firſt three articles of this treaty it was agreed, that Maurice and the confederates ſhould lay down their arms, and lend their troops to Ferdinand to aſſiſt him againſt the Turks; and that the landgrave of Heſſe ſhould be ſet at liberty. By the fourth it was agreed, that the Rule of Faith called the *Interim* ſhould be conſidered as null and void; that the contending parties ſhould enjoy the free and undiſturbed exerciſe of their religion, until a diet ſhould be aſſembled to determine amicably the preſent diſputes (which diet was to meet in the ſpace of ſix months); and that this religious liberty ſhould continue always, in caſe it ſhould be found impoſſible to come to an uniformity in doctrine and worſhip. It was alſo determined, that all thoſe who had ſuffered baniſhment, or any other calamity, on account of their having been concerned in the league or war of Smalcald, ſhould be reinſtated in their privileges, poſſeſſions, and employments; that the imperial chamber at Spire ſhould be open to the Proteſtants as well as to the Catholics; and that there ſhould always be a certain number of Lutherans in that high court.—To this peace Albert, marquis of Brandenburg, refuſed to ſubſcribe; and continued the war againſt the Roman-catholics, committing ſuch ravages in the empire that a confederacy was at laſt formed againſt him. At the head of this confederacy was Maurice elector of Saxony, who died of a wound he received in a battle fought on the occaſion in 1553.

The aſſembling of the diet promiſed by Charles was prevented by various incidents: however, it met at Augſburg in 1555, where it was opened by Ferdinand in name of the emperor, and terminated thoſe deplorable calamities which had ſo long deſolated the empire. After various debates, the following acts were paſſed, on the 25th of September: That the Proteſtants who followed the Confeſſion of Augſburg ſhould be for the future conſidered as entirely free from the juriſdiction of the Roman pontiff, and from the authority and ſuperintendance of the biſhops; that they were left at perfect liberty to enact laws for themſelves relating to their religious ſentiments, diſcipline, and worſhip; that all the inhabitants of the German empire ſhould be allowed to judge for themſelves in religious matters, and to join themſelves to that church whoſe doctrine and worſhip they thought the moſt pure and conſonant to the ſpirit of true Chriſtianity; and that all thoſe who ſhould injure or perſecute any perſon under religious pretences, and on account of their opinions, ſhould be declared and proceeded againſt as public enemies of the empire, invaders of its liberty, and diſturbers of its peace.

Thus was the Reformation eſtabliſhed in many parts of the German empire, where it continues to this day; nor have the efforts of the popiſh powers at any time been able to ſuppreſs it, or even to prevent it from gaining ground. It was not, however, in Germany alone that a reformation of religion took place. Almoſt all the kingdoms of Europe began to open their eyes to the truth about the ſame time. The reformed religion was propagated in Sweden, ſoon after Luther's rupture with the church of Rome, by one of his diſciples named *Olaus Petri*. The zealous efforts of this miſſionary were ſeconded by Guſtavus Vaſa, whom the Swedes had raiſed to the throne in place of Chriſtiern king of Denmark, whoſe horrid barbarity loſt him the crown. This prince, however, was as prudent as he was zealous; and, as the minds of the Swedes were in a fluctuating ſtate, he wiſely avoided all kind of vehemence and precipitation in ſpreading the new doctrine. Accordingly, the firſt object of his attention was the inſtruction of his people in the ſacred doctrines of the Holy Scriptures: for which purpoſe he invited into his dominions ſeveral learned Germans, and ſpread abroad through the kingdom the Swediſh tranſlation of the Bible that had been made by Olaus Petri. Some time after this, in 1526, he appointed a conference at Upſal, between this reformer and Peter Gallius, a zealous defender of the ancient ſuperſtition, in which each of the champions was to bring forth his arguments, that it might be ſeen on which ſide the truth lay. In this diſpute Olaus obtained a ſignal victory; which contributed much to confirm Guſtavus in his perſuaſion of the truth of Luther's doctrine, and to promote its progreſs in Sweden. The following year another event gave the finiſhing ſtroke to its propagation and ſucceſs. This was the aſſembly of the ſtates at Weſteraas, where Guſtavus recommended the doctrine of the reformers with ſuch zeal, that, after warm debates fomented by the clergy in general, it was unanimouſly reſolved that the reformation introduced by Luther ſhould have place in Sweden. This reſolution was principally owing to the firmneſs and magnanimity of Guſtavus, who declared publicly, that he would lay down the ſceptre and retire from the kingdom, rather than rule a people enſlaved by the orders and authority of the pope, and more controlled by the tyranny of their biſhops than by the laws of their monarch. From this time the papal empire in Sweden was entirely overthrown, and Guſtavus declared head of the church.

In Denmark, the Reformation was introduced as early as the year 1521, in conſequence of the ardent deſire diſcovered by Chriſtiern II. of having his ſubjects inſtructed in the doctrines of Luther. This monarch, notwithſtanding his cruelty, for which his name has been rendered odious, was nevertheleſs deſirous of delivering his dominions from the tyranny of the church of Rome. For this purpoſe, in the year 1520 he ſent for Martin Reinard, one of the diſciples of Carloſtadt, out of Saxony, and appointed him profeſſor of divinity at Hafnia; and after his death, which happened in 1521, he invited Carloſtadt himſelf to fill that important place. Carloſtadt accepted of this office indeed, but in a ſhort time returned to Germany; upon which Chriſtiern uſed his utmoſt endeavours to engage Luther to viſit his dominions, but in vain. However, the progreſs of Chriſtiern, in reforming the religion of his ſubjects, or rather of advancing his own power above that of the church, was checked, in the year 1523, by a conſpiracy, by which he was depoſed and baniſhed; his uncle Frederic, duke of Holſtein and Sleſwic, being appointed his ſucceſſor.

Frederic conducted the Reformation with much greater prudence than his predeceſſor. He permitted the Proteſtant doctors to preach publicly the ſentiments of Luther, but did not venture to change the eſtabliſhed government and diſcipline of the church. However, he contributed greatly to the progreſs of the reformation, by his ſucceſsful attempts in favour of religious liberty in an aſſembly of the ſtates held at Odenſee in 1527. Here he procured the publication of a famous edict, by which every ſubject of Denmark was declared free either to adhere to the tenets of the church of Rome, or to the doctrine of Luther. The papal tyranny was totally deſtroyed by his ſucceſſor Chriſtiern III. He began by ſuppreſſing the deſpotic authority of the biſhops, and reſtoring to their lawful owners a great part of the wealth and poſſeſſions which the church had acquired by various ſtratagems. This was followed by a plan of religious doctrine, worſhip, and diſcipline, laid down by Bugenhagius, whom the king had ſent for from Wittemberg for that purpoſe; and in 1539 an aſſembly of the ſtates at Odenſee gave a ſolemn ſanction to all theſe tranſactions.

In France, alſo, the Reformation began to make ſome progreſs very early. Margaret, queen of Navarre, ſiſter to Francis I. the perpetual rival of Charles V. was a great friend to the new doctrine; and it appears that, as early as the year 1523, there were in ſeveral of the provinces of France great numbers of people who had conceived the greateſt averſion both to the doctrine and tyranny of the church of Rome; among whom were many of the firſt rank and dignity, and even ſome of the epiſcopal order. But as their number increaſed daily, and troubles and commotions were excited in ſeveral places on account of the religious differences, the authority of the king intervened, and many perſons eminent for their virtue and piety were put to death in the moſt barbarous manner. Indeed Francis, who had either no religion at all, or, at beſt, no fixed and conſiſtent ſyſtem of religious principles, conducted himſelf towards the Proteſtants in ſuch a manner as beſt anſwered his private views. Sometimes he reſolved to invite Melancthon into France, probably with a view to pleaſe his ſiſter the queen of Navarre, whom he loved tenderly, and who had ſtrongly imbibed the Proteſtant principles. At other times he exerciſed the moſt infernal cruelty towards the reformed; and once made the following mad declaration, That if he thought the blood in his arm was tainted by the Lutheran hereſy, he would have it cut off; and that he would not ſpare even his own children if they entertained ſentiments contrary to thoſe of the Catholic church.

About this time the famous Calvin began to draw the attention of the public, but more eſpecially of the queen of Navarre. His zeal expoſed him to danger; and the friends of the reformation, whom Francis was daily committing to the flames, placed him more than once in the moſt perilous ſituation, from which he was delivered by the interpoſition of the queen of Navarre. He therefore retired out of France to Baſil in Swiſſerland; where he publiſhed his Chriſtian Inſtitutions, and became afterwards ſo famous.

Thoſe among the French who firſt renounced the juriſdiction of the Romiſh church, are commonly called *Lutherans* by the writers of thoſe early times. Hence it has been ſuppoſed that they had all imbibed the peculiar ſentiments of Luther. But this appears by no means to have been the caſe: for the vicinity of the cities of Geneva, Lauſanne, &c. which had adopted the doctrines of Calvin, produced a remarkable effect upon the French Proteſtant churches; inſomuch that, about the middle of this century, they all entered into communion with the church of Geneva. The French Proteſtants were called *Huguenots* (See HUGUENOTS) by their adverſaries by way of contempt. Their ſate was very ſevere, being perſecuted with unparalleled fury; and though many princes of the blood, and of the firſt nobility, had embraced their ſentiments, yet in no part of the world did the reformers ſuffer ſo much. At laſt all commotions were quelled by the fortitude and magnanimity of Henry IV. who in the year 1598 granted all his ſubjects full liberty of conſcience by the famous Edict of Nantes, and ſeemed to have thoroughly eſtabliſhed the Reformation throughout his dominions. During the minority of Louis XIV. however, this edict was revoked by cardinal Mazarine, ſince which time the Proteſtants have often been cruelly perſecuted; nor was the profeſſion of the reformed religion in France at any time ſo ſafe as in moſt other countries of Europe.

In the other parts of Europe the oppoſition to the church of Rome was but faint and ambiguous before the diet of Augſburg. Before that period, however, it appears from undoubted teſtimony, that the doctrine of Luther had made a conſiderable, though probably ſecret, progreſs through Spain, Hungary, Bohemia, Britain, Poland and the Netherlands; and had in all theſe countries many friends, of whom ſeveral repaired to Wittemberg, in order to enlarge their knowledge by means of Luther's converſation. Some of theſe countries threw off the Romiſh yoke entirely, and in others a prodigious number of families embraced the principles of the reformed religion. It is certain indeed, and the Roman catholics themſelves acknowledge it without heſitation, that the papal doctrines and authority would have fallen into ruin in all parts of the world at once, had not the force of the ſecular arm been employed to ſupport the tottering edifice. In the Netherlands particularly the moſt grievous perſecutions took place, ſo that by the emperor Charles V. upwards of 100,000 were deſtroyed, while ſtill greater cruelties were exerciſed upon the people by his ſon Philip II. The revolt of the United Provinces, however, and motives of real policy, at laſt put a ſtop to theſe furious proceedings; and, though in many provinces of the Netherlands the eſtabliſhment of the Popiſh religion was ſtill continued, the Proteſtants have been long free of the danger of perſecution on account of their principles.

The Reformation made a conſiderable progreſs in Spain and Italy ſoon after the rupture between Luther and the Roman pontiff. In all the provinces of Italy, but more eſpecially in the territories of Venice, Tuſcany and Naples, the ſuperſtition of Rome loſt ground, and great numbers of people of all ranks expreſſed an averſion to the papal yoke. This occaſioned violent and dangerous commotions in the kingdom of Naples in the year 1546; which, however, were at laſt quelled by the united efforts of Charles V. and his viceroy Don Pedro di Toledo. In ſeveral places the pope put a ſtop to the progreſs of the reformation, by letting looſe the inquiſitors; who ſpread dreadful marks of their barbarity through the greateſt part of Italy. Theſe formidable miniſters of ſuperſtition put ſo many to death, and perpetrated ſuch horrid acts of cruelty and oppreſſion, that moſt of the reformed conſulted their ſafety by a voluntary exile, while others returned to the religion of Rome, at leaſt in external appearance. But the inquiſition, which frighted into the profeſſion of popery ſeveral Proteſtants in other parts of Italy, could never make its way into the kingdom of Naples; nor could either the authority or entreaties of the pope engage the Neapolitans to admit even viſiting inquiſitors.

In Spain, ſeveral people embraced the Proteſtant religion, not only from the controverſies of Luther, but even from thoſe divines whom Charles V. had brought with him into Germany in order to refute the doctrines of Luther. For theſe doctors imbibed the pretended hereſy inſtead of refuting it, and propagated it more or leſs on their return home. But the inquiſition, which could obtain no footing in Naples, reigned triumphant in Spain, and by the moſt dreadful methods frightened the people back into popery, and ſuppreſſed the deſire of exchanging their ſuperſtition for a more rational plan of religion. It was indeed preſumed that Charles himſelf died a Proteſtant; and it ſeems to be certain, that, when the approach of death had diſſipated thoſe ſchemes of ambition and grandeur which had ſo long blinded him, his ſentiments became much more rational and agreeable to Chriſtianity than they had ever been. All the eccleſiaſtics who had attended him, as ſoon as he expired, were ſent to the inquiſition, and committed to the flames, or put to death by ſome other method equally terrible. Such was the fate of Auguſtine Caſal, the emperor's preacher; of Conſtantine Pontius, his confeſſor; of Egidius, whom he had named to the biſhopric of Tortoſa; of Bartholomew de Caranza, a Dominican, who had been confeſſor to king Philip and queen Mary; with 20 others of leſs note.

In England, the principles of the Reformation began to be adopted as ſoon as an account of Luther's doctrines could be conveyed thither. In that kingdom there were ſtill great remains of the ſect called *Lollards*, whoſe doctrine reſembled that of Luther; and among whom of conſequence the ſentiments of our reformer gained great credit. Henry VIII. king of England at that time, was a violent partiſan of the church of Rome, and had a particular veneration for the writings of Thomas Aquinas. Being informed that Luther ſpoke of his favourite author with contempt, he conceived a violent prejudice againſt the reformer, and even wrote againſt him, as we have already obſerved. Luther did not heſitate at writing againſt his majeſty, overcame him in argument, and treated him with very little ceremony. The firſt ſtep towards public reformation, however, was not taken till the year 1529. Great complaints had been made in England, and of a very ancient date, of the uſurpations of the clergy; and by the prevalence of the Lutheran opinions, theſe complaints were now become more general than before. The Houſe of Commons finding the occaſion favourable, paſſed ſeveral bills, reſtraining the impoſitions of the clergy: but what threatened the eccleſiaſtical order with the greateſt danger were the ſevere reproaches thrown out almoſt without oppoſition in the houſe againſt the diſſolute lives, ambition, and avarice of the prieſts, and their continual encroachments on the privileges of the laity. The bills for regulating the clergy met with oppoſition in the Houſe of Lords; and biſhop Fiſher imputed them to want of faith in the Commons, and to a formed deſign, proceeding from heretical and Lutheran principles, of robbing the church of her patrimony, and overturning the national religion. The Commons, however, complained to the king, by their ſpeaker Sir Thomas Audley, of theſe reflections thrown out againſt them; and the biſhop was obliged to retract his words.

Though Henry had not the leaſt idea of rejecting any even of the moſt abſurd Romiſh ſuperſtitions; yet, as the oppreſſions of the clergy ſuited very ill with the violence of his own temper, he was pleaſed with every opportunity of leſſening their power. In the parliament of 1531, he ſhowed his deſign of humbling the clergy in the moſt effectual manner. An obſolete ſtatute was revived, from which it was pretended that it was criminal to ſubmit to the legatine power which had been exerciſed by cardinal Wolſey. By this ſtroke the whole body of clergy was declared guilty at once. They were too well acquainted with Henry's diſpoſition, however, to reply, that their ruin would have been the certain conſequence of their not ſubmitting to Wolſey's commiſſion, which had been given by royal authority. Inſtead of making any defence of this kind, they choſe to throw themſelves on the mercy of their ſovereign; which, however, it coſt them 118,840l. to procure. A confeſſion was likewiſe extorted from them, that the king was protector and ſupreme head of the church of England; though ſome of them had the dexterity to get a clauſe inſerted, which invalidated the whole ſubmiſſion, viz. *in ſo far as is permitted by the law of Chriſt.*

The king, having thus begun to reduce the power of the clergy, kept no bounds with them afterwards. He did not indeed attempt any reformation in religious matters; nay, he perſecuted moſt violently ſuch as did attempt this in the leaſt. Indeed, the moſt eſſential article of his creed ſeems to have been his own ſupremacy; for, whoever denied this was ſure to ſuffer the moſt ſevere penalties, whether Proteſtant or Papiſt.

He died in 1547, and was ſucceeded by his only ſon Edward VI. This amiable prince, whoſe early youth was crowned with that wiſdom, ſagacity, and virtue, that would have done honour to advanced years, gave new ſpirit and vigour to the Proteſtant cauſe, and was its brighteſt ornament, as well as its moſt effectual ſupport. He encouraged learned and pious men of foreign countries to ſettle in England, and addreſſed a particular invitation to Martin Bucer and Paul Fagius, whoſe moderation added a luſtre to their other virtues, that by the miniſtry and labours of theſe eminent men, in concert with thoſe of the friends of the Reformation in England, he might purge his dominions from the ſordid fictions of popery, and eſtabliſh the pure doctrines of Chriſtianity in their place. For this purpoſe, he iſſued out the wiſeſt orders for the reſtoration of true religion; but his reign was too ſhort to accompliſh fully ſuch a glorious purpoſe. In the year 1553, he was taken from his loving and afflicted ſubjects, whoſe ſorrow was inexpreſſible, and ſuited to their loſs. His ſiſter Mary (the daughter of Catharine of Arragon, from whom Henry had been ſeparated by the famous divorce), a furious bigot to the church of Rome, and a princeſs whoſe natural character, like the ſpirit of her religion, was deſpotic and cruel, ſucceeded him on the Britiſh throne, and impoſed anew the arbitrary laws and the tyrannical yoke of Rome upon the people of England. Nor were the methods ſhe employed in the cauſe of ſuperſtition better than the cauſe itſelf, or tempered by any ſentiments of equity or compaſſion. Barbarous tortures, and death in the moſt ſhocking forms, awaited thoſe who oppoſed her will, or made the leaſt ſtand againſt the reſtoration of popery. And among many other victims, the learned and pious Cranmer, archbiſhop of Canterbury, who had been one of the moſt illuſtrious inſtruments of the Reformation in England, fell a ſacrifice to her fury. This odious ſcene of perſecution was happily concluded in the year 1558, by the death of the queen, who left no iſſue; and, as ſoon as her ſucceſſor the lady Elizabeth aſcended the throne, all things aſſumed a new and a pleaſing aſpect. This illuſtrious princeſs, whoſe ſentiments, counſels and projects breathed a ſpirit ſuperior to the natural ſoftneſs and delicacy of her ſex, exerted this vigorous and manly ſpirit in the defence of oppreſſed conſcience and expiring liberty, broke anew the deſpotic yoke of papal authority and ſuperſtition, and, delivering her people from the bondage of Rome, eſtabliſhed that form of religious doctrine and eccleſiaſtical government which ſtill ſubſiſts in England. This religious eſtabliſhment differs, in ſome reſpects, from the plan that had been formed by thoſe whom Edward VI. had employed for promoting the cauſe of the Reformation, and approaches nearer to the rites and diſcipline of former times; though it is widely different, and, in the moſt important points, entirely oppoſite to the principles of the Roman hierarchy.

The cauſe of the Reformation underwent in Ireland the ſame viciſſitudes and revolutions that had attended it in England. When Henry VIII. after the abolition of the papal authority, was declared ſupreme head upon earth of the church of England, George Brown, a native of England, and a monk of the Auguſtine order, whom that monarch had created, in the year 1535, archbiſhop of Dublin, began to act with the utmoſt vigour in conſequence of this change in the hierarchy. He purged the churches of his dioceſe from ſuperſtition in all its various forms, pulled down images, deſtroyed relics, aboliſhed abſurd and idolatrous rites, and, by the influence as well as authority he had in Ireland, cauſed the king's ſupremacy to be acknowledged in that nation. Henry ſhowed, ſoon after, that this ſupremacy was not a vain title; for he baniſhed the monks out of that kingdom, confiſcated their revenues, and deſtroyed their convents. In the reign of Edward VI. ſtill further progreſs was made in the removal of popiſh ſuperſtitions, by the zealous labours of biſhop Brown, and the auſpicious encouragement he granted to all who exerted themſelves in the cauſe of the Reformation. But the death of this excellent prince, and the acceſſion of queen Mary, had like to have changed the face of affairs in Ireland as much as in England; but her deſigns were diſappoined by a very curious adventure, of which the following account has been copied from the papers of Richard earl of Corke. "Queen Mary, having dealt ſeverely with the Proteſtants in England, about the latter end of her reign ſigned a commiſſion for to take the ſame courſe with them in Ireland; and to execute the ſame with greater force, ſhe nominates Dr. Cole one of the commiſſioners. This doctor coming, with the commiſſion, to Cheſter on his journey, the mayor of that city hearing that her majeſty was ſending a meſſenger into Ireland, and he being a churchman, waited on the doctor, who in diſcourſe with the mayor taketh out of a cloke-bag a leather box, ſaying unto him, *Here is a commiſſion that ſhall laſh the Heretics of Ireland*, calling the Proteſtants by that title. The good woman of the houſe being well affected to the Proteſtant religion, and alſo having a brother named *John Edmonds* of the ſame, then a citizen in Dublin, was much troubled at the doctor's words; but watching her convenient time while the mayor took his leave, and the doctor complimented him down the ſtairs, ſhe opens the box, takes the commiſſion out, and places in lieu thereof a ſheet of paper with a pack of cards wrapt up therein, the knave of clubs being faced uppermoſt. The doctor coming up to his chamber, ſuſpecting nothing of what had been done, put up the box as formerly. The next day going to the water-ſide, wind and weather ſerving him, he ſails towards Ireland, and landed on the 7th of October 1558 at Dublin. Then coming to the caſtle, the lord Fitz-Walter, being lord deputy, ſent for him to come before him and the privy-council; who coming in, after he had made a ſpeech relating upon what account he came over, he preſents the box unto the lord-deputy; who cauſing it to be opened, that the ſecretary might read the commiſſion, there was nothing ſave a pack of cards with the knave of clubs uppermoſt; which not only ſtartled the lord-deputy and council, but the doctor, who aſſured them he had a commiſſion, but knew not how it was gone. Then the lord-deputy made anſwer: Let us have another commiſſion, and we will ſhuffle the cards in the mean while. The doctor, being troubled in his mind, went away, and returned into England, and coming to the court obtained another commiſſion; but ſtaying for a wind on the water-ſide, news came to him that the queen was dead: and thus God preſerved the Proteſtants of Ireland." Queen Elizabeth was ſo delighted with this ſtory, which was related to her by lord Fitz-Walter on his return to England, that ſhe ſent for Elizabeth Edmonds, whoſe huſband's name was *Matterſhad*, and gave her a penſion of 40l. during her life.

In Scotland, the ſeeds of reformation were very early ſown, by ſeveral noblemen who had reſided in Germany during the religious diſputes there. But for many years it was ſuppreſſed by the power of the pope, ſeconded by inhuman laws and barbarous executions. The moſt eminent oppoſer of the papal juriſdiction was John Knox, a diſciple of Calvin, a man of great zeal and invincible fortitude. On all occaſions he raiſed the drooping ſpirits of the reformers, and encouraged them to go on with their work notwithſtanding the oppoſition and treachery of the queen-regent; till at laſt, in 1561, by the aſſiſtance of an Engliſh army ſent by Elizabeth, popery was in a manner totally extirpated throughout the kingdom.—From this period the form of doctrine, worſhip, and diſcipline eſtabliſhed by Calvin at Geneva, has had the aſcendency in Scotland. But for an account of the difficulties which the Scottiſh reformers had to ſtruggle with, and the manner in which theſe were overcome, the hiſtories of Scotland muſt be reſorted to.

For further information on the ſubject of the Reformation in general, we refer our readers to the works of Burnet and Brandt, to Beauſobre's *Hiſtoire de la Reformation dans l'Empire, et les Etats de la Confeſſion d'Augſbourg depuis* 1517—1530, in 4 vols. 8vo, Berlin 1785, and Moſheim's Eccleſiaſtical Hiſtory. See alſo Sleidan *De Statu Religionis & Reipublicæ Carolo V.*; *Cæſaris Commentarii*; and Father Paul's Hiſtory of the Council of Trent.

REFRACTION, in general, is the deviation of a moving body from its direct courſe, occaſioned by the different denſity of the medium in which it moves; or it is a change of direction occaſioned by a body's falling obliquely out of one medium into another. The word is chiefly made uſe of with regard to the rays of light. See Optics.

REFRANGIBILITY of Light, the diſpoſition of rays to be refracted. The term is chiefly applied to the diſpoſition of rays to produce different colours, according to their different degrees of refrangibility. See Chromatics and Optics *paſſim*.

REFRIGERATIVE, in medicine, a remedy which refreſhes the inward parts by cooling them; as clyſters, ptiſans, &c.

REFRIGERATORY, in chemiſtry, a veſſel filled with cold water, through which the worm paſſes in diſtillations; the uſe of which is to condenſe the vapours as they paſs through the worm.

Cities of REFUGE, were places provided as *Aſyla*, for ſuch as againſt their will ſhould happen to kill a man. Of theſe cities there were three on each ſide Jordan: on this ſide were Kedeſh of Naphthali, Hebron, and Schechem; beyond Jordan were Bezer, Golan, and Ramoth-Gilead. When any of the Hebrews, or ſtrangers that dwelt in their country, happened to ſpill the blood of a man, they might retire thither to be out of the reach of the violent attempts of the relations of the deceaſed, and to prepare for their defence and juſtification before the judges. The manſlayer underwent two trials: firſt before the judges of the city of refuge to which he had fled; and ſecondly before the judges of his own city. If found guilty, he was put to death with all the ſeverity of the law. If he was acquitted, he was not immediately ſet at liberty; but, to inſpire a degree of horror againſt even involuntary homicide, he was reconducted to the place of refuge, and obliged to continue there in a ſort of baniſhment till the death of the high-prieſt. If, before this time, he ventured out, the revenger of blood might freely kill him; but after the high-prieſt's death he was at liberty to go were he pleaſed without moleſtation. It was neceſſary that the perſon who fled to any of the cities of refuge ſhould underſtand ſome trade or calling, that he might not be burthenſome to the inhabitants. The cities of refuge were required to be well ſupplied with water and neceſſary proviſions. They were alſo to be of eaſy acceſs, to have good roads leading to them, with commodious bridges where there was occaſion. The width of the roads was to be 32 cubits or 48 feet at leaſt. It was further required, that at all croſs-ways direction-poſts ſhould be erected, with an inſcription pointing out the road to the cities of refuge. The 15th of Adar, which anſwers to our February moon, was appointed for the city magiſtrates to ſee that the roads were in good condition. No perſon in any of theſe cities was allowed to make weapons, leſt the relations of the deceaſed ſhould be furniſhed with the means of gratifying their revenge. Deut. xix. 3. iv. 41. 43.; Joſh. xx. 7. Three other cities of refuge were conditionally promiſed, but never granted. See Asylum.

REFUGEES, a term at firſt applied to the French Proteſtants, who, by the revocation of the edict of Nantz, were conſtrained to fly from perſecution, and take refuge in foreign countries. Since that time, however, it has been extended to all ſuch as leave their country in times of diſtreſs; and hence, ſince the revolt of the Britiſh colonies in America, we have frequently heard of *American refugees*.

REGALE, a magnificent entertainment or treat, given to ambaſſadors and other perſons of diſtinction, to entertain or do them honour. It is uſual in Italy, at the arrival of a traveller of eminence, to ſend him a regale, that is, a preſent of ſweetmeats, fruits, &c. by way of refreſhment.

REGALIA, in law, the rights and prerogatives of a king. See Prerogative. *Regalia* is alſo uſed for the apparatus of a coronation; as the crown, the ſceptre with the croſs, that with the dove, St. Edward's ſtaff, the globe, and the orb with the croſs, four ſeveral ſwords, &c.—The regalia of Scotland were depoſited in the caſtle of Edinburgh in the year 1707, in what is called the *Jewel Office*. This room was lately opened by ſome commiſſioners appointed by the king, when the large cheſt in which it is ſuppoſed they were placed was found; but as it has not, that we have heard of, been opened, it is impoſſible to ſay whether they be there or not. It is very generally thought they were carried to the Tower of London in the reign of queen Anne; and a crown is there ſhown which is called the Scotch crown. We do not believe, however, that that is the real crown of Scotland; and think it probable that the Scotch regalia are in the cheſt which was lately found. If they are not there, they muſt have been taken away by ſtealth, and either deſtroyed or melted down, for we do not believe that they are in the Tower of London.

Court *of* REGARD. See Forest-*Courts*.

REGARDANT, in heraldry, ſignifies looking behind; and it is uſed for a lion, or other beaſt, with his face turned towards his tail.

REGARDER, an ancient officer of the king's foreſt, ſworn to make the regard of the foreſt every year; that is, to take a view of its limits, to inquire into all offences and defaults committed by the foreſters within the foreſt, and to obſerve whether all the officers have executed their reſpective duties. See Forest-*Laws*.

REGATA, or Regatta, a ſpecies of amuſement peculiar to the republic of Venice. This ſpectacle has the power of exciting the greateſt emotions of the heart, admiration, enthuſiaſm, a ſenſe of glory, and the whole train of our beſt feelings. The grand regata is only exhibited on particular occaſions, as the viſits of foreign princes and kings at Venice.

It is difficult to give a juſt idea of the ardour that the notice of a *regata* ſpreads among all claſſes of the inhabitants of Venice. Proud of the excluſive privilege of giving ſuch a ſpectacle, through the wonderful local circumſtances of their city, they are highly delighted with making preparations a long time before, in order to contribute all they can towards the perfection and enjoyment of the ſpectacle. A thouſand intereſts are formed and augmented every day; parties in favour of the different competitors who are known; the protection of young noblemen given to the gondoliers in their ſervice; the deſire of honours and rewards in the aſpirants; and, in the midſt of all this, that ingenious national induſtry, which awakes the Venetians from their habitual indolence, to derive advantage from the buſineſs and agitation of the moment: all theſe circumſtances united give to the numerous inhabitants of this lively city a degree of ſpirit and animation which render it during that time a delightful abode in the eyes of the philoſopher and the ſtranger. Crowds of people flock from the adjacent parts, and travellers joyfully repair to this ſcene of gaiety and pleaſure.

Although it is allowable for any man to go and inſcribe his name in the liſt of combatants until the fixed number is complete, it will not be amiſs to remark one thing, which has relation to more ancient times. The ſtate of a gondolier (ſee Gondola) is of much conſideration among the people; which is very natural, that having been the primitive condition of the inhabitants of this country. But, beſides this general conſideration, there are among them ſome families truly diſtinguiſhed and reſpected by their equals, whoſe antiquity is acknowledged, and who, on account of a ſucceſſion of virtuous men, able in their profeſſion, and honoured for the prizes they have carried off in theſe conteſts, form the body of noble gondoliers; often more worthy of that title than the higher order of nobility, who only derive their honours from the merit of their anceſtors, or from their own riches. The conſideration for thoſe families is carried ſo far, that, in the diſputes frequently ariſing among the gondoliers in their ordinary paſſage of the canals, we ſometimes ſee a quarrel inſtantly made up by the ſimple interpoſition of a third perſon, who has chanced to be of this reverend body. They are rigid with reſpect to miſalliances in their families, and they endeavour reciprocally to give and take their wives among thoſe of their own rank. But we muſt remark here, with pleaſure, that theſe diſtinctions infer no inequality of condition, nor admit any oppreſſion of inferiors, being founded ſolely on laudable and virtuous opinions. Diſtinctions derived from fortune only, are thoſe which always outrage nature, and often virtue.

In general, the competitors at the great regatas are choſen from among theſe families of reputation. As ſoon as they are fixed upon for this exploit, they ſpend the intermediate time in preparing themſelves for it, by a daily aſſiduous and fatiguing exerciſe. If they are in ſervice, their maſters during that time not only give them their liberty, but alſo augment their wages. This cuſtom would ſeem to indicate, that they look upon them as perſons conſecrated to the honour of the nation, and under a ſort of obligation to contribute to its glory.

At laſt the great day arrives. Their relations aſſemble together: they encourage the heroes by calling to their minds the records of their families; the women preſent the oar, beſeeching them, in an epic tone, to remember that they are the ſons of famous men, whoſe ſteps they will be expected to follow: this they do with as much ſolemnity as the Spartan women preſented the ſhield to their ſons, bidding them either return with or upon it. Religion, as practiſed among the lower claſs of people, has its ſhare in the preparations for this enterpriſe. They cauſe maſſes to be ſaid; they make vows to ſome particular church; and they arm their boats for the conteſt with the images of thoſe ſaints who are moſt in vogue. Sorcerers are not forgotten upon this occaſion. For gondoliers who have loſt the race often declare, that witchcraft had been practiſed againſt them, or certainly they muſt have won the day. Such a ſuppoſition prevents a poor fellow from thinking ill of himſelf; an opinion that might be favourable to him another time.

The courſe is about four miles. The boats ſtart from a certain place, run through the great winding canal, which divides the town into two parts, turn round a picket, and, coming back the ſame way, go and ſeize the prize, which is fixed at the acuteſt angle of the great canal, on the convex ſide, ſo that the point of ſight may be the more extended, and the prize ſeized in the ſight of the ſpectators on both ſides.

According to the number of competitors, different races are performed in different ſorts of boats; ſome with one oar and others with two. The prizes propoſed are four, indicated by four flags of different colours, with the different value of the prizes marked upon them.—Theſe flags, public and glorious monuments, are the prizes to which the competitors particularly aſpire. But the government always adds to each a genteel ſum of money; beſides that the conquerors, immediately after the victory, are ſurrounded by all the *beau monde*, who congratulate and make them preſents; after which they go, bearing their honourable trophy in their hand, down the whole length of the canal, and receive the applauſe of innumerable ſpectators.

This grand canal, ever ſtriking by the ſingularity and beauty of the buildings which border it, is, upon theſe occaſions, covered with an infinity of ſpectators, in all ſorts of barges, boats, and gondolas. The element on which they move is ſcarcely ſeen; but the noiſe of oars, the agitation of arms and bodies in perpetual motion, indicate the ſpectacle to be upon the water. At certain diſtances, on each ſide of the ſhore, are erected little amphitheatres and ſcaffoldings, where are placed bands of muſic; the harmonious ſound of which predominates now and then over the buzzing noiſe of the people. Some days before a *regata* one may ſee on the great canal many boats for pleaſure and entertainment. The young noble, the citizen, the rich artiſan, mounts a long boat of ſix or eight oars; his gondoliers decorated with rich and ſingular dreſſes, and the veſſel itſelf adorned with various ſtuffs. Among the nobles there are always a number who are at a conſiderable expenſe in theſe decorations; and at the *regata* itſelf exhibit on the water perſonages of mythologic ſtory, with the heroes of antiquity in their train, or amuſe themſelves with repreſenting the coſtumi of different nations: in ſhort, people contribute with a mad ſort of magnificence, from all quarters, to this maſquerade, the favourite diverſion of the Venetians. But theſe great machines, not being the leſs in motion on account of their ornaments, are not merely deſtined to grace the ſhow: they are employed at the regata, at every moment, to range the people, to protect the courſe, and to keep the avenue open and clear to the goal. The nobility, kneeling upon cuſhions at the prow of their veſſels, are attentive to theſe matters, and announce their orders to the moſt reſtive by darting at them little gilded or ſilvered balls, by means of certain bows with which they are furniſhed on this occaſion. And this is the only appearance of coercion in the Venetian police on theſe days of the greateſt tumult: nor is there to be ſeen, in any part of the city, a body of guards or patrol, nor even a gun or a halbert. The mildneſs of the nation, its gaiety, its education in the habit of believing that the government is ever awake, that it knows and ſees every thing; its reſpectful attachment to the body of patricians; the ſole aſpect of certain officers of the police in their robes, diſperſed in different places, at once operate and explain that tranquillity, that ſecurity, which we ſee in the midſt of the greateſt confuſion, and that ſurpriſing docility in ſo lively and fiery a people. Regatas have been attempted on the river Thames, but they were but humble imitations of the Venetian amuſement.

REGEL, or RIGEL, a fixed ſtar of the firſt magnitude, in Orion's left foot.

REGENERATION, in theology, the act of being born again by a ſpiritual birth, or the change of heart and life experienced by a perſon who forſakes a courſe of vice, and ſincerely embraces a life of virtue and piety.

REGENSBURG, or RATISBON. See RATISBON.

REGENT, one who governs a kingdom during the minority or abſence of the king. Before the revolution in France, the queen-mother had the regency of the kingdom during the minority of the king, under the title of *queen-regent*. In England, the methods of appointing this guardian or regent have been ſo various, and the duration of his power ſo uncertain, that from hence alone it may be collected that his office is unknown to the common law; and therefore (as Sir Edward Coke ſays, 4 Inſt. 58.) the ſureſt way is to have him made by authority of the great council in parliament. The earl of Pembroke by his own authority aſſumed in very troubleſome times the regency of Henry III. who was then only nine years old; but was declared of full age by the pope at 17, confirmed the great charter at 18, and took upon him the adminiſtration of the government at 20. A guardian and councils of regency were named for Edw III. by the parliament, which depoſed his father; the young king being then 15, and not aſſuming the government till three years after. When Richard II. ſucceeded at the age of 11, the duke of Lancaſter took upon him the management of the kingdom till the parliament met, which appointed a nominal council to aſſiſt him. Henry V. on his death bed named a regent and a guardian for his infant ſon Henry VI. then nine months old: but the parliament altered his diſpoſition, and appointed a protector and council, with a ſpecial limited authority. Both theſe princes remained in a ſtate of pupilage till the age of 23. Edward V. at the age of 13, was recommended by his father to the care of the duke of Glouceſter; who was declared protector by the privy-council. The ſtatutes 25 Hen. VIII. c. 12. and 28 Hen. VIII. c. 7. provided, that the ſucceſſor, if a male and under 18, or if a female and under 16, ſhould be till ſuch age in the governance of his or her natural mother, (if approved by the king,) and ſuch other counſellors as his majeſty ſhould by will or otherwiſe appoint: and he accordingly appointed his 16 executors to have the government of his ſon Edward VI. and the kingdom, which executors elected the earl of Hartford protector. The ſtatutes 24 Geo. II. c. 24. in caſe the crown ſhould deſcend to any of the children of Frederic late prince of Wales under the age of 18, appointed the princeſs dowager;—and that of 5 Geo. III. c. 27. in caſe of a like deſcent to any of his preſent majeſty's children, empowers the king to name either the queen or princeſs dowager, or any deſcendant of king George II. reſiding in this kingdom; to be guardian and regent till the ſucceſſor attains ſuch age, aſſiſted by a council of regency; the powers of them all being expreſsly defined and ſet down in the ſeveral acts.

REGENT alſo ſignifies a profeſſor of arts and ſciences in a college, having pupils under his care; but it is generally reſtrained to the lower claſſes, as to rhetoric, logic, &c. thoſe of philoſophy being called *profeſſors*. In the Engliſh univerſities it is applied to Maſters of Arts under five years ſtanding, and to Doctors under two, as Non-regent is to thoſe above that ſtanding.

REGGIO, an ancient and conſiderable town of Italy, in the kingdom of Naples, and in the Further Calabria, with an archbiſhop's ſee, and a woollen manufactory. It is ſeated in a delightful country, which produces plenty of oranges, and all their kindred fruits. The olives are exquiſite, and high flavoured. The town, however, can boaſt of neither beautiful buildings nor ſtrong fortifications. Of its edifices the Gothic cathedral is the only ſtriking one, but it affords nothing curious in architecture. The citadel is far from formidable, according to the preſent ſyſtem of tactics; nor could the city walls make a long reſiſtance againſt any enemy but Barbary corſairs; and even theſe they have not always been able to repel, for in 1543 it was laid in aſhes by Barbaroſſa. Muſtapha ſacked it 15 years after, and the deſolation was renewed in 1593 by another ſet of Turks. Its expoſed ſituation, on the very threſhold of Italy, and fronting Sicily, has from the earlieſt period rendered it liable to attacks and devaſtation. The Chalcidians ſeized upon it, or, according to the uſual Greek phraſe, founded it, and called the colony *Rhegion*, from a word that means a break or crack, alluding to its poſition on the point where Sicily broke off from the continent. Anaxilas oppreſſed its liberties. Dionyſius the Elder took it, and put many of the principal citizens to death, in revenge for their having refuſed his alliance. The Campanian legion, ſent to protect the Rhegians, turned its ſword againſt them, maſſacred many inhabitants, and tyrannized over the remainder, till the Roman ſenate thought proper to puniſh theſe traitors with exemplary ſeverity, though at the ſame time it entered into a league with the revolted garriſon of Meſſina. This union with a ſet of villains, guilty of the ſame crime, proved that no love of juſtice, but political reaſons alone, drew down its vengeance on the Campanians.—It is about 12 miles S. E. of Meſſina, and 190 S. by E. of Naples. E. lon. 16. 0. N. lat. 38. 4.

Reggio, an ancient, handſome, and ſtrong town of Italy, in the duchy of Modena, with a ſtrong citadel, and a biſhop's ſee. It has been ruined ſeveral times by the Goths, and other nations. In the cathedral are paintings by the greateſt maſters; and in the ſquare is the ſtatue of Brennus, chief of the Gauls. The inhabitants are about 22,000, who carry on a great trade in ſilk. It was taken by prince Eugene in 1706, and by the king of Sardinia in 1742. It is ſeated in a fertile country to the ſouth of the Apennines, and to the north of a ſpacious plain, 15 miles north-weſt of Modena, and 80 ſouth-eaſt of Milan. E. lon 11. 5. N. lat. 44. 43. The duchy of this name is bounded on the weſt by that of Modena, and produces a great deal of ſilk, and belongs to the duke of Modena, except the marquiſate of St. Martin, which belongs to a prince of that name.

REGICIDE, king-killer, a word chiefly uſed with us in ſpeaking of the perſons concerned in the trial, condemnation, and execution, of king Charles I.

REGIFUGIUM was a feaſt celebrated at Rome on the 24th of February, in commemoration of the expulſion of *Tarquinius Superbus*, and the abolition of regal power. It was alſo performed on the 26th of May, when the king of the ſacrifices, or *Rex Sacrorum*, offered bean flour and bacon in the place where the aſſemblies where held. The ſacrifice being over, the people haſted away with all ſpeed, to denote the precipitate flight of King Tarquin.

REGIMEN, the regulation of diet, and, in a more general ſenſe, of all the non-naturals, with a view to preſerve or reſtore health. See Abstinence, Aliment, Food, Diet, Drink, and Medicine. The viciſſitude of exerciſe and reſt forms alſo a neceſſary part of regimen. See Exercise. It is beneficial to be at reſt now and then, but more ſo frequently to uſe exerciſe, becauſe inaction renders the body weak and liſtleſs, and labour ſtrengthens it. But a medium is to be obſerved in all things, and too much fatigue is to be avoided: for frequent and violent exerciſe overpowers the natural ſtrength, and waſtes the body; but moderate exerciſe ought always to be uſed before meals. Now, of all kinds of exerciſe, riding on horſeback is the moſt convenient: or, if the perſon be too weak to bear it, riding in a coach, or at leaſt in a litter: next follow fencing, playing at ball, running, walking. But it is one of the inconveniences of old age, that there is ſeldom ſufficient ſtrength for uſing bodily exerciſe, though it be extremely requiſite for health: wherefore frictions with the fleſh bruſh are neceſſary at this time of life; which ſhould be performed by the perſon himſelf, if poſſible: if not, by his ſervants. Sleep is the ſweet ſoother of cares, and reſtorer of ſtrength; as it repairs and replaces the waſtes that are made by the labours and exerciſes of the day. But exceſſive ſleep has its inconveniences; for it blunts the ſenſes, and renders them leſs fit for the duties of life. The proper time for ſleep is the night, when darkneſs and ſilence invite and bring it on: day-ſleep is leſs refreſhing; which rule if it be proper for the multitude to obſerve, much more is the obſervance of it neceſſary for perſons addicted to literary ſtudies, whoſe minds and bodies are more ſuſceptible of injuries.

Regimen, in grammar, that part of ſyntax, or conſtruction, which regulates the dependency of words, and the alterations which one occaſions in another.

Regimen *for Seamen*. See Seamen.

REGIMENT, is a body of men, either horſe, foot, or artillery, commanded by a colonel, lieutenant colonel, and major. Each regiment of foot is divided into companies; but the number of companies differs: though in Britain our regiments are generally 10 companies, one of which is always grenadiers, excluſive of the two independent companies. Regiments of horſe are commonly ſix troops, but there are ſome of nine. Dragoon regiments are generally in war-time 8 troops, and in time of peace but 6. Each regiment has a chaplain, quarter-maſter, adjutant, and ſurgeon. Some German regiments conſiſt of 2000 foot; and the regiment of Picardy in France conſiſted of 6000, being 120 companies, of 50 men in each company. Regiments were firſt formed in France in the year 1558, and in England in the year 1660.

REGIOMONTANUS. See Muller.

REGION, in geography, a large extent of land, inhabited by many people of the ſame nation, and incloſed within certain limits or bounds. The modern aſtronomers divide the moon into ſeveral regions, or large tracts of land, to each of which they give its proper name.

Region, in phyſiology, is taken for a diviſion of our atmoſphere, which is divided into the upper, middle, and lower regions. The upper region commences from the tops of the mountains, and reaches to the utmoſt limits of the atmoſphere. In this region reign a perpetual equable calmneſs, clearneſs, and ſerenity. The middle region is that in which the clouds reſide, and where meteors are formed, extending from the extremity of the loweſt to the tops of the higheſt mountains. The loweſt region is that in which we breathe, which is bounded by the reflection of the ſun's rays; or by the height to which they rebound from the earth. See Atmosphere and Air.

Æthereal Region, in coſmography, is the whole extent of the univerſe, in which are included all the heavenly bodies, and even the orb of the fixed ſtars.

Elementry Region, according to the Ariſtotelians, is a ſphere terminated by the concavity of the moon's orb, comprehending the atmoſphere of the earth.

Region, in anatomy, a diviſion of the human body, otherwiſe called *cavity*, of which anatomiſts reckon three, viz. the upper region, or that of the head; the middle region, that of the thorax or breaſt; and the lower, the abdomen, or belly. See Anatomy.

Region, in ancient Rome, was a part or diviſion of the city. The regions were only four in number till Auguſtus Cæſar's time, who divided the city into fourteen; over each of which he ſettled two ſurveyors, called *curatores viarum*, who were appointed annually, and took their diviſions by lot. Theſe fourteen regions contained four hundred and twenty-four ſtreets, thirty-one of which were called *greater* or *royal ſtreets*, which began at the gilt pillar that ſtood at the entry of the open place, in the middle of the city. The extent of theſe diviſions varied greatly, ſome being from 12000 or 13000 to 33000 feet or upwards in circumference. Authors, however, are not agreed as to the exact limits of each. The curatores viarum wore the purple, had each two lictors in their proper diviſions, and had ſlaves under them to take care of fires that happened to break out. They had alſo two officers, called *denunciatores*, in each region, to give account of any diſorders. Four *vico-magiſtri* alſo were appointed in each ſtreet, who took care of the ſtreets allotted them, and carried the orders of the city to each citizen.

REGISTER, a public book, in which are entered and recorded memoirs, acts, and minutes, to be had recourſe to occaſionally for knowing and proving matters of fact. Of theſe there are ſeveral kinds; as, 1. Regiſter of *deeds* in Yorkſhire and Middleſex, in which are regiſtered all deeds, conveyances, wills, &c. that affect any lands or tenements in thoſe counties, which are otherwiſe void againſt any ſubſequent purchaſers or mortgagees, &c. but this does not extend to any copyhold eſtate, nor to leaſes at a rack-rent, or where they do not exceed 21 years. The regiſtered memorials muſt be ingroſſed on parchment, under the hand and ſeal of ſome of the granters or grantees, atteſted by witneſſes who are to prove the ſigning or ſealing of them and the execution of the deed. But theſe regiſters, which are confined to two counties, are in Scotland general, by which the laws of North Britain are rendered very eaſy and regular. Of theſe there are two kinds; the one general, fixed at Edinburgh, under the direction of the lord regiſter; and the other is kept in the ſeveral ſhires, ſtewartries, and regalities, the clerks of which are obliged to tranſmit the regiſters of their reſpective courts to the general regiſter.—2. *Pariſh-regiſters* are books in which are regiſtered the baptiſms, marriages, and burials of each pariſh.

Registers were kept both at Athens and Rome, in which were inſerted the names of ſuch children as were to be brought up, as ſoon as they were born. Marcus Aurelius required all free perſons to give in accounts of their children, within 30 days after the birth, to the treaſurer of the empire, in order to their being depoſited in the temple of Saturn, where the public acts were kept. Officers were alſo appointed as public regiſters in the provinces, that recourſe might be had to their liſts of names, for ſettling diſputes, or proving any perſon's freedom.

Register *Ships*, in commerce, are veſſels which obtain a permiſſion either from the king of Spain, or the council of the Indies, to traffic in the ports of the Spaniſh Weſt Indies; which are thus called from their being regiſtered before they ſet ſail from Cadiz for Buenos Ayres.

REGISTERS, in chemiſtry, are holes or chinks with ſtopples, contrived in the ſides of furnaces, to regulate the fire; that is, to make the heat more intenſe or remiſs, by opening them to let in the air, or keeping them cloſe to exclude it. There are alſo regiſters in the ſteam-engine. See Steam-*Engine*.

REGISTRAR, an officer in the Engliſh univerſities, who has the keeping of all the public records.

REGIUM, Regium *Lepidi*, *Regium Lepidum* (anc. geog.); a town of Ciſalpine Gaul, on the Via Æmilia, ſo called from Æmilius Lepidus, who was conſul with C. Flaminius; but whence it was ſurnamed *Regium* is altogether uncertain. Tacitus relates, that at the battle of Bedriacum, a bird of an unuſual ſize was ſeen perching in a famous grove near Regium Lepidum. Now called *Reggio*, a city of Modena. E. lon. 11. 0. N. lat. 44 45. See Reggio.

REGNARD (John Francis), one of the beſt French comic writers after Moliere, was born at Paris in 1647. He had ſcarcely finiſhed his ſtudies, when an ardent paſſion for travelling carried him over the greateſt part of Europe. When he ſettled in his own country, he was made a treaſurer of France, and lieutenant of the waters and foreſts: he wrote a great many comedies; and, though naturally of a gay genius, died of chagrin in the 52d year of his age. His works, conſiſting of comedies and travels, were printed at Rouen, in 5 vols. 12mo, 1732.

REGNIER (Mathurin), the firſt French poet who ſucceeded in ſatire, was born at Chartres in 1573. He was brought up to the church, a place for which his debaucheries rendered him very unſuitable; and theſe by his own confeſſion were ſo exceſſive, that at 30 he had all the infirmities of age. Yet he obtained a canonry in the church of Chartres, with other benefices; and died in 1613. There is a neat Elzevir edition of his works, 12mo, 1652, Leyden; but the moſt elegant is that with notes by M. Broſſette, 4to, 17[illegible]9, London

Regnier des Marets (Seraphin), a French poet, born at Paris in 1632. He diſtinguiſhed himſelf early by his poetical talents, and in 1684 was made perpetual ſecretary to the French academy on the death of Mezeray: it was he who drew up all thoſe papers in the name of the academy againſt Furetiere: the king gave him the priory of Grammont, and he had alſo an abbey. He died in 1713, and his works are, French, Italian, Spaniſh, and Latin poems, 2 vols. a French grammar; and an Italian tranſlation of Anacreon's odes, with ſome other tranſlations.

REGNUM (anc. geog.), a town of the Regni, a people in Britain, next the Cantii, now Surrey, Suſſex, and the coaſt of Hampſhire, (Camden); a town ſituated, by the Itinerary numbers, on the confines of the Belgæ, in a place now called *Ringwood*, in Hampſhire, on the rivulet Avon, running down from Saliſbury, and about ten miles or more diſtant from the ſea.

REGRATOR, ſignifies him who buys and ſells any wares or victuals in the *ſame* market or fair: and regrators are particularly deſcribed to be thoſe who buy, or get into their hands, in fairs or markets, any grain, fiſh, butter, cheeſe, ſheep, lambs, calves, ſwine, pigs, geeſe, capons, hens, chickens, pigeons, conies, or other dead victuals whatſoever, brought to a fair or market to be ſold there, and do ſell the ſame again in the ſame fair, market, or place, or in ſome other within four miles thereof. Regrating is a kind of *huckſtry*, by which victuals are made dearer; for every ſeller will gain ſomething, which muſt of conſequence enhance the price. And, in ancient times, both the engroſſer and regrator were comprehended under the word *foreſtaller*. Regrators are puniſhable by loſs and forfeiture of goods, and impriſonment, according to the firſt, ſecond, or third offence, &c.

REGENSBERG, a handſome though ſmall town of Swiſſerland, in the canton of Zurich, and capital of a bailiwick of the ſame name, with a ſtrong caſtle; ſeated on a hill, which is part of Mount Jura. There is a well ſunk through a rock 36 fathoms deep.

REGULAR, denotes any thing that is agreeable to the rules of art: thus we ſay, a regular building verb, &c. A regular figure, in geometry, is one whoſe ſides, and conſequently angles, are equal; and a regular figure with three or four ſides is commonly termed an *equilateral triangle* or *ſquare*, as all others with more ſides are called *regular polygons*.

Regular, in a monaſtery, a perſon who has taken the vows; becauſe he is bound to obſerve the rules of the order he has embraced.

REGULATION, a rule or order preſcribed by a ſuperior, for the proper management of ſome affair.

REGULATOR *of a* Watch, the ſmall ſpring belonging to the balance; ſerving to adjuſt its motions, and make it go faſter or ſlower. See Watch.

REGULBIUM, or Regulvium, (Notitia Imperii); mentioned nowhere elſe more early: a town of the Cantii, in Britain. Now Reculver, a village on the coaſt, near the iſland of Thanet, towards the Thames, to the north of Canterbury, (Camden).

REGULUS (M. Attilius), a conſul during the firſt Punic war. He reduced Brunduſium, and in his ſecond conſulſhip he took 64 and ſunk 30 galleys of the Carthaginian fleet on the coaſts of Sicily. Afterwards he landed in Africa; and ſo rapid was his ſucceſs, that in a ſhort time he made himſelf maſter of about 200 places of conſequence on the coaſt. The Carthaginians ſued for peace, but the conqueror refuſed to grant it; and ſoon after he was defeated in a battle by Xanthippus, and 30,000 of his men were left on the field of battle, and 15,000 taken priſoners. Regulus was in the number of the captives, and he was carried in triumph to Carthage. He was ſent by the enemy to Rome, to propoſe an accommodation and an exchange of priſoners; and if his commiſſion was unſucceſsful, he was bound by the moſt ſolemn oaths to return to Carthage without delay. When he came to Rome, Regulus diſſuaded his countrymen from accepting the terms which the enemy propoſed; and when his opinion had had due influence on the ſenate, Regulus returned to Carthage agreeably to his engagements. The Carthaginians were told that their offer of peace had been rejected at Rome by the means of Regulus; and therefore they prepared to puniſh him with the greateſt ſeverity. His eye-brows were cut, and he was expoſed for ſome days to the exceſſive heat of the meridian ſun, and afterwards confined in a barrel, whoſe ſides were every where filled with large iron ſpikes, till he died in the greateſt agonies. His ſufferings were heard of at Rome; and the ſenate permitted his widow to inflict whatever puniſhment ſhe pleaſed on ſome of the moſt illuſtrious captives of Carthage which were in their hands. She confined them alſo in preſſes filled with ſharp iron points; and was ſo exquiſite in her cruelty, that the ſenate interfered, and ſtopped the barbarity of her puniſhment. Regulus died about 251 years before Chriſt.—Memmius, a Roman, made governor of Greece by Caligula. While Regulus was in his province, the emperor wiſhed to bring the celebrated ſtatue of Jupiter Olympius by Phidias to Rome, but this was ſupernaturally prevented; and according to ancient authors, the ſhip which was to convey it was deſtroyed by lightning, and the workmen who attempted to remove the ſtatue were terrified away by ſudden noiſes.—A man who condemned Sejanus.—Roſcius, a man who held the conſulſhip but for one day, in the reign of Vitellius.

Regulus, in chemiſtry, an imperfect metallic ſubſtance that falls to the bottom of the crucible in the melting of ores or impure metallic ſubſtances. It is the fineſt or pureſt part of the metal; and, according to the alchemiſts, is denominated *regulus*, or *little king*, as being the firſt-born of the royal metallic blood. According to them, it is really a ſon, but not a perfect man; *i. e.* not yet a perfect metal, for want of time and proper nouriſhment. To procure the regulus or mercurial parts of metals, &c. flux powders are commonly uſed; as nitre, tartar, &c. which purge the ſulphureous part adhering to the metal, by attracting and abſorbing it to themſelves.

Regulus *of Antimony*. See Chemistry, p. 433.

Regulus *of Arſenic*. The ancient proceſs for making regulus of arſenic conſiſted in mixing four parts of arſenic with two parts of black flux, one part of borax, and one part of filings of iron or of copper, and quickly fuſing the mixture in a crucible. After the operation is finiſhed, a regulus of arſenic will be found at the bottom of the crucible of a white livid colour, and of conſiderable ſolidity. The iron and copper employed in this proceſs are not intended, as in the operation for the martial regulus of antimony, to precipitate the arſenic, and to ſeparate it from ſulphur or any other ſubſtance; for the white arſenic is pure, and nothing is to be taken from it; but, on the contrary, the inflammable principle is to be added to reduce it to a regulus. The true uſe of theſe metals in the preſent operation is to unite with the regulus of arſenic, to give it more body, and to prevent its entire diſſipation in vapours. Hence the addition of iron, while it procures theſe advantages, has the inconveniency of altering the purity of the regulus: for the metallic ſubſtance obtained is a regulus of arſenic allayed with iron. It may, however, be purified from the iron by ſublimation in a cloſe veſſel; by which operation the reguliſed arſenical part, which is very volatile, is ſublimed to the top of the veſſel, and is ſeparated from the iron, which being of a fixed nature remains at the bottom. We are not, however, very certain, that in this kind of rectification the regulus of arſenic does not carry along with it a certain quantity of iron; for, in general, a volatile ſubſtance raiſes along with it, in ſublimation, a part of any fixed matter with which it happened to be united.

Regulus of arſenic made by the method we have deſcribed, and which we conſider as the only one which is pure, has all the properties of a ſemimetal. It has metallic gravity, opacity, and luſtre. Its colour is white and livid, it tarniſhes in the air, is very brittle, but much more volatile than any other ſemimetal. It eaſily loſes its inflammable principle, when ſublimed in veſſels into which the air has acceſs; the ſublimate having the appearance of gray flowers, which by repeated ſublimations become entirely white, and ſimilar to white cryſtalline arſenic. When regulus of arſenic is heated quickly and ſtrongly in open air, as under a muffle, it burns with a white or blueiſh flame, and diſſipates in a thick fume, which has a very fetid ſmell, like that of garlic.

Regulus of arſenic may be combined with acids and moſt metals. We ſhall only further obſerve here, that, according to Mr. Brandt, in the Swediſh Memoirs, the regulus of arſenic cannot be united with mercury. Although the phenomena exhibited by white arſenic and regulus of arſenic in ſolutions and allays are probably the ſame, yet an accurate compariſon of theſe would deſerve notice, eſpecially if the regulus employed were well made; for ſome difference muſt proceed from the greater or leſs quantity of what in the old chemiſtry is called phlogiſton, with which it is united.

Regulus *of Cobalt*, is a ſemimetal lately diſcovered, and not yet perfectly well known: for the manner of making it ſee Chemistry, p. 432.

Many curious and intereſting remarks are ſtill to be diſcovered concerning this ſingular ſemimetal, and we may hope to receive further information from the endeavours of chemiſts who have undertaken the examination of it.

REHEARSAL, in muſic and the drama, an eſſay or experiment of ſome compoſition, generally made in private, previous to its repreſentation or performance in public, in order to render the actors and performers more perfect in their parts.

REICHENBERG, a caſtle of Germany, in the circle of the Upper Rhine and county of Catzenlenbogen. It is ſeated on a mountain near the Rhine, and belongs to the prince of Heſſe Rheinfeld. E. lon. 7. 57. N. lat. 50. 4.

REIN-deer, or *Tarandus*. See Cervus.

REINS, in anatomy, the ſame with Kidneys. See Anatomy.

Reins *of a Bridle*, are two long ſlips of leather, faſtened on each ſide of a curb or ſnaffle, which the rider holds in his hand to keep the horſe in ſubjection. There is alſo what is called *falſe reins*, which is a lath of leather, paſſed ſometimes through the arch of the banquet, to bend the horſe's neck.

REJOINDER, in law, is the defendant's anſwer to the plaintiff's replication or reply. Thus, in the court of chancery, the defendant puts in an anſwer to the plaintiff's bill, which is ſometimes alſo called an *exception*; the plaintiff's anſwer to that is called a *replication*, and the defendant's anſwer to that a *rejoinder*.

RELAND (Adrian), an eminent Orientaliſt, born at Ryp, in North Holland, in 1676. During three years ſtudy under Surenhuſius, he made an uncommon progreſs in the Hebrew, Syriac, Chaldee, and Arabic languages; and theſe languages were always his favourite ſtudy. In 1701, he was, by the recommendation of king William, appointed profeſſor of Oriental languages and eccleſiaſtical antiquities in the univerſity of Utrecht; and died of the ſmall-pox in 1718. He was diſtinguiſhed by his modeſty, humanity, and learning; and carried on a correſpondence with the moſt eminent ſcholars of his time. His principal works are, 1. An excellent deſcription of Paleſtine. 2. Five diſſertations on the Medals of the ancient Hebrews; and ſeveral other diſſertations on different ſubjects. 3. An Introduction to the Hebrew Grammar. 4. The Antiquities of the ancient Hebrews. 5. On the Mahometan Religion. Theſe works are all written in Latin.

RELATION, the mutual reſpect of two things, or what each is with regard to the other. See Metaphysics.

Relation, in geometry. See Ratio.

Relation, is alſo uſed for analogy. See Analogy, and Metaphysics.

RELATIVE, ſomething relating to or reſpecting another.

Relative, in muſic. See Mode.

Relative-*Terms*, in logic, are words which imply relation; ſuch are maſter and ſervant, huſband and wife, &c. In grammar, relative words are thoſe which anſwer to ſome other word foregoing, called the *antecedent*; ſuch are the relative pronouns *qui, quæ, quod*, &c. and in Engliſh, *who, whom, which*, &c. The word anſwering to theſe relatives is often underſtood, as "I know whom you mean," for "I know the perſon whom you mean."

RELAXATION, in medicine, the act of looſening or ſlackening; or the looſeneſs or ſlackneſs of the fibres, nerves, muſcles, &c.

RELAY, a ſupply of horſes, placed on the road, and appointed to be ready for a traveller to change, in order to make the greater expedition.

RELEASE, in law, is a diſcharge or conveyance of a man's right in lands or tenements, to another that hath ſome former eſtate in poſſeſſion. The words generally uſed therein are "remiſed, releaſed, and for ever quit-claimed." And theſe releaſes may enure, either, 1. By way of *enlarging an eſtate*, or *enlarger l'eſtate*: as, if there be tenant for life or years, remainder to another in fee, and he in remainder releaſes all his right to the particular tenant and his heirs, this gives him the eſtate in fee. But in this caſe the releſſee muſt be in *poſſeſſion* of ſome eſtate, for the releaſe to work upon; for, if there be leſſee for years, and, before he enters and is in poſſeſſion, the leſſor releaſes to him all his right in the reverſion, ſuch releaſe is void for want of poſſeſſion in the releſſee. 2. By way of *paſſing an eſtate*, or *mitter l'eſtate*: as, when one of two coparceners releaſeth all his right to the other, this paſſeth the fee-ſimple of the whole. And, in both theſe caſes, there muſt be a privity of eſtate between the releſſor and releſſee; that is, one of their eſtates muſt be ſo related to the other, as to make but one and the ſame eſtate in law. 3. By way of *paſſing a right*, or *mitter le droit*: as if a man be diſſeiſed, and releaſeth to his diſſeiſor all his right, hereby the diſſeiſor acquires a new right, which changes the quality of his eſtate, and renders that lawful which before was tortious. 4. By way of *extinguiſhment*: as, if my tenant for life makes a leaſe to A for life, remainder to B and his heirs, and I releaſe to A; this extinguiſhes my right to the reverſion, and ſhall enure to the advantage of B's remainder as well as of A's particular eſtate. 5. By way of *entry and feoffment*: as, if there be two joint diſſeiſors, and the diſſeiſee releaſes to one of them, he ſhall be ſole ſeiſed, and ſhall keep out his former companion; which is the ſame in effect as if the diſſeiſee had entered, and thereby put an end to the diſſeiſin, and afterwards had enfeoffed one of the diſſeiſors in fee. And hereupon we may obſerve, that when a man has in himſelf the poſſeſſion of lands, he muſt at the common law convey the freehold by feoffment and livery; which makes a notoriety in the country: but if a man has only a right or a future intereſt, he may convey that right or intereſt by a mere releaſe to him that is in poſſeſſion of the land: for the occupancy of the releſſee is a matter of ſufficient notoriety already.

RELICS, in the Romiſh church, the remains of the bodies or clothes of ſaints or martyrs, and the inſtruments by which they were put to death, devoutly preſerved, in honour to their memory; kiſſed, revered, and carried in proceſſion. The reſpect which was juſtly due to the martyrs and teachers of the Chriſtian faith, in a few ages increaſed almoſt to adoration; and at length adoration was really paid both to departed ſaints and to relics of holy men or holy things. The abuſes of the church of Rome, with reſpect to relics, are very flagrant and notorious. For, ſuch was the rage for them at one time, that, as F. Mabillon a Benedictine juſtly complains, the altars were loaded with ſuſpected relics; numerous ſpurious ones being everywhere offered to the piety and devotion of the faithful. He adds, too, that bones are often conſecrated, which, ſo far from belonging to ſaints, probably do not belong to Chriſtians. From the catacombs numerous relics have been taken, and yet it is not known who were the perſons interred therein. In the 11th century, relics were tried by fire, and thoſe which did not conſume were reckoned genuine, and the reſt not. Relics were, and ſtill are, preſerved on the altars whereon maſs is celebrated; a ſquare hole being made in the middle of the altar, big enough to receive the hand, and herein is the relic depoſited, being firſt wrapped in red ſilk, and encloſed in a leaden box.

The Romaniſts plead antiquity in behalf of relics: For the Manichees, out of hatred to the fleſh, which they conſidered as an evil principle, refuſed to honour the relics of ſaints; which is reckoned a kind of proof that the Catholics did it in the firſt ages.

We know, indeed, that the touching of linen cloths on relics, from an opinion of ſome extraordinary virtue derived therefrom, was as ancient as the firſt ages, there being a hole made in the coffins of the 40 martyrs at Conſtantinople expreſsly for this purpoſe. The honouring the relics of ſaints, on which the church of Rome afterwards founded her ſuperſtitious and lucrative uſe of them, as objects of devotion, as a kind of charms or amulets, and as inſtruments of pretended miracles, appears to have originated in a very ancient cuſtom that prevailed among Chriſtians, of aſſembling at the cemeteries or burying-places of the martyrs, for the purpoſe of commemorating them, and of performing divine worſhip. When the profeſſion of Chriſtianity obtained the protection of the civil government, under Conſtantine the Great, ſtately churches were erected over their ſepulchres, and their names and memories were treated with every poſſible token of affection and reſpect. This reverence, however, gradually exceeded all reaſonable bounds; and thoſe prayers and religious ſervices were thought to have a peculiar ſanctity and virtue, which were performed over their tombs. Hence the practice which afterwards obtained, of depoſiting relics of ſaints and martyrs under the altars in all churches. This practice was then thought of ſuch importance, that St. Ambroſe would not conſecrate a church becauſe it had no relics; and the council of Conſtantinople in Trullo ordained, that thoſe altars ſhould be demoliſhed under which there were found no relics. The rage of procuring relics for this and other purpoſes of a ſimilar nature became ſo exceſſive, that in 386 the emperor Theodoſius the Great was obliged to paſs a law, forbidding the people to dig up the bodies of the martyrs, and to traffic in their relics.

Such was the origin of that reſpect for ſacred relics, which afterwards was perverted into a formal worſhip of them, and became the occaſion of innumerable proceſſions, pilgrimages, and miracles, from which the church of Rome hath derived incredible advantage.—In the end of the ninth century, it was not ſufficient to reverence departed ſaints, and to confide in their interceſſions and ſuccours, to clothe them with an imaginary power of healing diſeaſes, working miracles, and delivering from all ſorts of calamities and dangers; their bones, their clothes, the apparel and furniture they had poſſeſſed during their lives, the very ground which they had touched, or in which their putrified carcaſes were laid, were treated with a ſtupid veneration, and ſuppoſed to retain the marvellous virtue of healing all diſorders both of body and mind, and of defending ſuch as poſſeſſed them againſt all the aſſaults and devices of the devil. The conſequence of all this was, that every one was eager to provide himſelf with theſe ſalutary remedies; conſequently great numbers undertook fatiguing and perilous voyages and ſubjected themſelves to all ſorts of hardſhips; while others made uſe of this deluſion to accumulate their riches, and to impoſe upon the miſerable multitude by the moſt impious and ſhocking inventions. As the demand for relics was prodigious and univerſal, the clergy employed the utmoſt dexterity to ſatisfy all demands, and were far from being nice in the methods they uſed for that end. The bodies of the ſaints were ſought by faſting and prayer, inſtituted by the prieſt in order to obtain a divine anſwer and an infallible direction, and this pretended direction never failed to accompliſh their deſires; the holy carcaſe was always found, and that always in conſequence, as they impiouſly gave out, of the ſuggeſtion and inſpiration of God himſelf. Each diſcovery of this kind was attended with exceſſive demonſtrations of joy, and animated the zeal of theſe devout ſeekers to enrich the church ſtill more and more with this new kind of treaſure. Many travelled with this view into the Eaſtern provinces, and frequented the places which Chriſt and his diſciples had honoured with their preſence, that, with the bones and other ſacred remains of the firſt heralds of the goſpel, they might comfort dejected minds, calm trembling conſciences, ſave ſinking ſtates, and defend their inhabitants from all ſorts of calamities. Nor did theſe pious travellers return home empty; the craft, dexterity, and knavery of the Greeks found a rich prey in the ſtupid credulity of the Latin relic-hunters, and made a profitable commerce of this new devotion. The latter paid conſiderable ſums for legs and arms, ſkulls and jaw-bones (ſeveral of which were pagan, and ſome not human), and other things that were ſuppoſed to have belonged to the primitive worthies of the Chriſtian church; and thus the Latin churches came to the poſſeſſion of thoſe celebrated relics of St. Mark, St. James, St. Bartholomew, Cyprian, Pantaleon, and others, which they ſhow at this day with ſo much oſtentation. But there were many who, unable to procure for themſelves theſe ſpiritual treaſures by voyages and prayers, had recourſe to violence and theft; for all ſorts of means, and all ſorts of attempts in a cauſe of this nature, were conſidered, when ſucceſsful, as pious and acceptable to the Supreme Being.—Beſides the arguments from antiquity to which the Papiſts refer, in vindication of their worſhip of relics, of which the reader may form ſome judgment from this article, Bellarmine appeals to Scripture in ſupport of it, and cites the following paſſages, viz. Exod. xiii. 19.; Deut. xxxiv. 6.; 2 Kings xiii. 21.; 2 Kings xxiii. 16, 17, 18.; Iſaiah xi. 10.; Matthew xi. 20, 21, 22.; Acts v. 12—15.; Acts xix. 11, 12. See Popery.

The Roman Catholics in Great Britain do not acknowledge any worſhip to be due to relics, but merely a high veneration and reſpect, by which means they think they honour God, who, they ſay, has often wrought very extraordinary miracles by them. But, however proper this veneration and reſpect may be, its abuſe has been ſo great and ſo general, as fully to warrant the rejection of them altogether.

Relics are forbidden to be uſed or brought into England by ſeveral ſtatutes: and juſtices of peace are empowered to ſearch houſes for popiſh books and relics, which, when found, are to be defaced and burnt, &c. 3 Jac. I. cap. 26.

RELICT, in law, the ſame with Widow.

RELIEF (*Relevamen*; but, in Domeſday, *Relevatio, Relevium*), ſignifies a certain ſum of money, which the tenant holding by knight's ſervice, grand ſerjeanty, or other tenure, (for which homage or legal ſervice is due), and being at full age at the death of his anceſtor, paid unto his lord at his entrance. See Primer. Though reliefs had their original while feods were only life eſtates, yet they continued after feods became hereditary; and were therefore looked upon, very juſtly, as one of the greateſt grievances of tenure: eſpecially when, at the firſt, they were merely arbitrary and at the will of the lord; ſo that, if he pleaſed to demand an exorbitant relief, it was in effect to diſinherit the heir. The Engliſh ill brooked this conſequence of their new-adopted policy; and therefore William the Conqueror by his laws *aſcertained* the relief, by directing (in imitation of the Daniſh heriots), that a certain quantity of arms, and habiliments of war, ſhould be paid by the earls, barons, and vavaſours reſpectively; and, if the latter had no arms, they ſhould pay 100s. William Rufus broke through this compoſition, and again demanded arbitrary uncertain reliefs, as due by the feodal laws; thereby in effect obliging every heir to new-purchaſe or *redeem* his land: but his brother Henry I. by the charter before mentioned, reſtored his father's law; and ordained, that the relief to be paid ſhould be according to the law ſo eſtabliſhed, and not an arbitrary redemption.—But afterwards, when, by an ordinance in 27 Hen. II. called the *aſſiſe of arms*, it was provided, that every man's armour ſhould deſcend to his heir, for defence of the realm, and it thereby became impracticable to pay theſe acknowledgements in arms according to the laws of the Conqueror, the compoſition was univerſally accepted of 100s for every knight's fee, as we find it ever after eſtabliſhed. But it muſt be remembered, that this relief was only then payable, if the heir at the death of his anceſtor had attained his full age of 21 years.

To RELIEVE *the* Guard, is to put freſh men upon guard, which is generally every 24 hours.

To Relieve *the Trenches*, is to relieve the guard of the trenches, by appointing thoſe for that duty who have been there before.

To Relieve *the Sentries*, is to put freſh men upon that duty from the guard, which is generally done every two hours, by a corporal who attends the relief, to ſee that the proper orders are delivered to the ſoldier who relieves.

RELIEVO, or Relief, in ſculpture, &c. is the projecture or ſtanding out of a figure which riſes prominent from the ground or plane on which it is formed; whether that figure be cut with the chiſel, moulded, or caſt. There are three kinds or degrees of relievo, viz. alto, baſſo, and demi-relievo. The alto-relievo, called alſo *haut-relief*, or *high-relievo*, is when the figure is formed after nature, and projects as much as the life. Baſſo-relievo, bas-relief, or low-relievo, is when the work is raiſed a little from the ground, as in medals, and the frontiſpieces of buildings; and particularly in the hiſtories, feſtoons, foliages, and other ornaments of friezes. Demi-relievo is when one half of the figure riſes from the plane. When, in a baſſo-relievo, there are parts that ſtand clear out, detached from the reſt, the work is called a *demi-baſſo*. In architecture, the relievo or projecture of the ornaments ought always to be proportioned to the magnitude of the building it adorns, and to the diſtance at which it is to be viewed.

Relievo, or *Relief*, in painting, is the degree of boldneſs with which the figures ſeem, at a due diſtance, to ſtand out from the ground of the painting. The relievo depends much upon the depth of the ſhadow, and the ſtrength of the light; or on the height of the different colours, bordering on one another; and particularly on the difference of the colour of the figure from that of the ground: thus, when the light is ſo diſpoſed as to make the neareſt parts of the figure advance, and is well diffuſed on the maſſes, yet inſenſibly diminiſhing, and terminating in a large ſpacious ſhadow, brought off inſenſibly, the relievo is ſaid to be bold, and the clair obſcure well underſtood.

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INDEX to the TREATISES

IN THE

EIGHTH VOLUME.

The Figures refer to the Page, Letter *a* to the Firſt Column of the Page, and *b* to the Second.

PHYSICS.

AGRICULTURE, and a rude medicine, were the firſt arts, 30 *b*
Ariſtotle, what he calls Nature is in our days called a God, 27 *a*
Axioms, two in phyſics, 34 *a*
Bacon's Novum Organum Scientiarum, 40 *b*
Body, why ſo called, 26 *b*
Boſcovich's definition of fluids, 35 *b*
Breath, what is meant by, 26 *a*
Britiſh philoſophers have been moſt ſucceſsful, 30 *a*
Buats, Chevalier, empirical rule of, 42 *a*
Coheſion, force of defined, 34 *b*
Corpuſcular force defined 35 *a*
Deſcription of the firſt huſbandmen, 31 *b*
———— of any thing, what is ſo called, 25 *a*
Diſtinctive nature of a thing, what, 25 *b*
Experimental philoſophy, defined, 40 *a*
Force, what is meant by Lord Monboddo by that expreſſion, 27 *b*
Franklin and Æpinus, are the moſt ſucceſsful authors on electricity, 36 *b*
Gallician ſchools, the, have as yet made but little impreſſions in Great Britain, 30 *a*
Gilbert, Dr. was the firſt who conſidered the magnetical phenomena, 36 *b*
Greeks, the, were good arithmeticians while geometry was in its infancy, 31 *b*
Gunpowder, defined, 36 *b*
Hales, Dr. has eſtabliſhed curious facts in animal and vegetable economy, 33 *b*
Hiſtorian, the, who is ignorant of natural philoſophy eaſily admits the miraculous, 42 *b*
Hydroſtatics, defined, 36 *a*
Immediate, the, exertion of the cauſe in chemiſtry is not perceived, 32 *a*
Inertia, what, 37 *b*
Inquiry, by experiment, a treatiſe on much wanted, 40 *b*
Intention, what is meant by, 25 *b*
Knowledge of nature, might have prevented many condemnations for ſorcery, 42 *b*
Laws of motion defined, 34 *a*
Magnetiſm, what, 36 *b*
Material ſyſtem, what is meant by, 29 *b*
Mathematics are eſſential to the ſtudy of philoſophy, 39 *b*
Mathematical reaſoning made uſe of by Dr. Friend, Keil, Boerhaave, Hartley, and others, 32 *b*
Mechanical philoſophy defined, 33 *b*
Mind and body, why ſo called, 27 *a*
—— and matter, the important difference between, 27 *b*
—— what is meant by that expreſſion, 26 *a*
Mirabeau and Diderot, deteſtable ſophiſms of, 43 *b*
Monades, of Leibnitz, what, 27 *a*
Monboddo, Lord, what he means by the word Force, 27 *b*
Natural hiſtory of the phyſical ſciences, what, 32 *a*
Nature of a thing, what, 25
Navigator, the, muſt have recourſe to aſtronomy, 42 *a*
Newton has enlarged our ſtock of knowledge by his explanation of the planetary motions, 33 *a*
Newton's definition of fluids, 35 *b*
———— myſteries of corporeal action illuſtrated by a figure, 38 *a*
Phenomenon, what is the meaning of
Phyſics, defined, 25 *a*, 30 *a*
——— ſee Philoſophy
Phyſician, a rude one deſcribed, 30 *b*
Pneumatics, defined, 36 *a*
Religion, teachers of ſciences neceſſary to, 43 *a*
Roemer's diſcovery that apparition was not inſtantaneous, 37 *a*
Schola Phyſica comprehended all the phenomena of the material world, 36 *b*
Summum bonum, what is meant by, 29 *a*
Supreme Mind, what is meant by, 28 *b*
Syſtem of nature, what may be properly ſo called, 25 *a*
Tartar nations, hanging is held in horror by the, 26 *b*
Taſte for the mathematical ſciences has declined in Great Britain, 39 *b*
Tendere verſus ſolem, the meaning of that phraſe, 39 *a*
Thinking and unthinking beings, claſſes of, 26 *a*

Thinks, wiſhes, and deſigns, that air or breath cannot be the ſubſtance which, 26 *b*
Univerſal gravitation, what, 34 *b*
Univerſe, what may be ſo called, 25 *a*
Vapour, what, 36 *a*
Wind, what, 36 *a*
Work of art, the world appears to be a, 28 *b*

PHYSIOGNOMY.

ANCIENTS, the, extended not the ſcience of phyſiognomy beyond man, 44 *a*
Ariſtotle's method of teaching phyſiognomy, 45 *a*
Boyle admits of the extenſive ſignification of phyſiognomy, 44 *a*
Cicero appears to have been particularly attached to this ſcience, 45 *b*
Deity, the perfection of, phyſiognomy ſhows the, 47 *b*
Egypt, the ſcience of phyſiognomy cultivated in, 44 *b*
Formey, M. attacks Lavater's work, 47 *a*
Gwyther, Dr. noticed phyſiognomy with approbation, 46 *a*
Hippocrates and Galen, many phyſiognomical obſervations occur in, 45 *b*
Lavater, M. has illuſtrated his remarks by engravings, 46 *b*
Lavater, M. his great work on phyſiognomy, 46 *a*
Parſons, Dr. wrote his Human Phyſiognomy Explained, 46 *a*
Pernetty, M. and M. Le Cat, a long controverſy between, 44 *b*
Phyſiognomy, defined, 44 *a*
——— ſee Signature
——— Polemon of Athens, Adamantius the ſophiſt, and ſeveral others wrote on the ſubject of, 45 *b*
Pythagoræan ſchool, were ſubjected to the phyſiognomy of their maſters, 45 *b*
Roman empire, this profeſſion was practiſed under the, 45 *b*
Salluſt, Suetonius, Seneca, Pliny, Plutarch, and others, many phyſiognomical remarks occur in, 45 *b*
Theophraſtus, wrote a treatiſe on phyſiognomy of manners, 45 *a*

PHYSIOLOGY.

ABSORPTION, 75 *a*
Animal magnetiſm, what, 51 *a*
——— electricity, what, 51 *a*
Animals ſubſiſt in their torpid ſtate by the re-abſorption of fat, 63 *a*
———, table of, 56
Aubenton, D', reaſons with clearneſs on Zoophytes, 59 *b*
Azot, that the animal organs can fix, 51 *a*
Azyr, D', a table of phyſiology by, 57
Bellini, of Florence, firſt introduced phyſiology, 49 *a*
Blood which is in continual motion has a circular courſe, 52 *b*
Bonnet ſuppoſes that in ſome world more perfect than ours, the rocks may be organized, &c. 60 *note*
Bonnet, M. called nerve by the name of marrow, 53 *a*
Borelli, was of opinion that ſome animals lived upon ſand, 71 *a*
——— profeſſor, wrote his work, De Motu Animalium, 49 *b*
Chaptal, M. is aſſured that fiſhes are ſenſible of the action of all gaſes, 65 *b*
——— M. ſuppoſed that ſoils act but as ſo many ſpunges, 69 *b*
——— h's elements of chemiſtry, a quotation from, 70 *b*
Chemiſtry now holds that place which was formerly poſſeſſed by geometry and mechanics, 50 *a*
Chyle, what, 73 *a*
Circulation, of the blood, 76 *b*. Hippocrates ſpeaks of the uſual and conſtant motion of the blood, *ibid*. Galen diſcovered that the arteries contained blood as well as the veins, *ibid*. Veſalius differs from Galen, 77 *a*. Cæſalpinus knew not the leſſer circulation, but had obſerved that there were times when the blood flowed from the branches of the veins towards their trunks, *ibid*. Hieronymus Fabricius, diſcovered that veins had their valves, in one of his diſſections, 77 *b*. Harvey, Dr. was the firſt who diſcovered the circulation of the blood, and taught it in 1616. His diſcovery ſhowed that in moſt animals the blood circulates in arteries and veins, and through the medium of one, or of more hearts, 78 *a*
Circulation, of living bodies, a table of, 58
Cœca, what, 73 *a*
Crawford, Dr. on the theory of animal heat, 66 *note*
Darwin, Dr. ſays caterpillars which feed on leaves are generally green, 83 *a*
Death, 92 *a*
Digeſtion, 69 *b*
——— of living bodies, a table of, 57
D'Azyr, table of, 93
Edgeworth, conſtructed an automaton which moved through a room which it inhabited, 84 *b*
Eggs, new, when covered with varniſh, or placed under the exhauſted receiver, are ſecured againſt corruption, 62 *b*
Fermentation, one of the cauſes of digeſtion, 74 *a*
Functions, or properties of living bodies, a table of, 57
Galen, diſcovered that the arteries contained blood as well as the veins, 76 *b*
Generation, 88 *b*
——— of living bodies, a table of, 59
Graaf, De, diſcoveries relative to generation, 89 *a*
Growth of plants, is conſiderably affected by the electrical ſtate of the atmoſphere, the, 51 *a*
Habit, 88 *b*
Haggeren, M. has diſcovered that electric light is cauſed by the pollen, which in flying off is ſcattered upon the petals, 84 *note*
Haller's phyſiology is profeſſedly that of the human body, 55 *a*
Harvey, Dr. diſcovered the circulation of the blood, 77 *b*
Heriſſant, M. makes experiments on toads, 62 *b*
Hippocrates, maintained that the whole animal economy was a a circle, 60 *a*
Hunter's, Mr. axiom that two proceſſes cannot go on at the ſame time, 74 *note*
Hunter and *Munro*, Drs. claim the merit of having found out the uſe of the lymphatics, 75 *note*

Hunter's, Mr. obſervations on digeſtion, a quotation from, 74 *note*
——— Mr. has diſcovered that the male and the female pigeon ſecrete in their ingluvies a certain liquor for feeding their young, 72 *b*
Integumation, 82 *b*
Irritability, 83 *b*
——— of living bodies, a table of, 59
Leeuwenhoek's diſcoveries relative to generation, 89 *a*
Logic, a pompous parade of mathematical learning is ſometimes introduced inſtead of, 49 *a*
Lower, Mr. demonſtrated that blood received a new and a brighter colour in paſſing through the lungs, 63 *b*
Lymphatics, the beſt mode of demonſtrated, we owe to the celebrated Nuck, 75 *b*
Matrimonial connections, hints to ſuch perſons as form, 87 *note*
Mechanical, what, 49 *a*
Motion, 86 *a*
Munro, Dr. his diſcovery relative to the brains of fiſhes, 85 *a*
Natural, what, 49 *a*
Nicholls, Dr. diſcovered the ſmall capillary branches of blood running through a part, 78 *b*
Nutrition, 79 *b*
——— of living bodies, a table of, 57
Oſſification of living bodies, a table of, 58
Pearſon, Dr. has artificially converted the muſcular fibre into a ſubſtance reſembling ſpermaceti, 81 *a*
Phyſiology defined, 48 *a*
——— makes the neareſt approach to metaphyſics, 48 *b*
Phyſiology, ſee Anatomy
Pitcairn wrote his phyſico-mathematical elements of medicine 50 *a*
——— wiſhed that medicine were eſtabliſhed on mechanical principles, 49 *b*
Plato had thought that geometrical forms were divine, 50 *a*
——— thought that God himſelf was always geometriſing, 49 *b*
Prieſtley, his diſcovery with reſpect to reſpiration, 52 *a*
Principium ſorbile, what, 64 *a*
Provender of life, the, what, 63 *b*
Reaumur concluded that digeſtion was performed by a ſolvent, 50 *a*
Regnier de Graat, invented the ſyringe in 1664, 78 *b*
Reſpiration of living bodies, a table of, 58
———, of, 61 *b*
Secretion of living bodies, a table of, 58
———, 80 *a*
Senſibility of living bodies, a table of, 59
Sleep, 91 *a*
Swammerdam diſcovered the valves of the lymphatic veſſels, 75 *b*
Table of the functions or properties of living bodies, 57
——— of D'Azyr, 93
——— of animals, 56
Transformation, 87 *b*
Vermicular or periſtaltic motion, what, 73 *b*
Zoology defined, 55 *b*

PNEUMATICS.

AIR-PUMPS, the firſt invented by Otto Guericke about the year 1654, 221 *b*. The ſame deſcribed, 229 *a*. Boyle's air-pump deſcribed, 230 *a*. Boyle's air-pump as finally improved by Hawkeſbee deſcribed, 230 *b*. Dr. Hooke's air-pump deſcribed, *ib*. Mr. Smeaton's air-pump, as it is uſually made by Nairne, deſcribed, 234 *a*. Smeaton introduced a method of joining together the different pipes and other pieces, 234 *b*. By a guage that was immerſed in mercury, Mr. Smeaton found that his pump rarefied a hundred thouſand times, 235 *a*. Profeſſor Ruſſel about the year 1770 conſtructed a pump, in which both cocks and valves were avoided, 236 *b*
Air, fixed ſee Lungs and Reſpiration
—— the elaſticity of the effects of, 201 *b*
—— is known to be about 840 times lighter than water, 260 *a*
—— the compreſſion of, the firſt experiments on were made by Mr. Boyle, in 1661, 246 *a*. The moſt copious experiments are thoſe by Sulzer, *ib*. Sir. George Shuckburgh's, and General Roy's experiments on, *ib*. Sulzer's tables of the compreſſion of air,. 246 *b*. Dr. Hooke examined the compreſſion of air by immerſing a bottle to great depths in the ſea, 247 *a*. Sir Iſaac Newton's propoſitions determining the mechanical conſtitution of the atmoſphere, 248 *b*
—— weight of the, 222 *a*. Deſcartes firſt entertained the opinion that the preſſure of air was different in different places, 223 *a*. The ſame experiment was repeated in England by Dr. Power, *ib*. Mr. Sinclair obſerved the barometer at Lanark, and the top of mount Tinlock in Clydſdale, and found the depreſſion conſiderable, 223 *b*. Hence we may derive a method of meaſuring mountains, *ib*.
—— weighed according to Ariſtotle, 219 *b*
—— a machine for rarefying the, 227 *a*
—— Amonton found that the column of mercury which it ſupported when at the temperature 50 was increaſed ⅓ of the temperature 212, 256 *b*
Atmoſphere, what, 219 *a*
Atmoſpherical logarithmic curve, 250 *a*
Auzout, experiment exhibited by, 222 *a*
———'*s* experiment, which eſtabliſhes and illuſtrates the whole doctrine of atmoſpheric preſſure, 243 *a*
Barometers, the beſt with an enlarged ſcale was invented by Dr. Hooke, in 1668, 259 *a*
———, what, 222 *a*
Bellows deſcribed, 285 *b*
Bernoulli's theorem of centripetal forces, 271 *b*
Blow-pipe deſcribed, 289 *b*
Boyle's, Mr. air-pump deſcribed, 230 *a*
Carteſian devils deſcribed, 244 *b*
Cavallo, Tiberius, has given the deſcription of an air-pump, contrived and executed by Meſſrs. Haas and Hurten of London, 237 *a*
Chimneys, the drawing of, 281 *b*
Clubs of gentlemen aſſociated in Oxford and London for the cultivation of knowledge by experiment in 1642, 221 *a*
Compreſſion of the air, what, 224 *b*
Curve, the atmoſpherical logarithmic one, 250 *a*
Cuthbertſon's air-pump deſcribed, 238 *b*
Denſity of air, the, is proportional to the compreſſing force, 249 *a*
Deſcartes, firſt entertained the thought that the preſſure of the air would be different in different places, 223 *a*
Diaphragm, what, 278 *a*
Elaſticity of the air, the effects of, 261 *b*
——————— what, 224 *b*
Elephant, how he drinks, 280 *b*
Euler's, Mr. experiments on gunnery, 270 *b*

Euler's velocity of aerial pulſes, 275 *a*
Experiments of Canton, Zimmerman and others ſhow that water, mercury, oil, &c. are alſo compreſſible and perfectly elaſtic, 264 *a*
———— of weighing air, made by M. de Luc, General Roy, Mr. Trembley, and Sir G. Shuckburgh, 248 *a*
Fanners, common, deſcribed, 290 *b*
Furnaces, reverberatory, 284 *a*
Galileo, ſeemed to have been the firſt who underſtood the weight of air, 220 *a*
Germany, air-pumps were firſt invented there, 241 *a*
Guericke, Otto, was the firſt who invented an air-pump, 228 *b*
————'s air-pump deſcribed, 229 *a*
Hales, Dr. his experiments to clear the air from the noxious vapour which he ſuppoſed to be emitted from the lungs, 277 *a*
Halley, Dr. his barometric meaſurement of heights, 253 *a*
Hartley's doctrines of animal ſpirits and nervous fluids, 271 *b*
Hawkeſbee's double barrel and gauge in air-pumps were capital improvements, 241 *a*
Hero's fountain deſcribed, 225 *a*
Herſchel, Dr. his obſervations on the planet Venus, 251 *b*
Hooke, Dr. his experiments to know the preciſe weight of the air from a dry veſſel, 241 *b*
———— his air-pump deſcribed, 230 *b*
———— the beſt barometers with an enlarged ſcale invented by, in the year 1668, 259 *a*
———— finiſhed for Mr. Boyle an air-pump in 1658, 221 *a*
Horſley, Dr. has pointed out that rare air expands leſs than what is denſer, 257 *a*
Hutton, Dr. has proved that clouds are always formed when two parcels of air of different temperature mix together, 266*a*
Impulſive force, what, 218 *a*
Inſpiration, the proceſs of, explained on pneumatical principles, 278 *b*
Land-breeze, what, 281 *a*
Lavoiſier, the vital air, or the oxygen of, 277 *a*
————, Mr. and thoſe who were in concert with him in the inveſtigation of the different ſpecies of gas, have contrived an air pump, 238 *a*
Lavoiſierian ſchool, the chemiſts of the, call fixed air by the name of carbonic acid, 277 *a*
Logarithmic curve, what, 272 *b*
Luc's method of meaſurement of great heights, 257 *b*
Lynd, Dr. was the firſt that propoſed the method of meaſuring the velocities of the wind, 266 *b*
Machine for compreſſing of air, 225 *b*
Machines, blaſt deſcribed, 288 *a*
Materialiſm, what, 272 *a*
Mechanical properties, what, 218 *a*
Mountains, a table of the height of the moſt remarkable on the earth above the ſurface of the ocean in feet, 258 *b*
Newton, Sir Iſaac demonſtrates that bodies vibrate according to the laws of motion of a pendulum vibrating in a cycloid, 273 *b*
Newton's Principia quoted to prove with what velocity air will ruſh into a void when impelled by its weight alone, 260 *a*.
Newton's, Sir Iſaac, experiment of conſidering the motions of bodies in a reſiſting medium, 269 *b*
Papin's erections in France and Germany for drawing mines, 263 *b*
Paſcal obſerved the preſſure of the atmoſphere in France was variable, 223 *a*
Pneumatics defined, 217
————, ſee Phyſics
————, ſee Smoke
————, ſee Weather
Pneumatic engines, 285 *b*
Power, Dr. entertained the opinion that the air was of different preſſure in different places, 223 *a*
Prieſtley, Dr. found that venous blood incloſed in thin bladders, and other membranes, was rendered florid by keeping the bladders in contact with abundance of pure vital air, 277 *b*
Pumps, how they were anciently made, 220 *a*
Rarefying the air, a machine for, 227 *a*
Reſiſtance of fluids, what, 267 *b*
Robins's experiments on gunnery, 269 *b*
———— compariſon of the reſiſtance of a wedge, *ib. a*
Rouſe's table of the velocity in feet, and the impulſe on a foot in pounds, *ib.*
Roy, Gen. experiments for aſcertaining the expanſion of mercury, publiſhed in the 67th vol. of the Philoſ. Tranſ. 253 *b*
————, tables for the expanſion of mercury, 254, 255
Scheele, what was called empyreal air by, 285 *a*
Sea-breeze, what, 281 *a*
Shuckburgh, Sir G. deduced 0,0024 from his experiments as the mean expanſion of air in the ordinary caſes, 256 *b*
————'s method of meaſurement of great heights, 257 *b*
————, Sir Geo. the moſt accurate account of the weight of air is by, in 67th vol. of the Philo. Tract. 219 *b*
Smeaton, has made an air-pump to ſhow the materiality of air in a very diſtinct manner, 241 *a*
————, John, has given a table of the velocities of the wind, 266 *b*
————'s air-pump as it is uſually made by Nairne, deſcribed, 234 *a*
Stove, the form of a, deſcribed, 282 *b*
Syphon deſcribed, 243 *a*
Syringe, exhauſting, deſcribed, 228 *a*
Table of the height of moſt remarkable mountains on the earth above the ſurface of the ocean in feet, 258 *b*
—— of the velocities of the wind, a, 266 *b*
Theory of the reſiſtance and impulſe of the air, 268 *b*
Torricelli tries an experiment with a tube of mercury, 220 *b*
Torricellian tube, what, 221 *b*
Twilight, what, 249 *a*
Velocity, with what, air will ruſh into a void when impelled by its weight alone, 259 *b*
Weather-glaſs, what, 223
Wells ebbing and flowings of, deſcribed, 285 *a*
Wirtemberg Syphon, what, 243 *a*

POETRY.

ACCENT, what, 348 *b*
Achilles, people form their judgment from an imperfect ſketch given of him by Horace in his Art of Poetry, 302 *a*
Acute accent, what, 350 *a*
Addiſon, Mr. has written an epiſtle to lord Halifax, which contains the deſcription of the places about Rome, 339 *a*
Allegory, what, 341 *a*
Allegorical poetry, of, 340 *a*
Apollo was attended by the Graces, 293 *a*
—— became the god of poetry, *ib.*
Apoſtrophe, what, 313 *b*
Æſop is an example of the writers on fable, 342 *a*

Argument, 333 *b*
Ariſtotle's four propoſitions relate ſolely to tragedies, 321 *a*
Ariſtotle from the nature of fable divides tragedy into ſimple and complex, 319 *a*
——— ſays the hiſtorian exhibits things as they are, and the poet as they might be, 29 *b*
Armſtrong, Dr. has written in the Didactic manner in his Art of preſerving Health, 338 *b*
Arrangements, Unity, and Digreſſions, of, 304 *a*
Atterbury's, Dr. epigrams, 344 *b*
Baker, Mr. has written *The Univerſe* in the Didactic manner, 337 *b*
Beattie, Dr. maintains that the ultimate end of poetry is to pleaſe, 294 *a*
Beauties of nature ſhould be cheriſhed in young perſons, 295 *a*
Blair, Dr. ſays the epic poem is univerſally allowed to be the moſt dignified, 319 *b*
Characters, poetical, of, 302 *a*
Cicero's aim of rhetorical declamation was apparent truth, 314 *b*
Comedy, what, 322 *b*
Dacier, Madame, ſuppoſes that Priam had loſt his authority and was obliged to fall in with the politics of the times, 302 *b*
Deſcriptive poetry, of, 340 *a*
Didactic or preceptive poetry, of, 337 *a*
Drama and the Epopee, reſpective peculiarities of the, 323 *a*
Dramatic and epic compoſitions, 318 *a*
Dryden's ode on the death of Mrs. Killigrew a poem of the beſt kind, according to Dr. Johnſon, in our language, 335 *a*
Elegy, what, 335 *b*
—— of the, *ib.*
Engliſh heroic verſe, what, 349 *a*
——— poetical dialect, the. is not characteriſed by any peculiarities of inflection, 307 *b*
Epiſtle, of the, 339 *a*
Epic and dramatic compoſitions, 318 *a*
—— poem, ſays Dr. Blair, is univerſally allowed to be the moſt dignified, 319 *b*
Epigram, what, 344 *a*
———, of the, *ib.*
Epopee and the drama, reſpective peculiaries of the, 323 *n*
Epitaph, of the, 345 *a*
Eſſence and end of poetry, of the, 294 *a*
Fable, of, 341 *b*
Fell aſleep, a Scripture phraſe, 311 *a*
Figures and tropes promote ſtrength of expreſſion, *ib.*
——— and tropes, of, 309 *a*
Figurative expreſſion, the importance of, *ib.*
Harmony, what, 354 *b*
———, poetical, of 315 *a*
Hexameter lines in Latin and Greek poetry, what, 347 *a*
Hobbes's tranſlation of Homer, 310 *a*
Homer excels for rich invention and exact judgment, 302 *b*
Horace is an example of the jocoſe kind of ſatire, 343 *a*
——— mentioned Lucilius with eſteem, *ib.*
——— and Pindar are both examples of the lyric poetry, 331 *b*
——— declared the end of poetry to be two-fold, to pleaſe or to inſtruct, 294 *a*
Horace's maxim to be univerſal in poetry "non ſatis eſt, pulchra eſſe poemata, dulcia ſunto," 298 *b*
Hymns, what, 332 *b*
Hyperbole and protopopœia are among the moſt paſſionate figures, 3 *a*
Iliad and Odyſſey begin about ſix weeks before their concluſion, 304 *a*
Johnſon's obſervation in his Life of Milton, 303 *b*
Invention, of the ſtandard of poetical, 294 *b*
Italy, the people believed there that the poet Dante went down to hell, 296 *note*
Jonſon's, Ben, epitaphs, 345 *b*
Juvenal is an example of the ſerious kind of ſatire, 343 *a*
Language, of poetical, 306 *a*
——— of Homer differs materially from what was written and ſpoken in Greece in the days of Socrates, 306 *b*
Lares and Penates, little deities, 313 *a*
Longinus has preſerved a fragment of Sappho, 332 *a*
Lucian's True Hiſtory is a heap of extravagances put together without unity, 297 *a*
Lucilius, Horace has imitated him with eſteem, 313 *a*
Lucretius is the moſt conſiderable among the ancients who has written in the Didactic manner, 337 *b*
Lyric poetry, of, 331 *a*
Mars was a hair-brained ruffian, 301 *b*
Meaſure, in poetry, what, 349 *b*
Metaphor, ſimilitude, and allegory, what, 314 *b*
Milton has been cenſured for the impiety which ſometimes breaks from Satan's mouth, 303 *b*
——— ſays of the Deity, that he ſits "high-throned above all height," 312 *a*
Moral, what, 319 *a*
Moſes and Miriam the firſt authors that ſung on the borders of the Red Sea a ſong of divine praiſe, 293 *a*
Motions in poetry, what, 317 *b*
Ode pindaric, what, 333 *a*
Opera, of the, 350 *a*
———, ſee Muſic
Paradiſe Loſt, the action of commences not many days before Adam and Eve are expelled from the garden of Eden which is the concluding event, 304 *b*
Paſtoral, of the, 335 *b*
Pathetic, what, 319 *a*
Pauſes, what, 353 *a*
Penates and Lares little deities, 313 *a*
Perſonification, what, 312 *b*
Pindar and Horace are both examples of the lyric poetry, 331 *b*
Pindaric ode, an example of, 334
——— ode, what, 333 *a*
Play analyſed is a chain of connected facts of which each ſcene makes a link, a, 326 *b*
Poetry, of lyric, 331 *a*
———, of the different ſpecies of, part the ſecond, 318 *a*
———, deſcriptive, of, 340 *a*
———, allegorical, of, 340 *a*
——— defined, 293 *b*
———, further remarks on the nature of, 304 *a*
Poetic compoſition of a picture, what, 294 *a*
Poetical language, of, 306 *a*
——— words, of, 306 *b*
——— harmony, of, 315 *a*
——— characters, of, 302 *a*
Pope's. Mr. epigrams, 344 *b*
Prior's, Mr. epigrams, 344 *b*
Protopopœia and Hyperbole are among the moſt paſſionate figures, 312 *a*
Rhyme, what, 316 *a*
Runnia, the firſt inhabitants of which had their poetry, 293 *a*
Satan, in Paradiſe Loſt, is a character drawn and ſupported with the moſt conſummate judgment, 301 *b*
Sappho, Longinus has preſerved a fragment of, 332 *a*
Satire, of, 343 *a*
Savages and illiterate perſons have but few expreſſions, 309 *b*

Scheme, of poetic feet, a, 351 *note.*
Sound of poetical language, of the, 315 *a*
Strophe, what, 333 *a*
Syſtem of nature exhibited by poetry, of the, 297 *b*
Tacitus mentions the verſes of the Germans, 293 *a*
Taſſo's infernal tyrant was an ugly and overgrown monſter, 301 *b*
Terence, it is hard to ſay upon what model he has formed his plays, 329 *b*
Theology of the ancient poets, 296 *a*
Three Unities, the, 326 *a*
Tragedy, what, 322 *b*
Tranſformation of nouns into verbs and participles, the, 308 *a*
Trochee, what, 352 *a*
Tropes and figures are favourable to delicacy, 310 *a*
Tropes and figures promote brevity, 310 *b*
————————, of, 309 *a*
Unities, the three, 326 *a*
Verſe is not eſſential to poetry, 315 *b*
Verſes were invented in the firſt ages of the world, merely to aid the memory, 294 *b*
Verſification or regular meaſure, 315 *b*
Verſification, part the third, of poetry, 346
Virgil's Georgic is a noble ſpecimen of paſtoral poetry, 298 *b*
Virgil has written in the Didactic manner in his Georgic, 338 *a*
Words, of poetical, 306 *b*
Words, liſt of, the which are now almoſt peculiar to poetry, 307 *b*

POLYTHEISM.

AMMONITES called the ſun Moloch, 395 *b*
Anthropomorphites, what, 391 *b*
Brahme is the only ſelf-exiſtent divinity acknowledged by the philoſophical Hindoos, 401 *a*
Brute worſhip was not peculiar to Egypt, it was known among the Hindoos, 399 *a*
Brutes, reptiles, and vegetables, were worſhipped among the Egyptians, 397 *b*
Chaldæa, the idolatrous worſhip of the hoſt of heaven ſpread over the eaſt from, 392 *b*
Chryſor, invented many things uſeful to civil life, 394 *b*
Dæmonology, the origin of, 304 *a*
Deity, a ſenſe of, a difficult thing, 391 *a*
Diodorus relates that Sol firſt reigned in Egypt, 395 *b*
Egypt, Typhon was worſhipped there, 398 *a*
Egyptians, among the, brutes, reptiles and vegetables were worſhipped, 397 *b*
Friga was worſhipped among the Saxons, 397 *a*
Ganeſa, the, of the Hindoos has been proved to be the Janus of the Greeks and Romans, 396 *b*
Geneſis, the author of believes that all men have deſcended from the ſame progenitors, 391 *a*
Greeks, the, called ſpirits ſuperior to the ſoul of man, *dæmons*, and the Romans, *genii*, 393 *b*
Groves, why mentioned by the Hebrew lawgiver, 393 *b*
Herodotus, according to, every woman among the Babylonians was obliged once in her life to proſtitute herſelf to the goddeſs Venus.
———— ſays that the Perſians worſhipped the ſun, moon, and earth, 393 *a*
Hero-worſhip was ſuperinduced upon the planetary, 395 *b*
Heſiod, according to, Chaos and Tartarus were the greateſt and only ſelf exiſting gods, 399 *b*
Idol of the Moon, was worſhipped among the Saxons, the, 397 *a*
Iſis, the Moon was ſo called among the ancient Egyptians, 395 *b*
Jove was the ancient name of moſt kings before the Trojan wars 3 6 *a*
Jupiter, Apollo, and Mars, are deſcribed by the poets as the raviſhers of women, 396 *a*
Kames, Lord, ſays that it was always univerſally admitted as true, that there exiſt beings above the human race, 390 *a*
—————. objections to his hypotheſis concerning *a ſenſe of Deity* 390 *b*
Lycopolis, there was a town in Upper Egypt ſo called, becauſe the inhabitants worſhipped the wolf, 398 *a*
Magi, Perſian, objects of worſhip of the, 392 *a*
Moral ſenſe, what, 390 *b*
Moſes cautions the people of Iſrael againſt Tſaba heſemim, 392 *b*
Origin of brute-worſhip in Egypt, the, 398 *b*
Ormuzd, the name of a Perſian god, 391 *b*
Oſiris, the Sun was ſo called among the ancient Egyptians, 395 *b*
Perſian god, called Yazdan, 391 *b*
Philoſophers of Athens and Rome, polytheiſm was in contempt among, 396 *a*
Plutarch is commonly ſuppoſed to have believed in two ſelf-exiſtent principles, a good and an evil, 400 *note*
Polytheiſm defined, 390 *a*
————, ſee Religion,
———— was in contempt among the philoſophers of Athens and Rome, 396 *a*
————, ſee Inſtinct
Sabians, a ſect of eaſtern idolaters, 392 *b*
Sanchoniathon informs us that the two firſt mortals were Æon and Protogonus, 393 *a*
Saturn, the, of Greece and Rome, appears to have been the ſame perſonage with the Menu of Hindoſtan, 396 *b*
Saxons, among the, the Idol of the Sun was placed in a temple and adored, 396 *b*
Seater, or Crodo, a Saxon god. 397 *a*
Sun, moon, and ſtars, were worſhipped by ſavages, 392 *b*
—— the, was called Oſiris among the ancient Egyptians, 395 *a*
—— the, was called by the Ammonites Moloch, 395 *b*
Thor was worſhipped among the Saxons, 397 *a*
Tſaba heſemim, againſt which Moſes cautions the people of Iſrael, 392 *b*
Typhon was worſhipped in Egypt, 398 *a*
Woden was worſhipped among the Saxons, 397 *a*
Yazdan, the name of a Perſian god, 391 *b*

PROJECTILES.

AMPLITUDE of the range, what, 533 *a*
Angle of elevation, the, what, 533 *a*
——- of poſition, the, what, 533 *a*
Balls uſed in military ſervice are of caſt iron or of lead, whoſe ſpecific gravities are 7,207 and 11,37, 538 *a*
Bernoulli's, Mr. John, experiments on gunnery, 537 *a*

Bombardier, the, in throwing ſhells is directed entirely by trial, 532 *b*
Curve, the logarithmic, what, 540 *b*
Elevation, the angle of, what, 533 *a*
Galileo was the firſt who applied mathematical knowledge to the motion of free bodies, 528 *a*
Gunnery, the theory of, 533 *a*
Herman's experiments of gunnery, 544 *b*
Hutton's, Dr. experiments upon gunnery at Woolwich, 552 *b*
Impetus, what, 533 *a*
Keill, Dr. had engaged in an altercation with John Bernoulli, upon the ſubject of gunnery. 546 *b*
Leibnitz and Newton a curious literary anecdote between, 529 *b*
Muller's, Mr. experiments on gunnery, 539 *a*
Newton and Leibnitz a curious literary anecdote between 529 *b*
——— was the firſt who obſerved that there was a limit to the velocity which gravity could communicate to a body, 543 *b*
———'s Principia recommended to the readers upon Projectiles, 528 *b*
Parabolic theory corrected, the, 534 *a*
Paul's, St. Cathedral, experiments were made by dropping balls from, 537 *a*
Pendulums, ſee Reſiſtance of Fluids.
Phyſical diſcuſſion, it is prudent to confront every theoretical concluſion by experiment, in, 536 *b*
Perpendicular aſcents and deſcents of heavy bodies through the air, the doctrine of, 541, 546 *a*
Poſition, the angle of, what, 533 *a*
Producing height, what, 530 *a*
Projectiles defined, 528 *a*
———, ſee mechanics and gunnery.
Robins, Mr. found that a muſket-ball diſcharged with the uſual allotment of powder had the velocity of 1700 feet in a ſecond, 533 *b*
———'s Mr. experiments upon gunnery, 537 *b*
Rouſe, Mr. meaſured the reſiſtance by the effect of the wind on a plane properly expoſed to it, 537 *b*
Table for the uſual ſizes of cannon ſhot computed both by the Newtonian theory of reſiſtance, and by the reſiſtances obſerved in Robins's experiments, 538 *b*
——— of elevations, giving the greateſt range, 552 *a*
Terminal velocity by gravity, what, 534 *b*
Theory of the air's reſiſtance can be of little ſervice to the artilleriſt, unleſs the force of gunpowder were uniform, 553 *a*
———, the parabolic, corrected, 534 *a*
———, the parabolic, is very unfit for directing the practice of the artilleriſt, 533 *b*
——— of gunnery compared with experiment, 533 *a*
——— of gunnery, 533 *a*
——— of the motion of projectiles in vacuo, the, 531 *b*
Treatiſes which have been written on gunnery, ſerve for young mathematicians to amuſe themſelves with, 534 *a*
Velocity, to determine in the different points of the trajectory, and the time of deſcribing its ſeveral portions, 548 *b*
——— produced, what, 530 *a*

PROJECTION OF THE SPHERE.

CIRCLE, every, on the ſphere, which does not paſs through the projecting point, is projected into a circle, Prop. 2d Theorem 2d, 555 *b*
Corollaries of the 2d propoſition, 555 *b*
——— to propoſition the 2d, theorem 2d, 556 *b*
Dialling, this method of, projection has been applied to, 565 *a*
Draw, to, a leſs circle perpendicular to the plane of projection, 563 *b*
Find the pole of a given projected circle, to, 564 *a*
Gnomonic projection of the ſphere, of the, 561 *b*
Line of meaſure, the, what, 555 *a*
Meaſure any portion of a projected circle and converſely, to, 561 *a*
Orthographic projection of the ſphere, of the, 559 *a*
Plane of projection, what, 555 *a*
Points, through two given, in the plane of the primitive to deſcribe the projection of a great circle, 560 *b*
Pole of projection, what, 555 *a*
Poles of a given projected circle, to find the, 561 *a*
Projection of the ſphere, defined, 555 *a*
——— of the ſphere, of the gnomonic kind, 561 *b*
——— is that of a leſs circle parallel to the primitive, when the, 561 *b*
——— of the ſphere, ſee Geography, Navigation, and Perſpective.
Scholium, upon the 20th propoſition, 559 *a*
Stereographic projection of the ſphere, of the, 555 *a*
When the given projection is of a leſs circle inclined to the primitive, 561 *b*

PYROTECHNY.

AMBER lights, 642 *b*
Aquatic fire-works, 665 *a*
Balloon caſes, or paper ſhells, 645 *a*
——— fuzes, to make, 649 *b*
——— wheels, 656 *b*
Benjamin, 640 *b*
Blue flame, 643 *a*
Boring rockets which have been driven ſolid, 647 *b*
Brimſtone or ſulphur, 640 *b*
Caduceous rockets, 651 *a*
Camphor, 640 *b*
Caſcades of Fire, 657 *a*
Caſes for illumination portfires, 645 *b*
Chandelier illuminated, 658 *b*
Charcoal, 640 *b*
Chineſe flyers, 655 *b*
——— fire, 642 *b*
——— fountains, 657 *a*
Colours produced by the different compoſitions, 643 *a*
Compoſitions and ingredients of, 640 *a*
Cone wheel illuminated double, 661 *b*
Cones or ſpiral wheels, 642 *b*
Cotton, quick-match, 643 *b*
Crackers, 645 *b*
Decorations different for line rockets, 655 *a*
——— for ſky-rockets, 647 *a*

Dodecaedron, 657 *b*
Double ſpiral wheel, 656 *b*
Drive or ram ſky-rockets, to, 646 *a*
Drove ſtars, 653 *a*
Earthquake, to make an artificial, 643 *a*
Figure-piece illuminated with five pointed ſtars, a, 664 *b*
Fire ſky-rockets without ſticks, to, 652 *b*
—— ſky-rockets under water, to, 666 *b*
—— globes for the water, 665 *b*
Firing, order of, 663 *a*
Fire-globes, 662 *a*
—— pumps, 661 *b*
—— pumps, 642 *b*
—— a brilliant, 642 *a*
—— common, a, 642 *b*
—— tree, the, 657 *a*
Fix one rocket on the top of another, to, 651 *a*
Flaming ſtars with brilliant wheels, 659 *a*
Fountain of ſky rockets, 663 *a*
Fruiloni wheels, 656 *b*
Gerbes, 642 *b*
Gerbes large, to make, 648 *a*
Gerbes ſmall, or white fountains, 648 *b*
Girandole cheſts for flights of rockets, 654 *a*
Globes illuminated with horizontal wheels, 657 *b*
Gunpowder, 640 *b*
—— brimſtone, and charcoal, to meal, 641 *a*
Honorary rockets, 651 *b*
Horizontal wheels, 656 *a*
—— wheel change to a vertical wheel with a ſun in front, to make an, 660 *b*
—— wheels for the water, 665 *a*
Illuminated ſpiral wheel, 656 *b*
—— regulating piece, 664 *b*
Ingredients and compoſitions, of, 640 *a*
Iron for gerbes, white fountains, and Chineſe fire, to prepare, 641 *b*
Leaders, or pipes of communication, 654 *a*
Line rockets, 655 *a*
Load air-balloons with the number of ſtars, ſerpents, ſnakes, &c. to, 648 *b*
Making, loading, and firing of pots des brins, 650 *b*
Marron batteries, 655 *a*
Marrons, 654 *b*
Mine ports, or ſerpents, 642 *b*
Mixing compoſitions, of, 645 *b*
Moon and ſeven ſtars, 661 *a*
Mortars to throw aigrettes, &c. 648 *b*
—— to throw aigrettes, and to load and fire them, to make, 6[illegible]0 *a*
Moulds for wheel-caſes or ſerpents, 644 *b*
—— caſes, mixture inſtruments, &c. of, 644 *a*
Neptune in his chariot, to repreſent, 667 *a*
Odoriferous water-balloons, 666 *a*
Order of firing, 663 *a*
Palm tree, 663 *b*
Paſteboard and paper mortars, to make, 648 *b*
Pin wheels, 662 *a*
Placing fire-works to be exhibited, 662 *b*
Plural wheels, 656 *b*
Port-fires, 642 *b*
Pots des Sauciſſons, 650 *b*
Preſerve ſteel or iron filings, to, 646 *a*
Projected regulated piece of nine mutations, 659 *a*
Proportion of mallets, 646 *b*
Pyrotechny defined, 640 *a*
Rains, 642 *a*
Rain-falls and ſtars for ſky-rockets, 652 *b*
Red fire, a, 642 *b*
Rocket ſtars, for, 641 *b*
Rockets, different kinds of, with their appendages and combinations, 651 *a*
Roll rockets and other caſes, to, 644 *b*
Rolling ſtars, 653 *b*
Roſe piece and ſun, 663 *b*
Royal balloons of ſerpents, 649 *a*
Saltpetre, 640 *a*
Scrolls for ſky-rockets, 653 *b*
Sea-fight with ſmall ſhips, a, 666 *a*
Signal ſky-rockets, 652 *a*
Single vertical wheels, 655 *b*
Spiral wheels, 656 *a*
Sky-rockets, charges for, 641 *b*
—— rocket, to divide the tail of the, as to form an arch, 651 *b*
—— rockets to fix two or more on one ſtick, 652 *a*
Spur fire, 641 *a*
Stands for ſky-rockets, 653 *b*
Star-wheel illuminated, the, 664 *b*
—— of different colours, compoſition for, 643 *a*
—— with points for regulated pieces, &c. 658 *a*
Sulphur or brimſtone, 640 *b*
Sun caſes, 642 *a*
—— fixed with a tranſparent face, 658 *a*
Swans and ducks in water, 66[illegible] *a*
Swarmers or ſmall rockets, 653 *b*
Table rockets, 655 *b*
—— of the dimenſions and poiſe of rocket ſticks, 647 *a*
—— of dimenſions for rocket moulds, 644 *a*
Tailed ſtars, 653 *a*
Thread and join leaders and place them on different works, to 662 *b*
Touch paper for capping of ſerpents, crackers, &c. 643 *b*
Tourbillon caſes, to make, 645 *a*
Tourbillons, 642 *b*
—— 650 *a*
Tranſparent ſtars with illuminated rays, 664 *a*
Vertical ſcroll wheel, 661 *b*
Volute, grand illuminated, with a projected wheel in front, 661 *a*
Water balloons, 642 *b*
—— ſquibs, 666 *a*
—— fire fountains, 667 *b*
—— balloons, 666 *a*
—— rockets, 665 *a*
—— mines, 665 *b*
—— rockets, 642 *a*
—— ſquibs, 642 *b*
Wheels and other works, of, 655 *b*
——, of, 642 *a*
—— and other works in combuſtibles, to make, 641 *b*
Yew-tree of brilliant fire, the 658 *a*

END OF THE EIGHTH VOLUME.

Printed by DAVIS, WILKS, and TAYLOR, Chancery-lane.